Meddelelser om Grønland

Illustrated Moss Flora of Arctic North America and Greenland.
1. Polytrichaceae

Gert S. Mogensen (Ed.)

Bioscience
17 · 1985

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Editor – Botany
Gert Steen Mogensen, Botanical Museum, Gothersgade 130, DK-1123 Copenhagen K. Telephone +45.1.111744.

Editor – Zoology
G. Høpner Petersen, Zoological Museum, Universitetsparken 15, DK-2100 Copenhagen Ø. Telephone +45.1.354111.

Instructions to authors. – See page 3 of cover.

Illustrated Moss Flora of Arctic North America and Greenland. 1. Polytrichaceae

Editor

Gert S. Mogensen

MEDDELELSER OM GRØNLAND, BIOSCIENCE 17 · 1985

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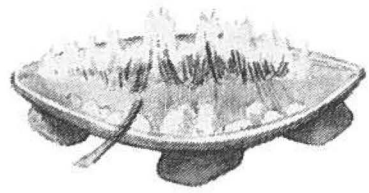


This first fascicle of Illustrated Moss Flora of Arctic North America and Greenland is dedicated to *William C. Steere,* New York Botanical Garden, and to the late *Kjeld A. Holmen,* Botanical Museum, University of Copenhagen.

Editor's acknowledgements

I wish to thank all the colleagues who have made this project possible by making their knowledge and expertise available to the IMFANAG, and also to thank each of my previous co-editors for the enthusiasm and valuable efforts they have given the project.

This project might never had come into existence without the efforts of William C. Steere. At the time of his resignation from the project in 1982, he and I had already raised the basic funding needed, and much of the work was well under way. During his period of co-editorship, William C. Steere generously contributed much wisdom and advice, and I thank him for his good help and guidance.

I owe sincere thanks to Lewis E. Anderson, Duke University, Durham, to Howard Crum, University of Michigan, Ann Arbor, and to Rolf Dahlgren and Bertel Hansen, both Botanical Museum, University of Copenhagen, for support and advice during the initial period of the project.

I wish to thank Thomas Bernth, who wrote all the programs needed for my data processor as well as most of the different versions of the base map that were produced. Guy R. Brassard, Memorial University of Newfoundland, also helped in preparing an initial version of the final map.

In addition to those already mentioned I owe sincere thanks to Linda Ley, the Natural Museum of Canada, Ottawa and to Elise Alster, Janne Holdgård, Kjeld Jørgensen, Grethe Nielsen, Bente Wennerwald, and Peter Wind, the Botanical Museum, University of Copenhagen; they have all helped me in a variety of ways beyond their formal duties.

A part of this project consists of operational routines and general procedures which are more time-consuming than envisaged when the project was initiated. Some of this work I have done as part of my duties. However, a major part, particularly in illustrating microscopical details of plants, and during the difficult period when routines were to be developed, was carried out at home during spare hours with my family. Over the years, I have never felt fading enthusiasm for this project from my family, Elisabeth, Nis and Rie, no matter how much of my time (and mind) it occupied. For this I want to thank all three of them most sincerely.

Thanks are due also to curators in the following herbaria for arranging loans of specimens or allowing access to collections: ALA, ALTA, B, BM, C, CANM, E, FH, G, H, ICEL, M, MICH, NFLD, NY, S, TRH, UBC, UPS.

Financial support is acknowledged from the following sources: National Science Foundation (to New York Botanical Garden, W. C. Steere), Carlsbergfondet (to G. S. Mogensen, 1979-), The Danish Natural Science Research Council (to G. S. Mogensen: 511-6663, 511-8653, 511-15683, 511-20373, 11-3403, 81-3169, 11-4024, 11-4761, 11-5278). The Commission for Scientific Research in Greenland is acknowledged sincerely for generosity and flexibility during publication of this series.

Botanical Museum, Copenhagen,
September 6th., 1985.

Gert Steen Mogensen

Editor's foreword

The Illustrated Moss Flora of Arctic North America and Greenland (IMFANAG) treats all mosses present north of the tree-line in Alaska and Canada, and in the whole of Greenland. The need for an up-to-date flora dealing with the approx. 500 species of mosses present in this area has been apparent for many years. Biologists working in applied sciences such as environmental studies, in wild-life and fresh-water fisheries, in general ecology, *etc.*, are all too familiar with the abundance of mosses in the arctic ecosystems and the difficulties in having them identified. In fact, most workers seem to have given up. This is most unfortunate because many moss species show a more precise response to small differences in the environment than do most flowering plants. Thus, a better understanding of the mosses could contribute much information of general value.

In publishing this new moss flora the foremost hope is that a group wider than the relatively few bryologists will find it possible and worthwhile to identify mosses. Further hopes are that IMFANAG will serve as a platform for taxonomy and bryogeography, and facilitate and stimulate future research in the Arctic.

The project

The Illustrated Moss Flora of Arctic North America and Greenland is a result of mutual efforts of bryologists in several - at present eight - countries. Treatments of genera, families and orders will be published largely in the sequence they are accomplished rather than in taxonomic order (Table 1). It is planned to re-publish all families in taxonomic order once the work is complete.

This project was originally conceived by William C. Steere, President Emeritus, the New York Botanical Garden, and Kjeld A. Holmen, the Botanical Museum, University of Copenhagen. After the sudden death of Kjeld A. Holmen, the project was re-started in 1976-78 by William C. Steere and the editor.

Several co-editors have greatly facilitated the work on IMFANAG during the years, viz. William C. Steere, the New York Botanical Garden, Robert R. Ireland, the Museum of Natural Sciences, National Museum of Canada, Ottawa, Barbara M. Murray, the Museum, University of Alaska Fairbanks, Fairbanks and Guy R. Brassard, Memorial University of Newfoundland, St. John's (the latter two from 1982 to 1985). In 1985 it was decided that the present editor should continue alone.

A general introduction to IMFANAG will appear in Volume 1 and inform in details about it's outlines. However, a number of treatments of families will be published prior to the introductory volume and therefore it seems appropriate here to give a brief comment about maps and illustrations.

The maps

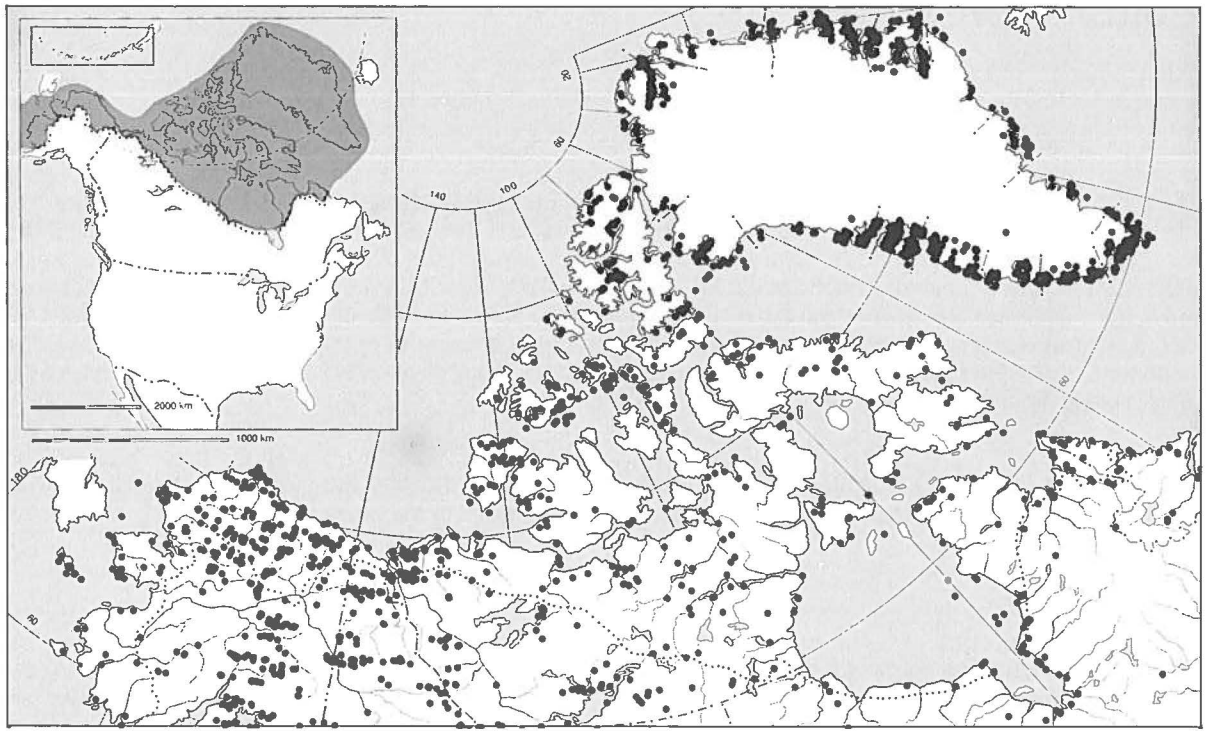
Knowledge of the geographic distribution of species is important in a wide spectrum of research fields. For this reason maps are provided for many species.

Each map consists of a dot map plus an insert map (Map 1). The dot map shows the distribution of a taxon within the area, as reflected by localities from which specimens have been seen by the respective authors; symbols indicate whether a taxon at a given locality is known in the gametophytic (○) or sporophytic (●) condition.

The insert map shows the approximate distribution in North America and Greenland, as assumed from literature reports and from knowledge of the respective authors at the time of completing the manuscripts.

In addition to the national boundaries, those of the Canadian Provinces are also given. Greenland is divided into 14 districts according to current curatorial practice established at in the Botanical Museum, University of Copenhagen (Map 2).

The tree-line is indicated on both maps as the line that delimits the area treated by IMFANAG southwards. In the field the tree-line is usually a zone of considerable width rather than a narrow line easy to define; therefore the position of this line on the maps is somewhat arbitrary. For this reason it was felt natural to include mosses from the whole of Greenland, although a few isolated valleys have local tree vegetation.



Map 1. Localities from which mosses have been identified for IMFANAG, status of July 1985. The map shows *c.* 3200 dots representing *c.* 14 000 specimens belonging to *c.* 300 species of mosses.
The insert map shows the geographic area covered by IMFANAG.

Good arguments could also be given for the inclusion of Iceland in this series, since some of the northern parts of the island can be considered arctic as well as alpine. On the whole the moss flora of Iceland is, however, closer to the temperate flora of northwestern Europe than it is to the arctic- and the North American temperate floras.

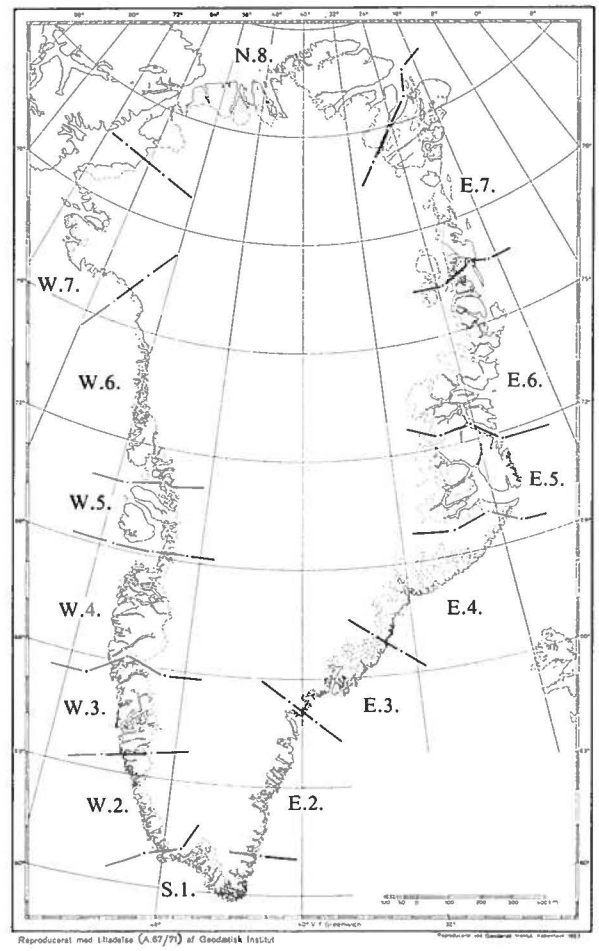
The maritime climate of western and southwestern Alaska greatly affects the tree-line and there some types of arctic tundra merge with maritime treeless vegetation. Therefore, the southern extension of the predominantly arctic area in Alaska is drawn somewhat arbitrarily.

Preparation of maps has been done by the editor and his staff unless otherwise stated; authors have supplied coordinates of localities or photocopies of specimens labels. Up to the present approx. 14 000 specimens have been entered into the data processor, representing more than 3200 localities (see Map 1). For a significant number of labels the editor supplied longitude and latitude as well as researching dubious locality names; much of this work was made possible by consulting historic sources of information, collector's field-notes, *etc.* The previous co-editors have also helped to identify incompletely labelled specimens.

Illustrations of mosses

All drawings are originals made from plants collected in the Arctic; voucher data for identification of the specimens are given under the respective species.

Map 2. Districts of Greenland referred to in the text.



The illustrations were made by Victoria Gordon Friis and myself in cooperation with the respective authors, who have approved the final plates. This work was initiated in 1979, and at the present about 300 plates have been completed or drafted. Hopefully, microscopical details of all taxa can be illustrated and habit-drawings of about 80 % of the specific taxa.

Key to illustrations

Each moss illustrated is shown at life size in the upper left-hand corner.

In composing the individual plate we have striven to use as few symbols and explanations as possible.

p	perichaetial or perigonial leaf
pe	peristome
p st	sterile plant
sp	spore(s)
x	cross-section; xc of costa; xl of leaf; xm of margin; xs of stem.

Table 1. Families of mosses to be treated in Illustrated Moss Flora of Arctic North America and Greenland arranged in taxonomic order.

Vol. 1:

Introduction
Key to genera
Indices
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Sphagnaceae
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Brachytheciaceae
Entodontaceae
Plagiotheciaceae
Hypnaceae
Rhytidiaceae
Hylocomiaceae

Polytrichaceae

by David G. Long

Royal Botanic Garden, Edinburgh EH3 5LR, Scotland.
Illustrations by Victoria G. Friis and Gert S. Mogensen[1]

Gametophytes perennial, often robust, green or brownish. Stems erect or ascending, simple or little-branched, with central strand, bearing rhizoids in lower parts. Axillary hairs present. Lower leaves scale-like; upper leaves mostly long and narrow, sometimes scale-like, differentiated into unistratose hyaline sheathing bases and green, opaque limbs, sometimes fragile. Costae single, relatively narrow in leaf bases, often very broad in limbs, often excurrent, bearing longitudinal green ventral lamellae. Laminae of limbs often bistratose, but with unistratose erect or infolded wings; borders occasionally differentiated; margins serrate to entire. Mostly dioicous. Perigonia cup-like or disc-like, stems innovating from centre. Perichaetia with usually elongated leaves.

Sporophytes terminal on stems. Setae elongate, erect, rarely curved. Capsules erect to horizontal, symmetric or sometimes oblique, cylindric, ovoid or 4–6-angled. Exothecial cells smooth or mamillose, with or without pits. Hypophyses weakly to strongly differentiated or absent, with or without stomata. Annuli absent. Opercula conic or rostrate. Peristomes nematodontous, of 32–64 short, blunt, smooth teeth composed of numerous overlapping fibrous U-shaped cells, teeth attached at apices to disc-like epiphragms. Spores smooth or minutely roughened. Calyptrae cucullate, naked or thinly to densely pilose.

1. Sporophytes absent (unknown in *Lyellia aspera*)
   2. Margins of leaf limbs with paired teeth; wings of laminae bistratose with unistratose intramarginal band ..... 6. *Lyellia*
   2. Margins of leaf limbs with single teeth or entire, wings of laminae unistratose
      3. Ventral lamellae 7–15, distinctly wavy
         4. Leaf limbs with hyaline border of oblique, rhombic cells ..... 1. *Psilopilum*
         4. Leaf limbs opaque, unbordered ..... 2. *Oligotrichum*
      3. Ventral lamellae 4–5 or 20–50, straight
         5. Ventral lamellae 4–5, covering only narrow costae ..... 2. *Oligotrichum parallelum*
         5. Ventral lamellae 20–50, covering broad costae and often part of leaf laminae
            6. End-cells of ventral lamellae finely papillose in side view
               7. End-cells of ventral lamellae broader than tall or isodiametric in transverse sections 3. *Pogonatum*
               7. End-cells of ventral lamellae taller than broad in transverse sections ..... 4. *Polytrichastrum*
            6. End-cells of ventral lamellae undifferentiated or each with a single large papilla-like thickening in side view
               8. End-cells of ventral lamellae in side view each with a large papilla-like thickening 5. *Polytrichum*
               8. End-cells of ventral lamellae undifferentiated, or thickened and flat-topped, never bearing a papilla-like thickening
                  9. End-cells of ventral lamellae in transverse sections rounded and symmetric. 4. *Polytrichastrum*
                  9. End-cells of ventral lamellae in transverse sections flat-topped or grooved, sometimes rounded but then usually oblique ..... 5. *Polytrichum swartzii*

1. Sporophytes present
   10. Calyptrae glabrous or with few hairs
      11. Capsules asymmetric, curved ..... 1. *Psilopilum*
      11. Capsules symmetric, straight ..... 2. *Oligotrichum*

---

[1]Botanical Museum, University of Copenhagen, Gothersgade 130, DK-1123 Copenhagen K, Denmark.
Illustrations were supported financially by Carlsbergfondet and the Danish Natural Science Research Council (both to G. S. Mogensen) and by the National Science Foundation (to New York Botanical Garden: W. C. Steere).

10. Calyptrae densely hairy
    12. Hypophyses and stomata absent; exothecial cells mamillose but not pitted; peristome teeth 32 ..... 3. *Pogonatum*
    12. Hypophyses present, weakly or strongly differentiated, bearing stomata; exothecial cells smooth, with or without pits, or if mamillose then always pitted; peristome teeth 64 (sometimes reduced to 40–55 by fusion)
        13. Capsules terete or with 4–6 rounded angles, weakly or not constricted between urns and hypophyses; exothecial cells not pitted ..... 4. *Polytrichastrum*
        13. Capsules sharply 4(–5)-angled, strongly constricted between urns and hypophyses; exothecial cells pitted ..... 5. *Polytrichum*

1. Psilopilum

Psilopilum Brid., Bryol. Univ. 2: 95. 1827. – Type: *P. arcticum* Brid.

Stems short, usually gregarious, simple, erect, rigid. Leaves scale-like, erect – spreading, ovate to obovate, bases weakly differentiated, slightly sheathing; limbs concave, apices obtuse or apiculate, cucullate, margins entire or crenate–dentate, opaque but with narrow hyaline borders. Costae narrow and well-defined throughout, ending below apices to very shortly excurrent; in cross-sections with numerous dorsal stereids in a broad band, but very narrow or almost obsolete ventral band, in upper parts smooth or with low dorsal teeth or lamellae. Ventral lamellae few, sinuose, covering only costae, in side-view entire to coarsely lobed and dentate; in transverse sections end-cells not differentiated, smooth, thin-walled. Median cells of leaf bases elongate–rectangular, thin-walled. Laminae of limbs weakly to strongly inrolled when dry, broad, unistratose throughout; cells quadrate or rounded–hexagonal, slightly thick-walled, towards margins bordered with a narrow band of oblique, rhombic cells; marginal teeth unicellular, rounded. Dioicous. Perigonia discoid, perigonial leaves spreading, with broad ovate bases and very short limbs. Perichaetial leaves erect, lanceolate, much longer than stem leaves.

Sporophytes often present. Setae elongate, erect. Capsules inclined to horizontal, asymmetric, weakly to strongly curved, cylindric to ovoid–gibbous, not angled; hypophyses short, with conspicuous stomata. Exothecial cells smooth. Peristomes of 32 crowded, pale, linear, blunt, unequal teeth. Lids bluntly rostrate. Calyptrae smooth or with a few hairs.

Formerly a broadly circumscribed "bipolar" genus, but now restricted by G. L. Smith (Mem. New York. Bot. Gard. 21(3): 1–83, 1971) to the two Northern Hemisphere species *P. cavifolium* and *P. laevigatum*, both with a circumpolar arctic distribution in northern Scandinavia, Siberia, Greenland, and North America. The Southern Hemisphere species were transferred by G. L. Smith to the genera *Oligotrichum, Notoligotrichum,* and *Itatiella*.

Closely allied to *Oligotrichum*, which differs in its unbordered leaves and straight, ±symmetric capsules.

1. Leaves erect-spreading when moist, curled when dry, ovate, margins entire or minutely denticulate near apices, ventral lamellae entire or crenulate in side view; capsules cylindric, weakly to moderately curved, not or weakly gibbous, suberect or inclined ..... 1. *P. cavifolium*
1. Leaves closely appressed when moist, appressed and scarcely curled when dry; obovate, margins crenate-dentate in uppermost ⅓, ventral lamellae coarsely dentate or lobed in side view; capsules ovoid-gibbous, strongly curved, horizontal ..... 2. *P. laevigatum*

1. P. cavifolium (Wils.) Hag.

Fig. 1. Map 3.

Bryologist 19: 70. 1916. – *Polytrichum cavifolium* Wils., in Seemann, Bot. Voyage Herald 44. 1852. – *Oligotrichum laevigatum* (Wahlenb.) Bruch *et al.* var. *cavifolium* (Wils.) Frye, in Grout, Moss Fl. North America 1(2): 110. 1937. – Type: Alaska, Kotzebue, 1848, leg. Seemann; holotype in BM, seen; isotype in NY, seen.

Catharinea tschuctschica C. Müll., Bot. Centralbl. 16: 93. 1883. – *Oligotrichum tschuctschicum* (C. Müll.) Lindb. & Arn., Kongl. Svenska Vetenskapsakad. Handl. 23: 10. 1890. – Syntypes: U.S.S.R., Tschuctschica Penins., 1881 & 1882, leg. Krause, not seen.

Oligotrichum laevigatum (Wahlenb.) Bruch *et al.* var. *laxirete* C. Jens., Meddr Grønland 15: 391. 1898. – Type: East Greenland, Cap Stewart, leg. Hartz, lectotype in C, seen.

Psilopilum laevigatum (Wahlenb.) Lindb. var. *aloma* Hag., Kongel. Norske Vidensk. Selsk. Skr. 1913(1): 25. 1914, *nom. superfl.* – Type: *Oligotrichum laevigatum* var. *laxirete* C. Jens.

Psilopilum tschuctschicum (C. Müll.) Paris var. *anomalum* Hag., Kongel. Norske Vidensk. Selsk. Skr. 1913(1): 25. 1914. – Type: Norway, leg. Kaurin, not seen.

Stems short, 6–10 (–18) mm. Leaves erect–spreading when moist, weakly curled when dry, ovate–oblong, 2–3 mm, upper leaves with limbs tubular when dry, apices cucullate, obtuse or minutely apiculate, margins entire

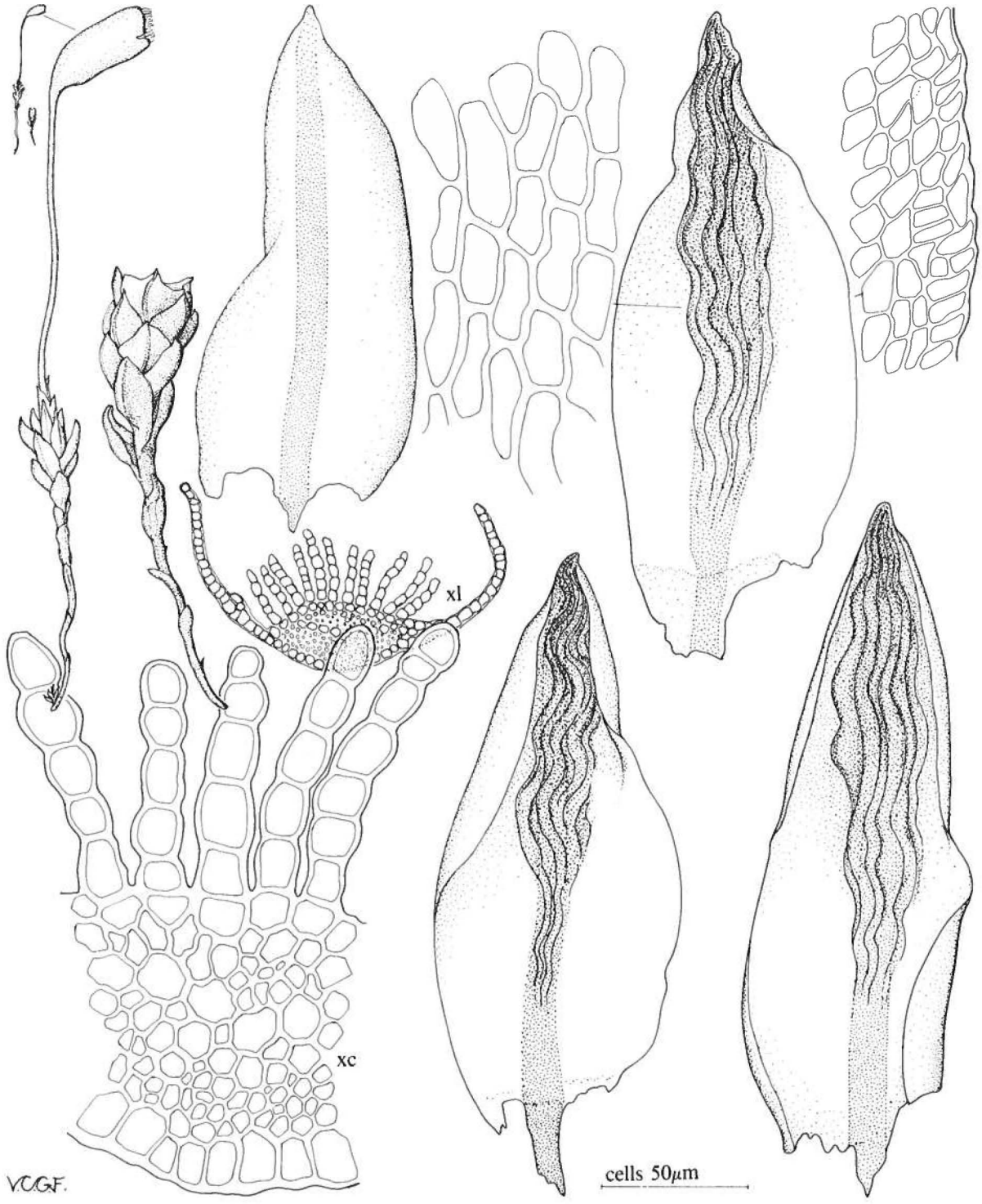
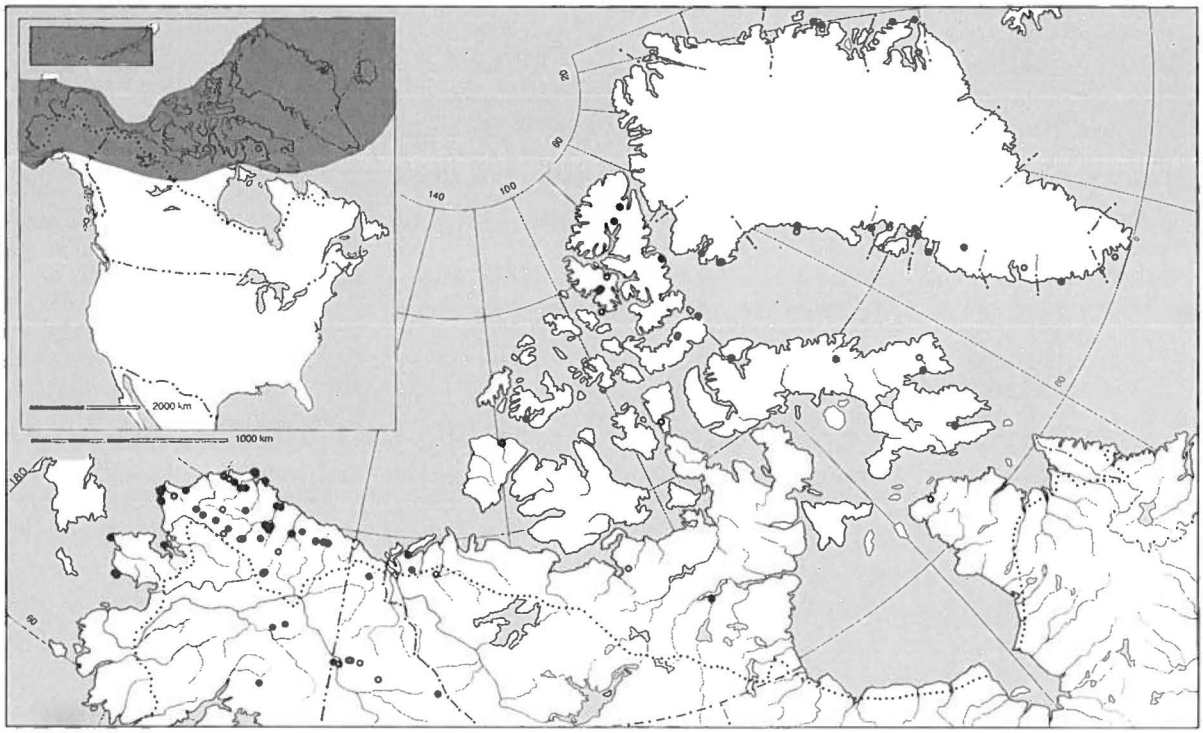
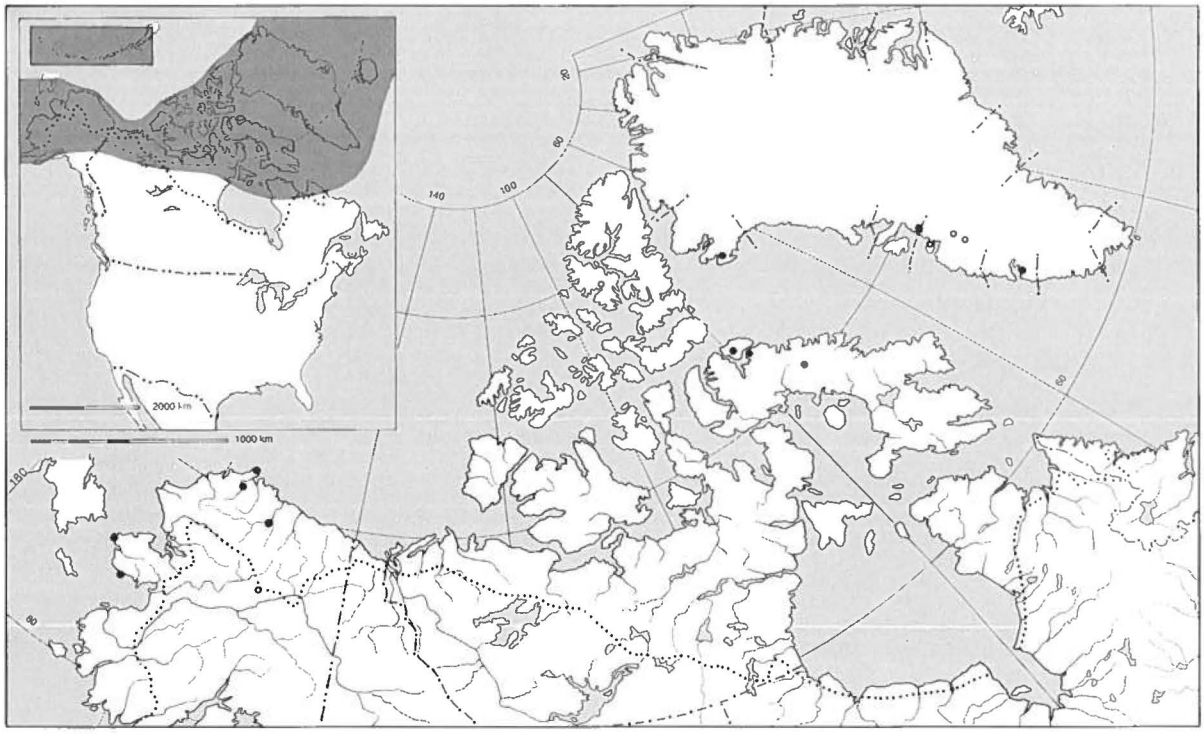


Fig. 1. *Psilopilum cavifolium*, Mt Zackenberg, NE-Greenland; leg. 1947 Holmen 33, (C).



Map 3. *Psilopilum cavifolium*.



Map 4. *Psilopilum laevigatum*.

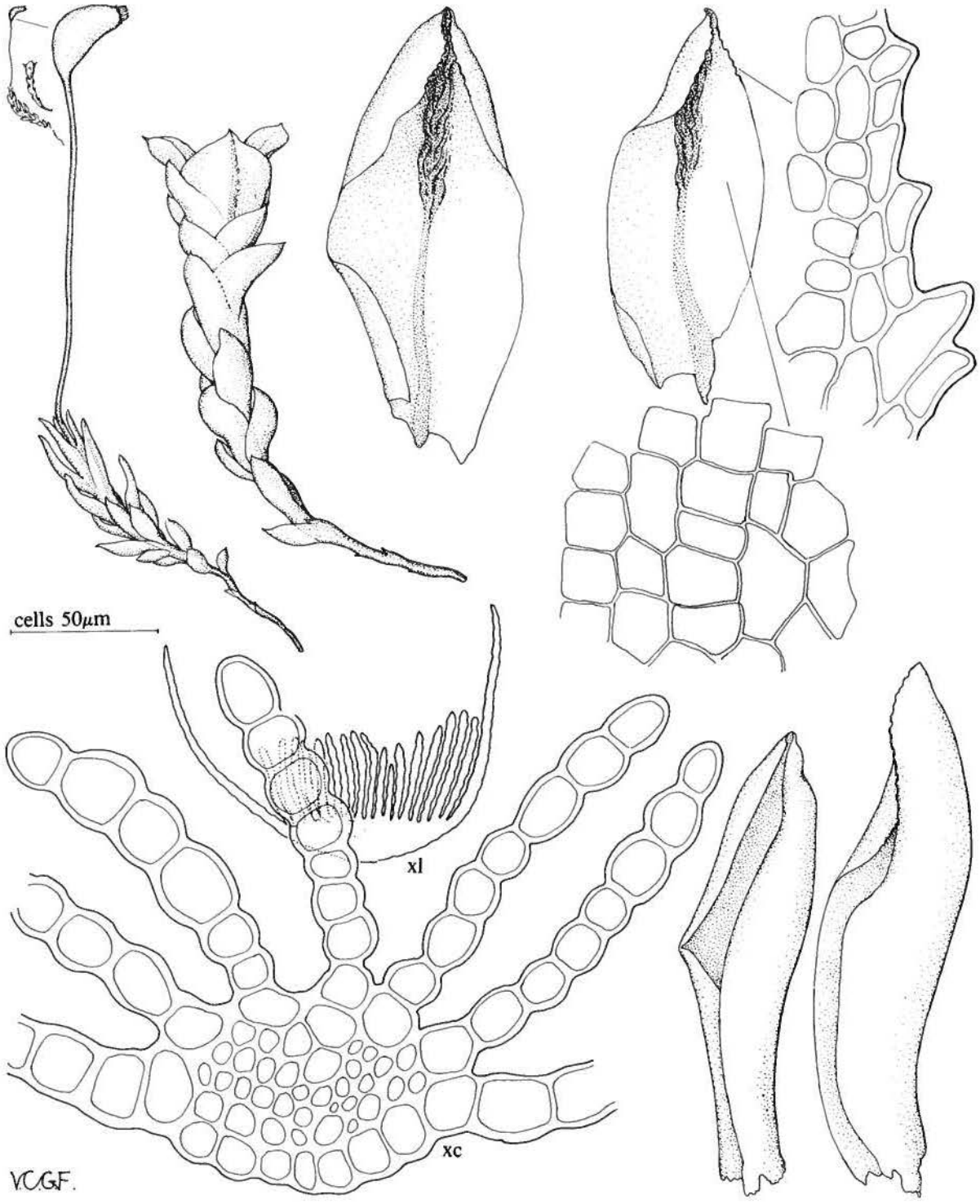


Fig. 2. *Psilopilum laevigatum*, head of Søndre Strømfjord, W-Greenland; leg. 1946 Holmen 4172, (C)

or minutely denticulate near apices. Costae ending in apices or very shortly excurrent, dorsally smooth or faintly roughened near apices. Ventral lamellae 7–10, 6–12 cells high, in side view entire but crenulate with bulging end-cells. Median cells of leaf bases 40–100 × 12–18 μm. Laminae 24–33 cells broad on each side at mid-limb; cells 15–20(–24) μm broad, equally thick-walled, becoming narrower and obliquely rhombic in the borders. Perichaetial leaves 2.5–3.5 mm.

Setae brown 8–18 mm. Capsules pale brown, dark brown when old, inclined to suberect, cylindric, rarely somewhat gibbous, moderately to strongly curved; urns 3.2–5.0 mm. Exothecial cells thin-walled. Peristome teeth very unequal, 250–380 μm. Spores almost smooth, 24–32 μm diameter.

A pioneer species, in bright green mats on disturbed soil and gravel, especially on road-cuttings, footpaths, and eroding river banks; also on lake shores, open tundra, moraine and cliff ledges; common at lower altitudes from sea level to 700 m, rarely up to 1300 m.

Very common throughout the northern part of the region, especially in lowland and coastal areas. An arctic species distributed throughout northern Siberia, Northern Scandinavia, Svalbard, Iceland, Greenland; in North America south to southwestern Alaska.

Selected specimens seen:

Greenland. S 1: Narssaq, "Narssaq sund", 60°56′N, 46°03′W; 1962 Steere 62–910 (C, CANM, NY). – W 5: Jakobshavn, 69°13′N, 51°06′W; 1956 Holmen 15966 (C, NY). – E6: Wollaston Foreland, Mt Zackenberg, 74°28′N, 20°35′W; 1950 Holmen *s.n.* (ALTA, C, CANM, E, NY).

Canada. Northwest Territories, Ellesmere I., head of Tanquary Fiord, 81°25′N, 76°55′W; 1964 Brassard 1740 (C, CANM, NY). – Aberdeen Lake, 64°38′N, 99°44′W; 1964 Scotter 4005 (CANM, MICH). – Melville I., 2 mls N of Bailey Point, 75°00′N, 114°58′W; 1965 Mosquin & Martin 6402 (CANM, NY). – Yukon Territory, Bonnet Lake, 68°11′N, 137°52′W; 1972 Scotter 17700a (C, NY).

Alaska. Sagavanirktok Quad., Sagwon upland, 69°23′N, 148°43′W; 1975 Murray 7477 (ALA). – Umiat Quad., W slope Mt Umiat, 69°22′N, 152°07′W; 1958 Shushan & Thomson B152 (ALA, CANM, E). – Barrow Quad., Barrow Village, 71°17′N, 156°47′W; 1960 Steere, Holmen & Mårtensson (Steere & Holmen, 1975: Bryoph. Arct. Exs. 8, ALTA, BM, MICH).

The typical form, widespread throughout the Arctic, has entire leaves with the costae smooth dorsally, and capsules quite cylindric. Some populations (possibly hybrids) from Greenland and Alaska have leaf margins minutely denticulate towards the apex, costae dorsally somewhat roughened or toothed, and broader, slightly gibbous capsules. These correspond to var. *anomalum* Hag. and have sometimes been misidentified as *P. laevigatum*. The latter differs from *P. cavifolium* in its usually taller, more slender shoots with shorter, closely appressed leaves which do not become tubular in the upper part when dry, margins serrate–dentate in upper part, ventral lamellae more numerous (11–15), irregularly lobed and dentate, and capsules inclined to horizontal, darker in colour, and strongly curved and gibbous. Rarely grows submerged, where gametophytes become tall and lax, as in aquatic forms of *Oligotrichum hercynicum*.

2. P. laevigatum (Wahlenb.) Lindb.

Fig. 2. Map 4.

Öfvers. Förh. Kongl. Svenska Vetensk.-Akad. 18(4): 190. 1861. – *Polytrichum laevigatum* Wahlenb., Fl. Lapponica 349. 1812. – *Oligotrichum laevigatum* (Wahlenb.) Bruch *et al.*, Bryol. Eur. 21/22, Pl. 414. 1844. – Syntypes: Finland, Sweden, syntype in S, seen.

Psilopilum arcticum Brid., Bryol. Univ. 2: 95. 1827, *nom. superfl.* – Type: *Polytrichum laevigatum* Wahlenb.

Oligotrichum glabratum Lindb., Musc. Scand. 12. 1879, *nom. superfl.* – Type: *Polytrichum laevigatum* Wahlenb.

Psilopilum laevigatum (Wahlenb.) Lindb. var. *hypnocarpum* Hag., Kongel. Norske Vidensk. Selsk. Skr. 1913(1): 24. 1914. – Syntypes: E-Greenland, isosyntypes in C, NY, seen.

Stems slender, 8–17 mm, wiry. Leaves not curled, closely appressed and erect both dry and moist, oblong–obovate, 1.5–2.5 mm, limbs not tubular above, apices cucullate, obtuse, margins irregularly crenate–dentate in upper half of limbs. Costae ending in or just below apices, usually smooth dorsally. Ventral lamellae 9–15, 6–11 cells high, in side view irregularly lobed and dentate, with crenulate margins. Median cells of leaf bases 45–90 × 12–30 μm, narrower at margins. Laminae 22–30 cells wide on each side at mid-limb; cells 15–24 (–30) μm wide, slightly thick-walled, marginal 1–2 rows oblique, linear–rhombic. Perichaetial leaves 3.8–4.5 mm, about 2 times as long as stem leaves or longer.

Setae brown, 7–15 mm. Capsules brown, becoming blackish with age, inclined to horizontal, strongly curved and gibbous–ovoid, urns 2.6–4.0 mm. Exothecial cells thin-walled. Peristome teeth 200–320 μm. Spores minutely papillose, 22–26 μm.

Ecologically very similar to *P. cavifolium*, growing in green mats on disturbed soil and detritus by roads, streams, waterfalls, and glaciers, but a much more local plant; sometimes in mixed populations with *P. cavifolium*.

Rather rare and local in West Greenland, arctic Canada, and Alaska, but extending farther south than *P. cavifolium* in North America, to southwestern Alaska and Labrador; widespread in Siberia, northern Scandinavia, Svalbard, and Iceland.

Selected specimens seen:

Greenland. W 4: Claushavn, 69°07′N, 50°55′W; 1870 Berggren *s. n.* (C, NY). – W 5: Jakobshavn, 69°13′N, 50°55′W; 1867 Brown *s. n.* (BM, E). – W 7: "Thule", 76°34′N, 68°48′W; 1956 Marr 56243 *p. p.* (CANM).

Canada. Northwest Territories, Baffin I., Lewis Glacier, 70°30′N, 74°40′W; 1963 Webber 51 (CANM). – Bylot I., Franklin district, mouth of Aktineq River, 72°48′N, 78°51′W; 1954 Drury *s. n.* (NY). – Melville I. *s. d.*, Ross *s. n.*, Herb. Brown (BM, E).

Alaska. Umiat Quad., Umiat, 69°25′N, 152°10′W; 1953 Borman *et al.* 53-1009A (CANM). – Barrow Quad., Barrow, Loon Lake, 71°17′N, 156°47′W; 1958 Shushan & Thomson B242 (ALA, CANM, E). – Nome, 64°30′N, 165°20′W; 1948 Lepage 22616 (MICH). – Seward Penins., Cape Prince of Wales, 65°48′N, 168°00′W; 1979 Flock FB221 *p. p.* (ALA).

2. Oligotrichum

Oligotrichum DC. in Lam. & DC., Fl. Française, ed. 3, 2: 491. 1805. – Type: *Polytrichum hercynicum* Hedw.

Plants short or tall, gregarious. Stems simple, rarely branched, erect. Basal leaves minute, appressed; upper leaves rigid or soft, erect when dry but sometimes curled or falcate–secund, erect, spreading or falcate–secund when moist, ovate–lanceolate to oblong–elliptic, bases not or weakly differentiated, scarcely sheathing; limbs flat or with strongly incurved laminae, apices flat or cucullate, acute, obtuse, or mucronate, margins subentire, denticulate or coarsely serrate, borders not differentiated (very weakly so in *O. parallelum*). Costae narrow and well-defined throughout, ending in apices or shortly excurrent, in cross-sections with a broad dorsal stereid band and a broad to narrow or almost obsolete ventral band, dorsal surface towards apices with low teeth or distinct lamellae. Ventral lamellae few, straight or sinuose, covering only costae, in side view entire to shallowly lobed or dentate, in transverse sections end-cells not differentiated, smooth, thin-walled. Median cells of leaf bases short to elongate–rectangular, thin-walled or slightly thickened. Laminae of limbs broad, unistratose, dorsal surface sometimes with low projecting lamelliform teeth, cells irregularly quadrate or hexagonal, walls thin or thickened at angles, marginal teeth 1–4-celled. Dioicous. Perigonia discoid, perigonial leaves short, broad, spreading. Perichaetial leaves narrower, erect.

Sporophytes often present. Setae elongate, erect. Capsules slightly inclined or erect, cylindric but broadest near bases, symmetric, not angled, without hypophyses but with conspicuous stomata at base. Exothecium smooth. Peristomes with 32 simple or divided, obtuse or subacute teeth. Lids with a short to long, blunt beak. Calyptrae with few scattered hairs or glabrous.

An almost worldwide genus of approximately 17 species, found from the Tropics to the High Arctic. *O. falcatum* is the only truly arctic member of the genus, *O. hercynicum* is widespread in many northern temperate regions, whilst *O. parallelum* is a North Pacific taxon, just reaching into arctic Alaska. Closely allied to *Psilopilum* (for differences see under that genus), but rather more loosely circumscribed with a considerable range of leaf-form and lamellae development.

1. Plants short, rigid, 1–2(–3) cm; leaves 1.6–3.1 mm, erect and weakly curled or falcate-secund when dry, laminae strongly incurved above, margins remotely denticulate or almost entire, ventral lamellae 8–14, sinuose.
   2. Leaves lanceolate or linear-lanceolate, erect and appressed with tips often incurved when dry, erect-spreading when moist; apices strongly cucullate, apiculate; dorsal lamellae well-developed, 2–4 cells high, often extending to below mid-leaf. ..... 1. *O. hercynicum*
   2. Leaves ovate-lanceolate, strongly falcate secund when dry, little-altered when moist; apices cucullate but tapering to an acute point; costae dorsally smooth or with low lamellae or teeth 1–2 cells high near apices. ..... 2. *O. falcatum*
1. Plants tall, soft, 2.5–6.0 cm; leaves 3.0–6.0 mm, strongly curled when dry, laminae plane and weakly undulate, margins sharply and coarsely serrate, ventral lamellae 4–5, straight. ..... 3. *O. parallelum*

1. O. hercynicum (Hedw.) DC. in Lam. & DC.

Fig. 3. Map 5.

Fl. Française, ed. 3, 492. 1805. – *Polytrichum hercynicum* Hedw., Sp. Musc. Frond. 94. 1801 – Type: Czechoslovakia or Poland, Sudety Mts, 1780, leg. Ehrhart, isotype in C, seen.

Bryum incurvum Brid., Musc. Rec. 2(3): 44. 1803. – *O. incurvum* (Brid.) Lindb. in Hartman, Handb. Skand. Fl. ed. 9,2: 45. 1864. – Type: France, leg. Villars, not seen.

O. hercynicum (Hedw.) DC. in Lam. & DC. var. *latifolium* C. Müll. & Kindb., in Macoun, Cat. Canadian Plants 6: 149. 1892. – Type: Canada, Selkirk Mts, 1890 leg. Macoun, isotype in FH, seen.

O. integrifolium Kindb., Rev. Bryol. Lichénol. 21(3): 40. 1894. – Type: *O. hercynicum* var. *latifolium* C. Müll. & Kindb.

Stems erect, 10–23(–30) mm, rigid. Upper leaves erect–spreading when moist, erect and appressed but with tips somewhat incurved when dry, lanceolate or linear–lanceolate, 2–2.8 mm, not decurrent at bases, laminae strongly incurved and tubular above; apices strongly cucullate, minutely mucronate; margins remotely denticulate to almost entire, dorsal surface of laminae often with scattered short projecting lamelliform teeth 1–3 cells high. Costae minutely excurrent as a short mucro, dorsally with several conspicuous low lamellae 2–4 cells high, which often extend from apices to below mid-leaf. Ventral lamellae 8–12, sinuose, 6–11 cells high, in side-view entire or shallowly notched; margins crenulate with bulging end-cells. Median cells of leaf bases shortly rectangular, 24–40 × 9–15 µm, with somewhat thickened walls, narrower towards margins, without enlarged alar cells. Laminae 16–30 cells broad on each side at mid-limb; cells irregularly quadrate, some broader than long, 9–15 µm wide, thick-walled especially at angles; marginal teeth minute, unicellular. Perigonial leaves broadly obovate. Perichaetial leaves narrow–lanceolate, 3–3.5 mm long.

Sporophytes occasional. Setae 10–15(–25) mm, pale brown. Capsules slightly inclined, urns 3.2–4.0 × 1.3–1.7 mm. Lids bluntly rostrate. Peristome teeth short,

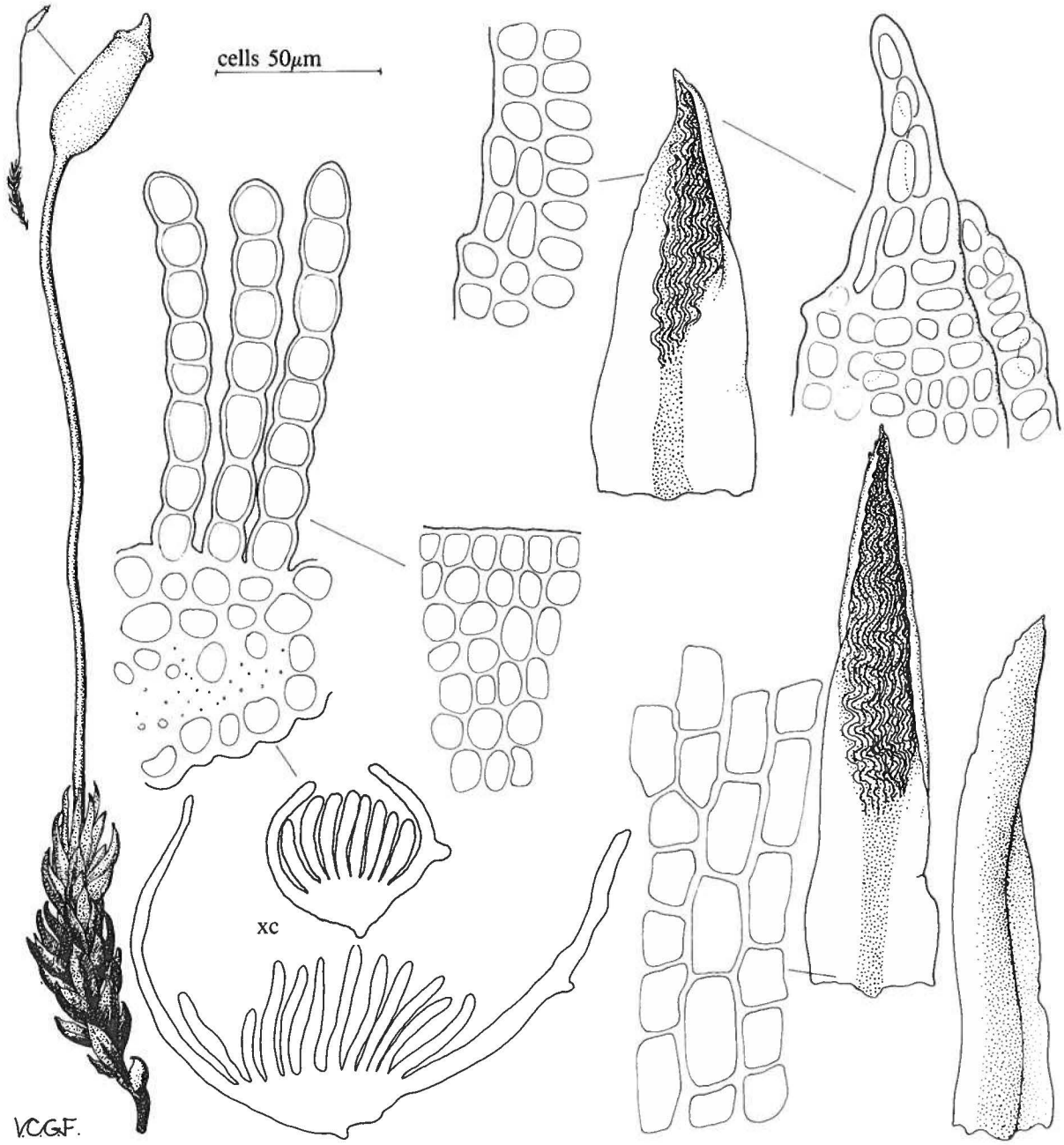
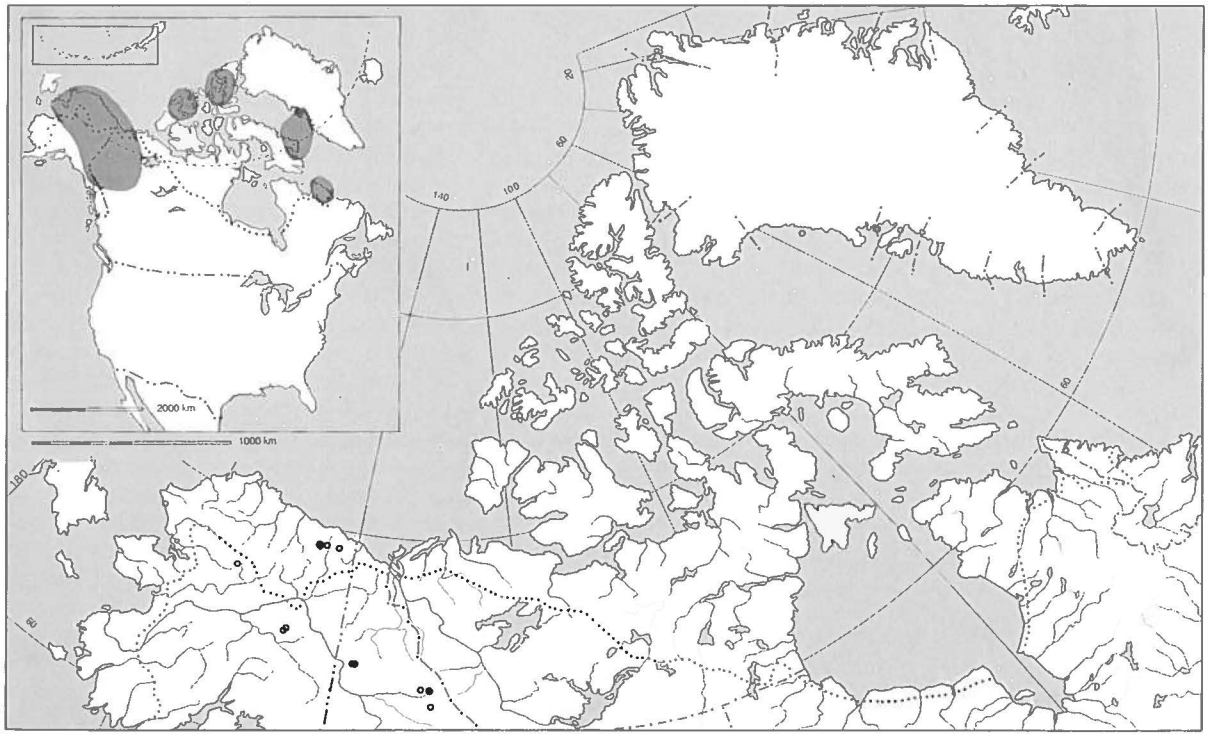


Fig. 3. *Oligotrichum hercynicum*, Anordliuitsoq, S-Greenland; leg. 1970 Jacobsen 9389, (C).

Map 5. *Oligotrichum hercynicum*.



Map 6. *Oligotrichum falcatum*.

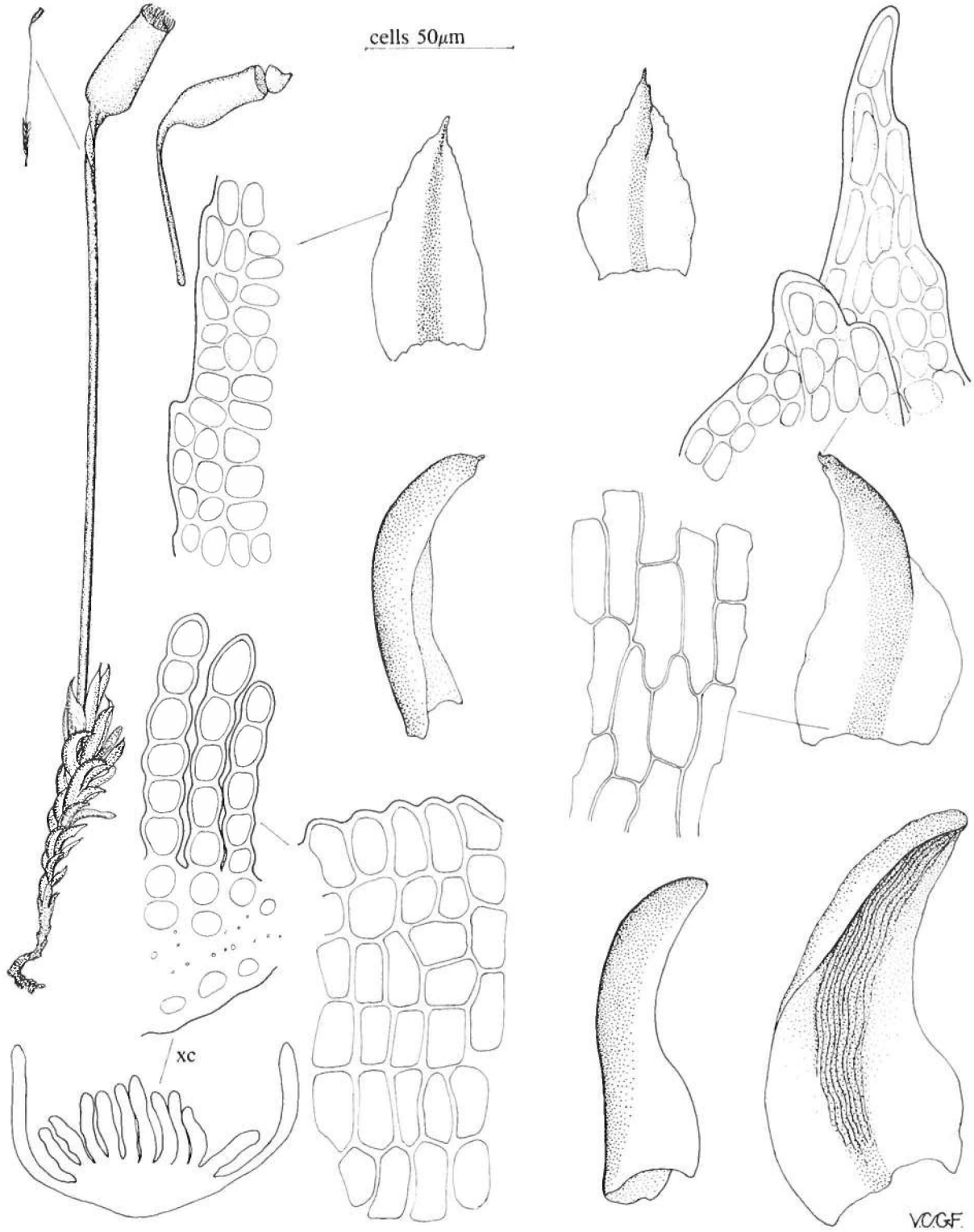


Fig. 4. *Oligotrichum falcatum*, Peters Lake and vicinity, A-Alaska; leg. 1974 Steere and Iwatsuki 74-789, (NY).

100–140 µm, blunt or subacute. Spores 14–15 µm, almost smooth.

A calcifuge pioneer species forming bright green patches on soil and gravel, often in disturbed sites such as road-cuttings, footpaths, lake-shores, stream-banks, scree-slopes and glacier-melt areas, sometimes in open tundra, from sea-level up to 1700 m. Sporophytes apparently common in South Greenland populations, but rare in those from northern Canada and Alaska, where the taxon is probably under-collected.

Displays a disjunct distribution in the region, similar to that of *Polytrichastrum sexangulare*, occurring only in southern Greenland, Alaska and Yukon Territory. An arctic–alpine, somewhat oceanic species scattered throughout the Arctic (Alaska, Canada, S-Greenland, Iceland, Siberia) and on the mountains of Europe south to Spain and Turkey; also in Japan; in western North America reported from Alaska, Aleutian Is, British Columbia, Washington, Oregon and Montana; in eastern North America only in Newfoundland.

Selected specimens seen:
Greenland. S 1: Kangerdluk, 60°13′N, 44°19′W; 1966 Gravesen & Hansen 66-740 (C, NY). – W 2: Ivigtut, 61°13′N, 48°10′W; 1946 Holmen 5221 (FH). – E 3: Qingertivaq, 66°06′N, 37°13′W; 1969 Holmen 69-611 (C, NY). – E 4: Mikis Fjord, 68°10′N, 31°30′W; 1971 Lewinsky 71-72 (C).
Canada. Yukon Territory, N Rackla Range, Gillespie Lake, 64°43′N, 134°00′W; 1976 Vitt 16514 (ALTA).
Alaska. Ambler River Quad., source of Cooper Creek, 67°17′N, 157°00′W; 1976 Lewis 2399 (NY). – Seward Penins., Stewart River near Sinuk River, 64°50′N, 164°08′W; 1949 Steere 13257 (NY).

Occasionally found in aquatic habitats where the gametophytes become much taller and laxer, with larger, distant leaves. For differences with *O. falcatum* and *O. parallelum*, see under those species.

2. O. falcatum Steere

Fig. 4. Map 6.

Bryologist 61(2): 115. 1958. – *Psilopilum falcatum* (Steere) Crum *et al.*, Brylogist 68(4): 434. 1965. – Type: Alaska, Mt Michelson Quad., Peters Lake, 1952, Steere 18959, holotype in NY, seen; isotypes in ALTA, C, FH, NY, seen.

Stems ascending to erect, 15–23 (–30) mm, rigid. Upper leaves ovate–lanceolate, curved and strongly falcate–secund, scarcely altered when dry, 1.6–3.1 mm, slightly decurrent at bases; laminae strongly incurved above; apices cucullate and tapering into sharp points; margins remotely denticulate or almost entire but mostly with several larger teeth just below apices; laminae with low teeth or lamellae on dorsal surface only near apices. Costae percurrent as sharp pellucid points, dorsally smooth, slightly roughened or occasionally with short, low lamellae or teeth 1–2 cells high near apices. Ventral lamellae 9–14, sinuose, 6–10(–13) cells high, in side-view irregularly lobed and notched, margins crenulate with bulging end-cells. Median cells of leaf bases shortly rectangular, 12–30 × 9–15 µm, thin-walled, sometimes small groups of larger alar cells differentiated, 30–45 × 15–18 µm. Laminae 18–28 cells broad on each side at mid-limb; cells irregularly quadrate or shortly rectangular, some broader than long, 6–15 µm broad, walls thickened, especially at angles, marginal teeth minute, unicellular. Male plants with leaves weakly falcate, perigonial leaves broadly ovate or suborbicular, spreading. Perichaetial leaves lanceolate, 3.5–4 mm, almost straight.

Sporophytes rare. Setae 11–16 mm. Capsules slightly inclined, urns 3.5–4 × 1.4–1.8 mm. Lids with a short, blunt, conic beak. Peristome teeth 120–200 µm, tapering, subacute, sometimes compound. Spores 19–21 µm, minutely papillose.

Calcifuge; in silvery-green patches on wet soil and rocks, often on friable shales, also reported from granite and quartzite, in habitats subject to regular or intermittent inundation, or constantly moist, *e.g.* beside snow-melt streams, lake-shores, waterfalls, on dripping rocks and in ravines, often on north- and east-facing slopes. In Alaska and Yukon Territory restricted to montane habitats at altitudes between 800 and 1750 m, but growing as low as 230 m on Axel Heiberg I.

A rare, but widely distributed species until very recently considered endemic to this region, perhaps limited by its obvious preference for mountain habitats. Locally common possibly only in northern Alaska and Yukon Territory, the only places where sporophytes have been found. As reported by Steere (Mosses of Arctic Alaska: 452–454, 1978) known from Alaska, Yukon Territory, Northwest Territories (Axel Heiberg I., Melville I.), western Greenland, and northern Labrador. Since that publication there are additional records from southwestern Yukon (Seward Glacier, St. Elias Mts, Steere 14339b, NY), Baffin I., and several new Alaskan localities. Plants recently reported from Xizang (Tibet) as this species (Li et al., Bryoflora of Xizang, Beijing 1985) differ in their greater development of the dorsal lamellae and may be subspecifically distinct.

Selected specimens seen:
Greenland. W 5: Nugssuaq Penins., S of Eqaluit, 70°17′N, 51°12′W; 1956 Holmen 13347 (C). – W 6: Kraulshavn, 74°07′N, 57°05′W; 1950 Jakobsen *s. n.* (C).
Canada. Labrador, Nachvak Fiord, 59°02′N, 64°03′W; 1975 Weber 1584 (ALTA, NY). – Northwest Territories, Baffin I., head of Clyde Inlet, 70°20′N, 68°20′W; 1950 Dansereau 363 (NY). – Axel Heiberg I., Ermine Ridge, 79°27′N, 90°48′W; 1967 Kuc M61 (CANM). – Yukon Territory, Tombstone Mt., 64°29′N, 138°33′W; 1973 Vitt 8114 (ALTA, NY).
Alaska. Demarcation Pt. Quad., Jago River, 69°24′N, 142°41′W; 1978 Murray 8453 (ALA). – Mt Michelson Quad., Peters Lake, 69°22′N, 145°03′W; 1960 Steere 600-722-3, *c. spor.* (FH, NY). – Point Hope Quad., Ogotoruk Creek, 68°05′N, 165°45′W; 1980 Murray 10276 (ALA,E). – Seward Penins., S slope Kigluaik Mts, 64°57′N, 165°30′W; 1949 Steere 13473 (NY).

Well-grown populations of *O. falcatum* can be readily distinguished from *O. hercynicum* by having all leaves regularly and strongly falcate–secund, both in the moist and dry states. This character is never shown by *O. hercynicum*, although occasionally the latter species can have uppermost leaves somewhat falcate–secund. In addition, some stunted forms of *O. falcatum* have leaves only weakly falcate–secund and resemble *O. hercynicum* in habit. Microscopically, the leaf-shape, leaf apex and dorsal surface of the costa will distinguish such forms.

3. O. parallelum (Mitt.) Kindb.

Fig. 5. Map 7.

Rev. Bryol. 21(3): 41. 1894. – *Atrichum parallelum* Mitt., J. Linn. Soc. Bot. 8: 48. 1865. – Type: Rocky Mountains, leg. Drummond, not seen.

Stems simple, erect, 2.5–6 cm. Upper leaves strongly curled when dry, spreading when moist, elliptic–oblong, 3–6 mm long, laminae not inrolled above, plane but weakly transversely undulate, narrowly decurrent at bases; apices flat, sharply pointed; margins sharply serrate, dorsal surface of laminae with few to many, scattered, short, lamelliform teeth 2–4 cells high. Costae tapering upwards, shortly excurrent, dorsally with 2–3 conspicuous lamellae 1–3 cells high, these entire below but sharply toothed near apices. Ventral lamellae 4–5, taller, straight, 3–6 cells high, in side view entire, smooth. Median cells of leaf bases rectangular, 45–90 (– 150) × 15–25 μm, walls thin, lax. Laminae 29–46 cells broad on each side at mid-limbs, cells irregularly hexagonal, 15–24 μm wide, thin-walled but slightly thickened at angles, towards margins 1–3 rows equally thick-walled but not forming distinct borders; marginal teeth large, ascending, of 2–4 subequal cells. Perigonial leaves obovate, cuspidate. Perichaetial leaves spreading, lanceolate, 6.5–7 mm long.

Sporophytes frequent. Setae reddish, wiry, 2.5–5 cm. Capsules inclined, cylindric, urns 5–6 × 1.6–2 mm. Lids with a short, blunt beak. Peristome teeth short, 150–180 μm, obtuse. Spores 14–17 μm, smooth.

In loose dark-green tufts on wet rocks and soil in shaded or exposed situations, *e.g.* by snow-melt streams, waterfalls, in ravines, on wet cliffs and screes, or in wet, open tundra. In arctic Alaska and Yukon Territory restricted to montane habitats from 685 to 1800 m, but further south it extends into moist *Picea* and *Tsuga* forest at lower altitudes, as low as 20 m on the Aleutian Is.

A North Pacific oceanic–montane species, widespread on the coastal mountains of Washington, British Columbia, Alaska, Aleutians, Kamchatka, and Japan, extending inland only in a single arctic locality in Alaska and into the Hess and Selwyn Mts of southern Yukon Territory.

Specimens seen:
Canada. Yukon Territory, Hess Mts, Keele Lake, 63°29'N 130°29'W; 1976 Horton 5522 (ALTA). – Hess Mts, Emerald Lake, 63°33'N, 131°12'W; 1978 Vitt 23450 (ALTA).
Alaska. Shungnak Quad., Mauneluk River, 66°59'N, 156°11'W; 1975 Lewis 594 (NY).

Differs conspicuously from *O. hercynicum* and *O. falcatum* in its larger size; leaves much curled when dry, plane and somewhat undulate when moist, with coarsely serrate margins, and fewer, straight ventral lamellae.

3. Pogonatum

Pogonatum P.-Beauv., Mag. Encycl. 5: 329. 1804. – Lectotype: *Polytrichum aloides* Hedw.

Stems short or tall, gregarious, simple or branched above, erect. Lower leaves small, appressed; upper leaves rigid, erect when dry, erect–spreading when moist, often caducous, with thin well-defined sheathing bases; limbs linear to lanceolate, opaque, flat, with margins weakly incurved above, apices acute or acuminate, margins serrate to entire, not bordered. Costae narrow and well-defined in basal sheaths, broader but poorly defined in limbs, shortly excurrent, in cross-section with well-developed dorsal and ventral stereid bands, dorsal surface smooth or toothed near apices. Ventral lamellae numerous, straight, covering costae and most of laminae, in side-view entire, in transverse section end-cells enlarged, thick-walled, finely papillose (in arctic species). Median cells of leaf bases rectangular to linear, thin-walled. Laminae of limbs bistratose with narrow unistratose wings, cells of wings quadrate, equally thick-walled; marginal teeth single, usually multicellular. Dioicous. Perigonia cup-shaped, perigonial leaves broadly ovate with short limbs. Perichaetial leaves similar to upper stem leaves but longer.

Sporophytes not infrequent. Setae elongate, erect. Capsules inclined, urns ovoid–cylindric, terete, symmetric, without hypophyses or stomata, exothecium roughened with a single mamilla without pit on each cell. Peristome teeth 32, oblong or lanceolate from low or high basal membrane. Lids shortly rostrate. Calyptrae densely hairy.

A large genus of 90 to 100 species, predominantly pantropical and with many species in the Himalaya and Japan; in other temperate regions with few species. The genus displays a wide range of gametophytic form, but is united by a unique combination of sporophyte characters, *viz.* the usually terete, never angular capsules, the urn without stomata and with mamillose exothecial cells without pits. *Polytrichastrum alpinum*, sometimes included in *Pogonatum* on account of its terete capsules with fewer than 64 peristome teeth, is best excluded as its capsules bear stomata and have smooth exothecial cells.

The specimen of *Pogonatum pensilvanicum* (Hedw.) P.-Beauv. from Greenland (Parker Snow Bay, 1916, leg. Hovey (NY)) is probably mislabelled; it is an American plant not known north of Newfoundland.

When sterile, stunted plants of several species of *Polytrichum* and *Polytrichastrum* may be confused with *Pogonatum*. Microscopially, all arctic speciess of *Polytrichum*, *Polytrichastrum longisetum* and the common form of *Polytrichastrum sexangulare* can be distinguished by the end-cells of the ventral lamellae which are never finely papillose as in *Pogonatum dentatum* and *P. urnigerum*. In *Polytrichastrum alpinum* and the form of *P. sexangulare* with finely papillose end-cells, these cells are taller than broad in transverse section, whilst in the two *Pogonatum* species they are broader than tall or isodiametric.

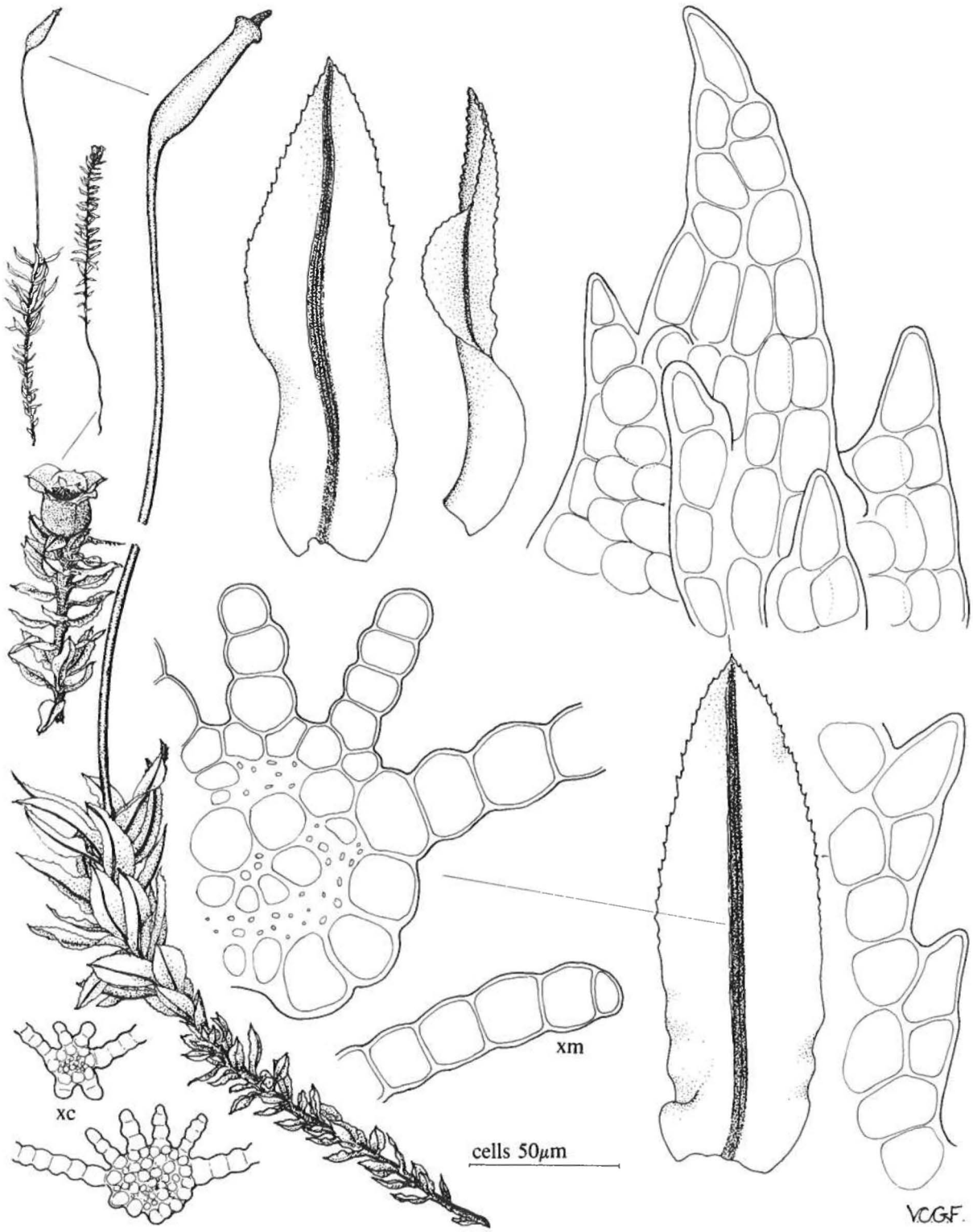
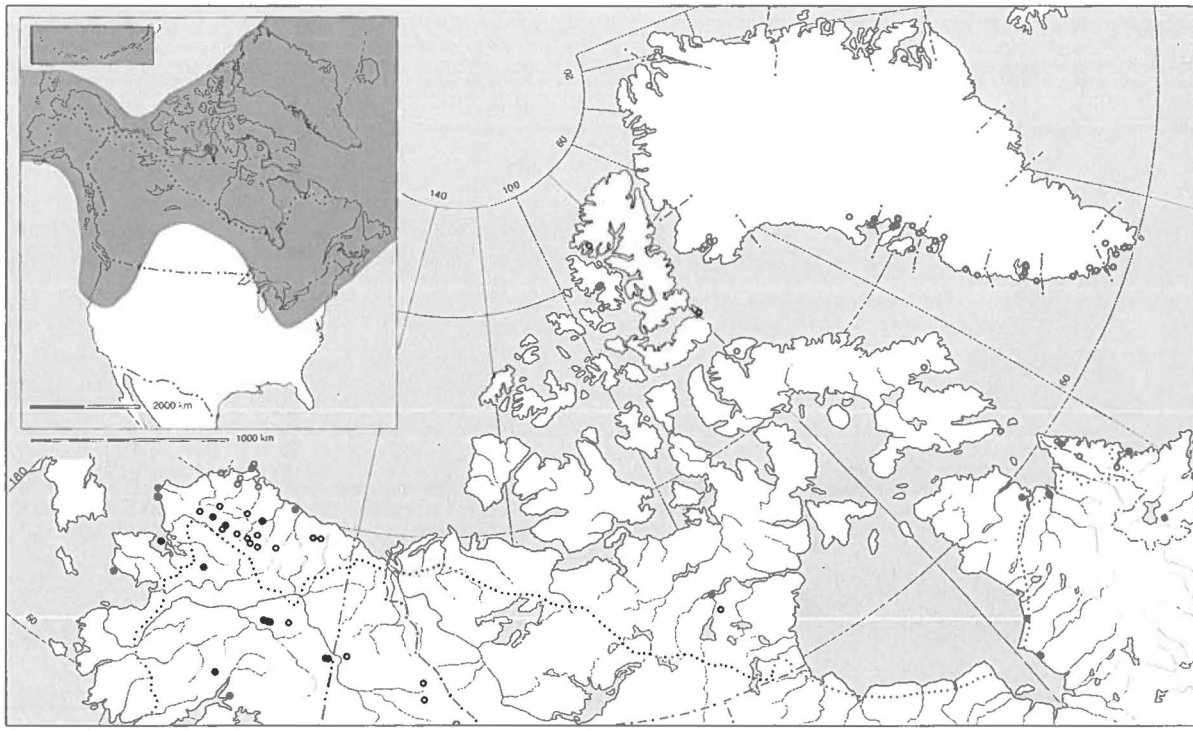


Fig. 5. *Oligotrichum parallelum*, near Crystal Lake, Mitkof I., SE-Alaska; leg. 1968 Worley, Schofield and Hamilton 8527, (UBC, C).

Map 7. *Oligotrichum parallelum*.



Map 8. *Pogonatum dentatum*.

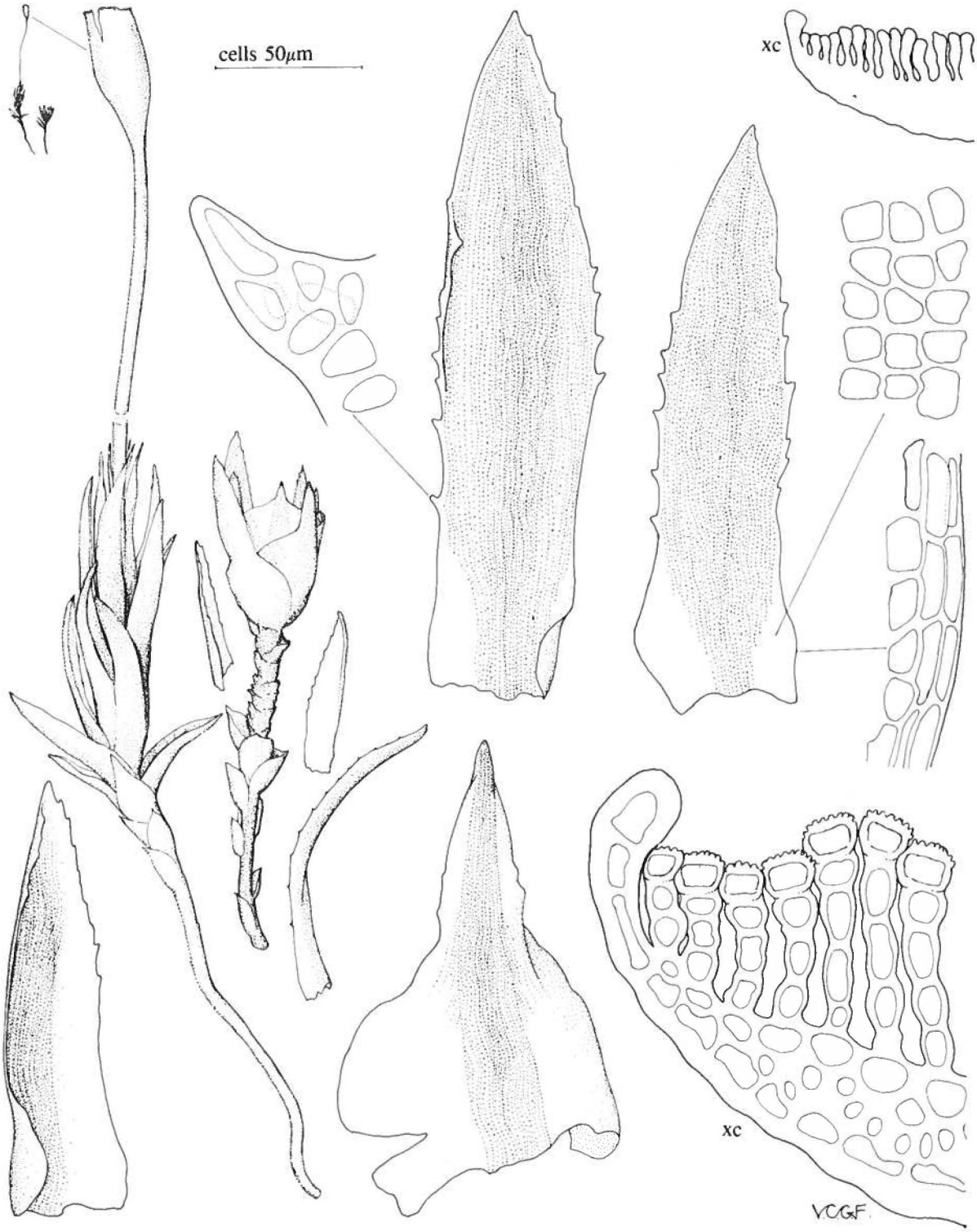


Fig. 6. *Pogonatum dentatum*, Esersiutilik, NW-Greenland; leg. 1956 Holmen 13682, (C).

1. Leaves loosely arranged and incurved when dry, serrate to serrulate; marginal teeth spreading, (1–)3–7-celled, terminal cell usually not much larger than others; ventral lamellae 24–31, end-cells flat-topped in transverse section; basal membrane very low, 15–30(–35) µm; spores 18–21 µm..... 1. *P. dentatum*
1. Leaves densely arranged, straight and closely imbricate when dry, serrate to entire; marginal teeth ascending, of 1(–2) large cells and 0–3 distinctly smaller cells; ventral lamellae 33–42(–46), end-cells round-topped in transverse section; basal membrane tall, 85–160 µm; spores 13–17 µm..... 2. *P. urnigerum*

1. P. dentatum (Brid.) Brid.

Fig. 6. Map 8.

Bryol. Univ. 2: 122. 1827. – *Polytrichum dentatum* Brid., J. Bot. (Schrader) 1800, 1,2: 287. 1801. – Type: Western North America, leg. Menzies, holotype in E, seen.

Polytrichum capillare Michaux, Fl. Boreali-Americana 2: 294. 1803. – *Pogonatum capillare* (Michaux) Brid., Bryol. Univ. 2: 127. 1827. – Type: Canada, holotype in PC, seen.

Polytrichum capillare Michaux var. *minus* Wahlenb., Fl. Lapponica 348. 1812 –Type: Lappland. Finland, Kyro, 1802, ?leg. Swartz, ?type in S, seen.

Stems short, mostly simple, sometimes branched above, 0.7–3 (–5) cm. Leaves loosely arranged, erect–spreading when moist, erect and incurved when dry, in dwarf forms often caducous from lower or middle part of sheathing bases; 3.0–4.5(–6.5) mm, from ovate sheathing bases rather abruptly tapering into linear–lanceolate limbs; apices acute, margins sharply serrate to serrulate, never completely entire, often distinctly incurved towards apices. Costae excurrent as short entire or denticulate points, dorsally smooth or with a few teeth near apices. Ventral lamellae 24–31, 5–7 cells high, in transverse section with end-cells rectangular, broader than others, flat-topped with narrowly rectangular lumens, thick-walled and densely papillose. Median cells of leaf bases rectangular, 25–60 × 12–18 µm, thin-walled. Laminae of limbs with narrow unistratose wings 1–3 cells broad at mid-limb, cells of wings quadrate, 14–17 µm broad, equally thickened. Marginal teeth broadly triangular, spreading or somewhat ascending, towards leaf apices becoming submarginal, mostly 3–7-celled with terminal cell not much larger than others, sometimes reduced to 1 small cell. Perichaetial leaves 4–5.5 mm, slightly longer than stem leaves.

Setae slender, brownish, 1.0–2.6(–3.5) cm. Capsules weakly inclined, brown, shortly ovoid–cylindric, urns 2.1–3.0 mm. Peristome teeth slender, whitish, (160–) 200–290 µm, subacute, borne on very low basal membrane 15–30(–35) µm tall. Spores almost smooth, 18–21 µm diameter.

In green or brown mats or as scattered stems amongst lichens and bryophytes such as *Polytrichum juniperinum* and *P. piliferum*, in dry, well-drained sun-exposed habitats on open rocky tundra, on hummocks, frost boils and polygons, gravelly slopes, talus and moraines, rarely close to glaciers or in snowbeds. A pioneer species probably favouring less disturbed sites than *P. urnigerum*. Frequently stunted and with caducous leaves in exposed situations; gametophytes taller and occasionally bearing sporophytes in more sheltered, moister habitats. Favours lower altitudes, but found up to 1700 m in Yukon Territory.

Widespread throughout the region, although less common in Greenland than the closely allied *P. urnigerum*; in Alaska *P. dentatum* is the commoner of the two especially in the arctic costal plain, where sporophytes are not rare. Caducous-leaved plants are commoner than in *P. urnigerum*. An arctic–alpine species distributed throughout arctic Alaska, Canada, Greenland, Iceland, U.S.S.R., Scandinavia and Svalbard; outside the Arctic restricted to mountainous parts of Scandinavia, Japan, western North America from southern Alaska and the Aleutians to Oregon, and in eastern North America from Labrador and Newfoundland to New England, Michigan and North Carolina.

Selected specimens seen:

Greenland. W 3: Kilaersarfik, Ameragdla, 64°15′N, 50°12′W; 1973 Lewinsky 73–920 (C). – W 6: Upernivik I., "Inukavsait Fjord", 72°20′N, 52°24′W; 1956 Holmen 13483 (C, NY). – E 5: Scoresby Sund, Rypefjord, 71°02′N, 27°45′W; 1958 Holmen 19016 (C).

Canada. Labrador, Churchill Falls, 53°36′N, 64°19′W; 1970 Brassard 5008 (C, NY). — Northwest Territories, Cobourg I., E coast, 75°49′N, 79°05′W; 1970 Blake 26c (CANM). – Ellesmere I., Van Hauen Pass, 81°07′N, 86°55′W; 1967 Brassard 2558 (CANM, NY).

Alaska. Chandler Lake Quad., Chandler Lake, 68°12′N, 152°47′W; 1966 Smith A1010 (ALA, BM, C, CANM, NY). – Barrow Quad., Point Barrow, 71°20′N, 156°39′W; 1952 Steere 19012 (CANM, NY) – Meade River Quad., Meade River P.O., 70°57′N, 157°27′W; 1953 Crum 20109 (NY). – Point Hope Quad., Ogotoruk Creek, 68°05′N, 165°45′W; 1980 Murray 9749 (ALA).

Pogonatum dentatum in the Arctic has been much confused with *P. urnigerum*. When well-grown, or when bearing sporophytes, *P. dentatum* can be readily recognized by its leaves with broad, spreading marginal teeth, which have the terminal cell not much larger than the lower cells, in its leaf section with the end-cells of lamellae flat-topped, by its narrow pale peristome teeth borne on a very low basal membrane, and by its spores 18–21 µm in diameter; in *P. urnigerum* the marginal teeth of the leaves are distinctly ascending and mostly with 1 cell much larger than the others, the ventral lamellae in section have rounded end-cells, the peristome teeth are brownish and borne on a tall basal membrane, and the spores are smaller, 13–17 µm in diameter. The two also differ in habit (leaves loosely arranged and not imbricate in *P. dentatum*), leaf apex (more finely pointed in *P. urnigerum*), leaf margin (more incurved towards apex in *P. dentatum* with teeth becoming submarginal), number of ventral lamellae (fewer in *P. dentatum*), length of cells in sheathing base (longer in *P. urnigerum*), cell size in lamina wings (larger in *P. dentatum*) and capsule shape (cylindric in *P. urnigerum*, ovoid–cylindric in *P. dentatum*).

In the Arctic, however, sporophytes are rare, particularly in *P. urnigerum*, the gametophytes frequently become stunted in both species, the marginal teeth reduced in size, and the leaves often readily-caducous. Such plants are often difficult to identify. In Greenland, Holmen (Meddr Grønland 163(2): 17. 1960) regarded plants with fragile leaves as *P. dentatum*, but in fact this type of vegetative propagation is common in both species.

Watson (Nytt Mag. Bot. 11: 169–170. 1964) cast doubt on the reliability of character of the lamella end-cells in transverse section in populations from Jan Mayen, but study of fruiting specimens of both species shows that it is a reliable and constant difference. In some dwarf forms of *P. urnigerum*, the lumen of the end-cells becomes almost flat as in *P. dentatum*, but the apex of the cell remains rounded or slightly pointed. In *P. dentatum* both the lumen and apex of the cell are quite flat in all forms. In *P. dentatum* some arctic forms have the marginal teeth much reduced in size, but never completely absent, unlike *P. urnigerum* where forms with reduced teeth or quite entire leaves are frequent.

2. P. urnigerum (Hedw.) P.-Beauv.

Fig. 7. Map 9.

Prodrome Aethéogamie 85. 1805. – *Polytrichum urnigerum* Hedw., Sp. Musc. Frond. 100. 1801. – Type: Europe, not seen.

Polytrichum urnigerum Hedw. var. *subintegrifolium* H. Arn. & C. Jens., Moose Sarekgebietes 137. 1910. – *Pogonatum urnigerum* (Hedw.) P.-Beauv. var. *subintegrifolium* (H. Arn. & C. Jens.) Möller, Ark. Bot. 16(3): 69. 1919. – Syntypes: Sweden, Sarek Mts, isosyntypes in BM, C, seen.

Stems short to tall, 0.8–4.0(–8.0) cm, commonly branched in upper part. Leaves crowded towards stem tips, glaucous green above, when dry erect, closely appressed, sometimes with tips curled, when moist widely spreading, in dwarf forms often caducous from lower or middle part of sheathing bases, (2.5–)3.2–5.0 mm, from ovate sheathing bases rather abruptly contracted into narrowly linear–lanceolate limbs; gradually tapering to fine points, margins plane or very weakly incurved towards apices, strongly serrate, serrulate or entire. Costae excurrent as subulate, sharply serrate to smooth points, dorsally smooth or with a few low teeth towards apices. Ventral lamellae 33–42(–46), 4–7 cells high, in transverse section with end-cells broadly ovate or orbicular, slightly broader than others, round-topped, with lumens either rounded or pentagonal and acutely topped, thick-walled and densely papillose Median cells of leaf bases linear, 30–65 × 9–12 μm, thin-walled, narrower towards margins. Limbs of laminae bistratose, with narrow unistratose wings 1–2 cells wide, cells of wings quadrate, 12–15 μm broad, thick-walled. Marginal teeth not becoming submarginal towards leaf apices, narrowly triangular, ascending, usually of 1(–2) large acute cells and 0–3 much smaller cells, in small forms often much reduced or absent. Perichaetial leaves 5–7 mm, slightly longer than stem leaves.

Setae slender, pale brown, 1.8–3.0(–4.0) cm. Capsules slightly inclined, pale brown, urns (2.0–)2.5–3.5 mm, cylindric. Peristome teeth linear (140–)170–225 μm, subacute, usually brown, borne on tall basal membrane 85–160 μm tall. Spores 13–17 μm, almost smooth.

In glaucous-green to brownish mats or as scattered stems, usually in open, disturbed habitats such as crumbling banks, road-cuttings, scree slopes, very common around glaciers and in snow-bed areas, sometimes in more stable, dry, open tundra, in alpine lichen/moss tundra and in dwarf shrub tundra. Common at all altitudes from sea level to 1700 m. Sporophytes very rare in the Arctic, but caducous-leaved forms common.

Widely distributed throughout arctic America, Greenland and Iceland, elsewhere a much more widespread taxon than *P. dentatum*, found throughout Europe south to Macaronesia, northern and eastern Asia, Iran, Himalaya, China, Korea, Japan; in North America south to Oregon, Colorado and New York.

Selected specimens seen:

Greenland. S 1: Narssarssuaq, 61°10′N, 45°23′W; 1962 Steere 62–687 (NY). – W 2: "Nunatak Lake", 61°55′N, 47°36′W; 1966 Larsson *s. n.* (C, NY). – W 6: Umiarfik Fjord, Svartenhuk Penins., 71°49′N, 55°25′W; 1956 Holmen 14629 (C, CANM, NY). – N 8: Heilprin Land, Brønlund Fjord, 82°10′N, 31°00′W; 1949 Holmen 8844 (CANM, NY).

Canada. Northwest Territories, Baffin I., head of Clyde Inlet, 69°50′N, 70°40′W; 1950 Wynne-Edwards 9342 (CANM, NY). – Melville I., N of Bailey Point, 75°00′N, 114°58′W 1965 Mosquin & Martin 6395 (CANM, NY). – Coppermine, Coronation Gulf, 67°47′N, 115°30′W; 1948 Steere 10804 (NY).

Alaska. Chandler Lake Quad., Chandler Lake, 68°12′N, 152°47′W; 1966 Smith A1017 (BM, C, NY). – Killik River Quad., Cascade Lake, 68°22′N, 154°35′W; 1974 Steere 74–877 (NY). – Survey Pass Quad., Alatna River, 67°53′N, 155°05′W; 1973 Murray 5565 (ALA).

A somewhat variable species likely to be confused only with *P. dentatum* (for differences see under that species), especially when sterile or stunted. Forms with reduced marginal teeth, or with leaves entire, are frequent and have sometimes been segregated as var. *subintegrifolium* (H. Arn. & C. Jens.) Möller. Intermediates are common and the character does not correlate with stature, leaf fragility or any other feature and is probably a habitat modification.

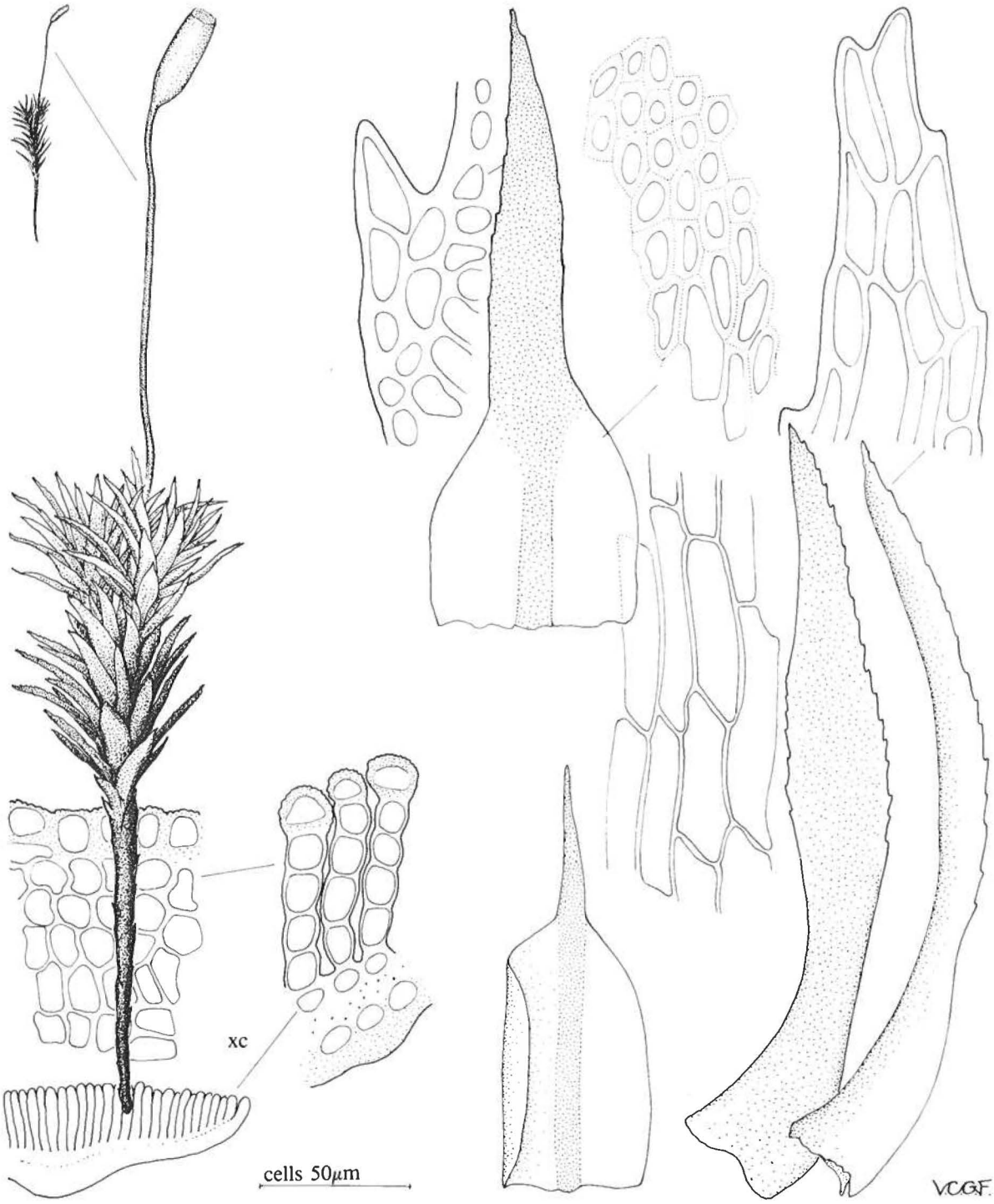
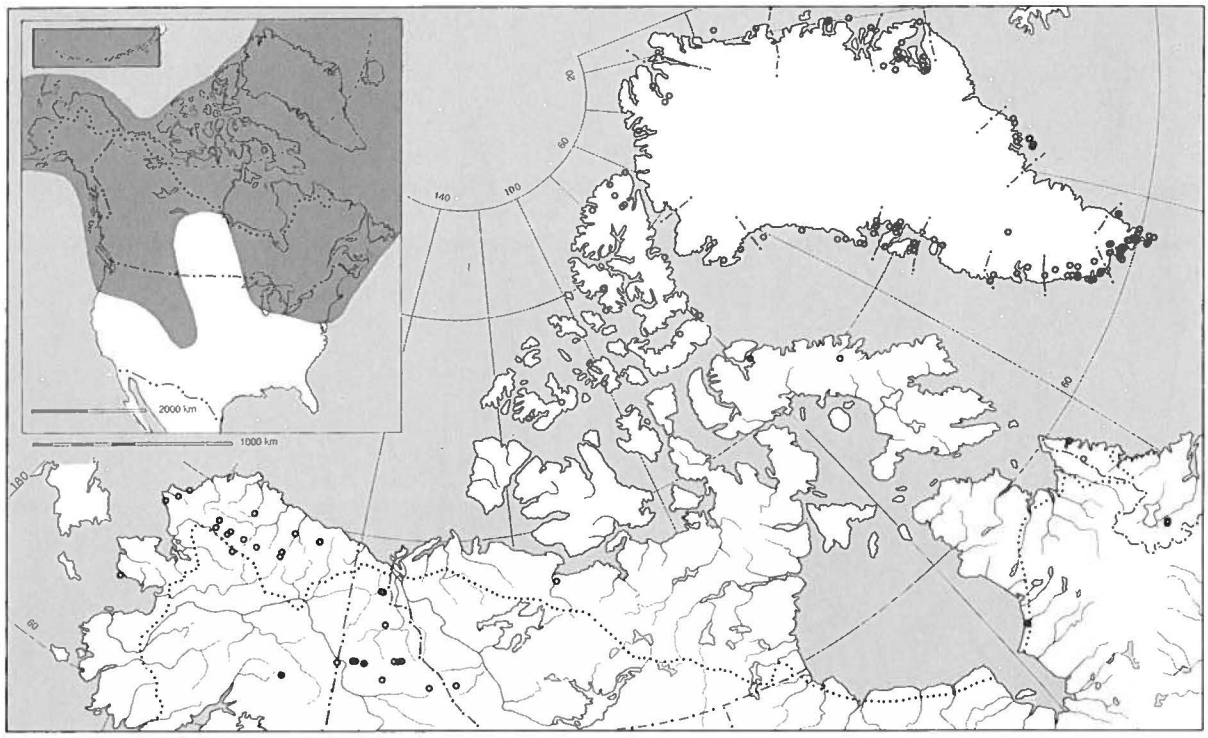
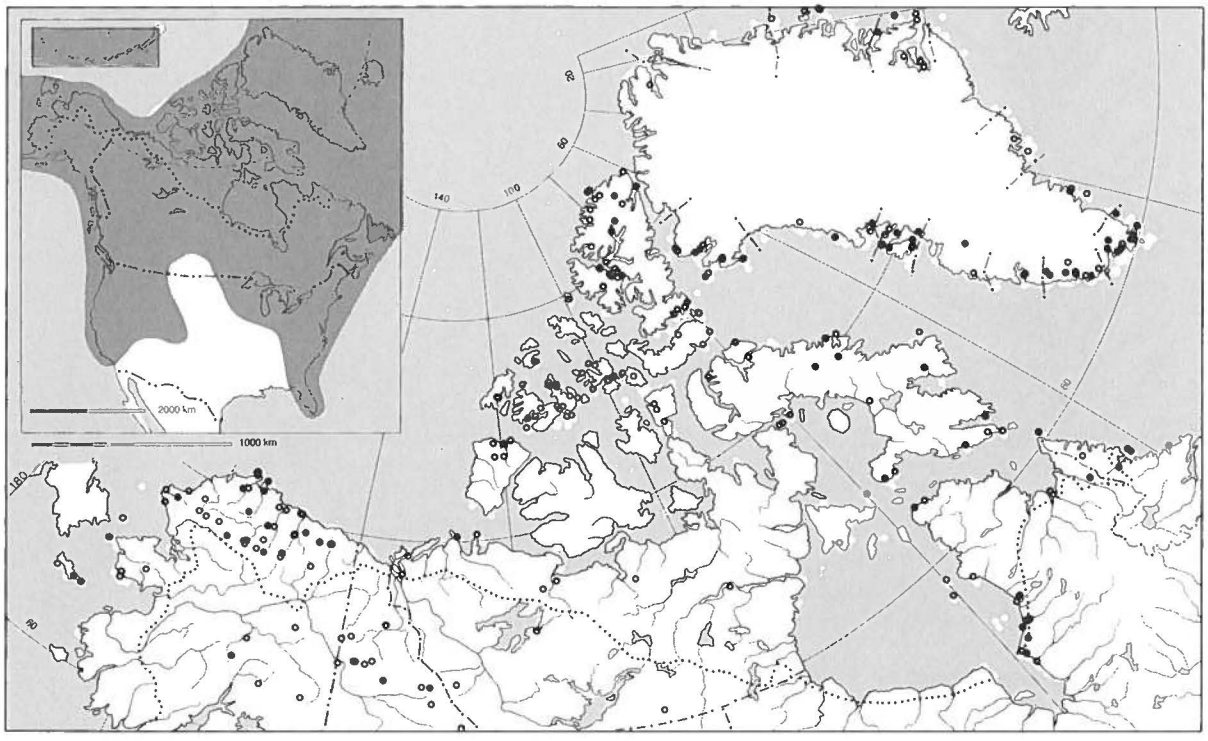


Fig. 7. *Pogonatum urnigerum*, Richardson Ridge, A-Alaska; leg. 1968 Sharp 9353 (NY, C).



Map 9. *Pogonatum urnigerum*.



Map 10. *Polytrichastrum alpinum* var. *alpinum*.

Fig. 8. *Polytrichastrum alpinum* var. *alpinum*, Ivnaq, W-Greenland; leg. 1971 Holmen and Mogensen 71-1071, (C).

4. Polytrichastrum

Polytrichastrum G. L. Smith, Mem. New York Bot. Gard. 21(3): 35. 1971. – Type: *Polytrichum alpinum* Hedw.

Stems short or tall, rigid, gregarious or scattered, simple or branched, erect. Lower leaves scale-like, appressed; upper leaves crowded, sometimes caducous, spreading when moist, erect, straight or weakly curled when dry, with thin, well-defined sheathing bases; limbs linear to lanceolate, opaque, flat or channelled, apices sharply pointed or blunt, toothed or entire, often produced into short coloured points; margins erect or inrolled, serrate or entire, not bordered. Costae narrow and well-defined in sheaths, broad but poorly-defined in limbs, shortly to long-excurrent, in cross-section with well-developed dorsal and ventral stereid bands, dorsal surface often toothed near apices. Ventral lamellae numerous, straight, covering costae and most of laminae; end-cells scarcely to strongly differentiated, thickened or not, smooth or finely papillose. Leaf bases unistratose, median cells linear to rectangular, thin-walled, becoming narrower towards margins. Laminae of limbs bistratose with narrow unistratose wings; cells of wings quadrate to transversely rectangular, incrassate; marginal teeth single, 1–4-celled. Dioicous. Perigonia discoid; perigonial leaves with short limbs and broad sheaths. Perichaetial leaves similar to stem leaves but with longer sheaths.

Sporophytes frequent. Setae elongate, erect. Capsules inclined to horizontal, obtusely 4–6-angled or terete, symmetric or slightly oblique, hypophyses weakly differentiated, confluent with urns, bearing large stomata. Exothecial cells smooth, not pitted (in arctic taxa). Peristomes of 64 simple teeth, sometimes 40–55 by fusion, teeth not appendaged or winged internally. Epiphragms fleshy, dorsal margins entire or with tooth-like processes opposite peristome teeth, ventral margins entire, annulus-like. Lids rostrate. Spores with warty papillar projections. Calyptrae densely covered with long hairs.

A recently segregated genus of 13 (or more) species, including some very widely distributed in both the Northern and Southern Hemispheres, and several with restricted or disjunct ranges in North America and the Himalaya. Distinguished from *Polytrichum s.str.* by the terete to obtusely 4–6-angled capsules with no constriction between urns and hypophyses, the smooth exothecial cells (without pits in arctic taxa), the peristome teeth which are not winged or appendaged internally, the epiphragms thick and entire or with marginal tooth-like processes, and the spores with warty papillar projections.

1. End-cells of ventral lamellae weakly differentiated, in side-view thin-walled, smooth; leaf margins coarsely serrate with large unicellular teeth; cells of lamina wings 12–21 μm broad..... 3. *P. longisetum*
1. End-cells of ventral lamellae strongly differentiated, in side-view thick-walled, finely papillose or smooth; leaf margins entire, or serrulate with small 1-celled teeth, or coarsely serrate with 2–4-celled teeth; cells of lamina wings 9–15 μm broad.
   2. Leaf limbs linear, apices blunt or subacute, cucullate; end-cells of ventral lamellae smooth or weakly papillose; capsules obtusely 5–6-angled, rarely subterete..... 2. *P. sexangulare*
   2. Leaf limbs linear–lanceolate, apices subulate, channelled but not cucullate; end-cells of ventral lamellae densely papillose; capsules terete.
      3. Leaves fragile, limbs usually constricted at tops of sheaths..... 1. *P. alpinum* var. *fragile*
      3. Leaves not fragile, limbs not or weakly constricted at tops of sheaths..... 1. *P. alpinum* var. *alpinum*

1. P. alpinum (Hedw.) G. L. Smith

Mem. New York Bot. Gard. 21(3): 37. 1971. – *Polytrichum alpinum* Hedw., Sp. Musc. Frond. 92. 1801. – *Pogonatum alpinum* (Hedw.) Röhling, Ann. Wetterau. Ges. 3(2): 226. 1814. – Syntypes: Europe, not seen.

Stems scattered or aggregated, simple or branched, 1.5–6.0(–10.0) cm. Leaves loosely to densely arranged, when moist erect–spreading to wide-spreading, when dry erect, not or weakly curled, 3.8–7.5 mm, from broad, rectangular sheathing bases rather abruptly tapering into flat linear–lanceolate limbs, sometimes constricted at bases of limbs and limbs caducous; apices subulate, channelled but not cucullate, with incurved margins; margins serrate, serrulate or entire. Costae excurrent as a brown serrate to entire point, dorsally toothed near apices or smooth. Ventral lamellae 24–40, 6–8 cells high, in side view flat-topped, in transverse section end-cells ovoid with much-thickened, densely finely papillose apices. Median cells of leaf bases linear or narrowly rectangular, 30–90 × 6–12 μm, thin-walled. Laminae of limbs with narrow unistratose erect wings, 2–6 cells broad at mid-limb, with quadrate to transversely rectangular cells 10–15 μm broad, equally thick-walled. Marginal teeth variable, ascending, acute, 1–4-celled with apical cell larger than others. Perichaetial leaves scarcely longer than stem leaves.

Setae brown, 0.8–3.0(–5.0) cm. Capsules weakly to strongly inclined, urns 3.1–5.8 mm, ovoid or subglobose to cylindric, terete, slightly oblique; exothecial cells smooth, not pitted; hypophyses distinct. Peristome teeth 40–55, irregularly developed, unequal, narrowly lanceolate, acute, yellowish, 130–250 μm, borne on low basal membrane 25–60 μm tall. Spores 18–24 μm, finely papillose.

Var. **alpinum**

Fig. 8. Map 10.

Polytrichum arcticum Brid., J. Bot. (Schrader) 1800, 1,2: 287. 1801. – *Polytrichum alpinum* var. *arcticum* (Brid.) Wahlenb., Fl. Suec. 2: 738. 1826. – Type: Sweden; isotype in BM, seen.

Polytrichum septentrionale Brid., J. Bot. (Schrader) 1800, 1,2: 285. 1801. – *Polytrichum alpinum* var. *septentrionale* (Brid.) Lindb., Not. Sällsk. Fauna Fl. Fenn. Förh. 9: 131. 1868. – *Polytrichastrum alpinum* (Hedw.) G. L. Smith var. *septentrionale* (Brid.) G. L. Smith, Mem. New York Bot. Gard. 21(3): 37. 1971. – Type: Norway, isotype in E, seen.

Polytrichum campanulatum Hornsch., in Nees, Horae Phys. Berol. Coll. 67. 1820. – *Polytrichum alpinum* Hedw. var. *campanulatum* (Hornsch.) C. Müll., Syn. Musc. Frond. 1: 211. 1848. – Type: Aleutians, Unalaska, leg. Chamisso, not seen.

Polytrichum brevifolium R. Brown, Suppl. App. Capt. Parry's Voyage 294. 1824. – *Polytrichum alpinum* var. *brevifolium* (R. Brown) C. Müll., Syn. Musc. Frond. 1: 211. 1848. – *Polytrichastrum alpinum* (Hedw.) G. L. Smith var. *brevifolium* (R. Brown) Brassard, Bryologist 75: 531. 1972. – Type: Melville I., leg. Ross, holotype in BM, seen.

Polytrichum propinquum R. Brown, Suppl. App. Capt. Parry's Voyage 294. 1824. – *Polytrichum alpinum* Hedw. var. *propinquum* (R. Brown) Hag., Kongel. Norske Vidensk. Selsk. Skr. 1913(1): 45. 1914. – Type: Melville I., leg. Ross, holotype in BM, seen.

Pogonatum alpinum (Hedw.) Röhling var. *simplex* Schimp., Coroll. 91. 1856. – *Polytrichum alpinum* Hedw. var. *simplex* (Schimp.) Limpr., Laubm. Deutschl. 2: 617. 1893. – Syntypes: Norway, Iceland, Greenland, not seen.

Polytrichum polare C. Müll., Bot. Zeitung (Berlin) 17: 205. 1859. – *Polytrichum alpinum* Hedw. var. *polare* (C. Müll.) Hag., Tromsø Mus. Aarsh. 21 & 22 (3): 263. 1905. – Type: Greenland, ?isotype in C, seen.

Polytrichum alpinum Hedw. var. *microdontium* Kindb., Ottawa Naturalist 5: 180. 1892. – *Polytrichum microdontium* (Kindb.) Kindb., Biblioth. Bot. 42: 66. 1897. – Syntypes: Alaska, leg. Macoun and Palmer, syntypes in S, seen.

Polytrichum vanhoeffenii Kindb, Biblioth. Bot. 42: 66. 1897. – Type: Greenland, Umanak Fjord, leg. Vanhöffen, holotype in S, seen.

Polytrichum alpinum Hedw. var. *integerrimum* Harmsen, in Harmsen & Seidenfaden, Meddr Grønland 82(2): 34. 1932. – Syntypes: Greenland, leg. Seidenfaden, syntypes in C, seen.

Leaves not fragile, limbs not caducous from top of sheath which is not or weakly constricted; leaf dentation and capsules variable.

The var. *alpinum* shows tolerance of a wide range of ecological conditions, both acidic and basic, but tends to favour relatively stable habitats such as moist tundra, fens, peat bogs, screes, cliff-ledges, tussock tundra, and dwarf-shrub tundra, and is frequent at all altitudes in the Arctic.

An extremely widespread taxon with essentially an arctic–alpine distribution, common throughout arctic and North Temperate regions of Europe and Asia south to Turkey, Himalaya and Taiwan; in the Antarctic, Australasia, South America and Mexico, towards the tropics restricted to high altitudes. Common in Greenland and in North America from arctic Canada, Alaska and the Aleutians south to California, Colorado and Florida. Sporophytes are frequent.

Selected specimens seen:

Greenland. S 1: Julianehåb district, "Tasiussaq", 60°15′N, 44°50′W; 1889 Hartz *s.n.* (CANM). – W 6: Nugssuaq, W end of Nugssuaq Penins., 70°42′N, 54°42′W; 1962 Steere 62–457 (CANM, NY). – E 5: Vestfjord, Kobberpynt, 70°31′N, 28°22′W; 1892 Hartz *s.n.* (CANM, MICH). – N 8: Heilprin Land, Brønlund Fjord, 82°10′N, 31°00′W; 1948 Porsild 6067 (C, CANM, BM).

Canada. Northwest Territories, Bathurst I., Davey's Camp, 75°45′N, 98°17′W; 1973 Ireland 16664 (ALA, CANM, FH). – Mackenzie Delta, Reindeer Station, 68°35′N, 134°00′N; 1978 Howland 741 (CANM). – Yukon Territory, Mt Klotz, 65°28′N, 138°20′W; 1973 Vitt 7582 (ALA).

Alaska. Killik R. Quad., Imiaknikpak Lake, 68°29′N, 154°03′W; 1973 Murray 6340 (ALA). – Teshekpuk Quad., E Simpson Test Well, 70°57′N, 154°40′W; 1979 Murray 8973 (ALA). – Barrow Quad., Point Barrow, 71°20′N, 156°39′W; 1951 Steere 16332 (CANM, NY).

Var. **fragile** (Bryhn) Long, *comb. nov.*

Fig. 9. Map 11.

Polytrichastrum alpinum (Hedw.) G. L. Smith var. *fragile* (Bryhn) Long, *comb. nov.* – Basionym: *Polytrichum fragile* Bryhn, Rep. Second Norwegian Arctic Exp. in "Fram", 2(11): 122. 1907. – *Polytrichum alpinum* Hedw. var. *fragile* (Bryhn) Nyholm, Ill. Moss Fl. Fennoscandia 2: 675. 1969. – *Polytrichastrum fragile* (Bryhn) Schljakov, Nov. Syst. Pl. non Vasc. 19: 209. 1982. – Syntypes: Greenland, Ellesmere Island, not seen.

Pogonatum lamellosum James, in Rothrock, Ann. Rep. Board of Regents Smithsonian Inst. 1867: 461. 1872. – Type: E. Siberia, leg. Dall, holotype in FH, seen.

Differs from var. *alpinum* in its readily fragile leaves which are usually distinctly constricted at the line of dehiscence at the bases of limbs; leaf serrations weakly developed or absent; capsules ovoid or subglobose.

Var. *fragile* is typically found in habitats subject to regular or occasional inundation, e.g. in wet meadows, by springs and especially on lake margins, with occasional reports from open tundra, beach ridges and on roadsides. It is a lowland plant rarely found over 100 m, but up to 800 m in Alaska.

A local but probably under-recorded taxon apparently common only in the coastal plain of arctic Alaska, with scattered records throughout arctic Canada; rare in Greenland, arctic Scandinavia, Svalbard and Siberia.

Selected specimens seen:

Greenland. W 7: Carey Is, Northwest I., 76°44′N, 73°20′W; 1976 Blake 1a (CANM). – E 5: S of Falsterelv, Scoresby Sund, 70°44′N, 24°08′W; 1971 Halliday B47c (E).

Canada. Northwest Territories, Baffin I., Frobisher Bay, 63°44′N, 68°56′W; 1948 Senn & Calder 3911 (CANM, NY). – E side Coburg I., 75°55′N, 79°08′W; 1968 Blake 5b (CANM). – Ellesmere I., Craig Harbour, 76°12′N, 81°05′W; 1923 Soper 865 (CANM). – Head of Hornby Bay, Great Bear Lake 66°35′N, 117°50′W; 1948 Steere 10498 (NY).

Alaska. Demarcation Point Quad., Beaufort Lagoon, 69°53′N, 142°18′W; 1974 Murray 7202 (ALA). – Harrison Bay Quad., Fish Creek Test Well, 70°19′N, 151°58′W; 1977 Murray 77-865 (ALA). – Barrow Quad., Point Barrow, 71°20′N, 156°39′W; 1951 Steere 15231 (ALA, CANM, NY). – Point Hope Quad., Ogotoruk Creek, 68°05′N, 165°45′W; 1980 Murray 9728 (ALA).

Polytrichastrum alpinum is an extremely polymorphic species, particularly in stature, development of leaf serration and capsule shape. Many infraspecific taxa have been reported from the Arctic, where variation seems to be especially wide. Capsule shape frequently correlates with development of leaf serration – plants named as var. *alpinum s. str.* have strongly serrate leaves and ovoid–cylindric or cylindric capsules; wilst those corresponding to var. *septentrionale* (Brid.) G. L. Smith have much reduced leaf serrations and subglobose or ovoid

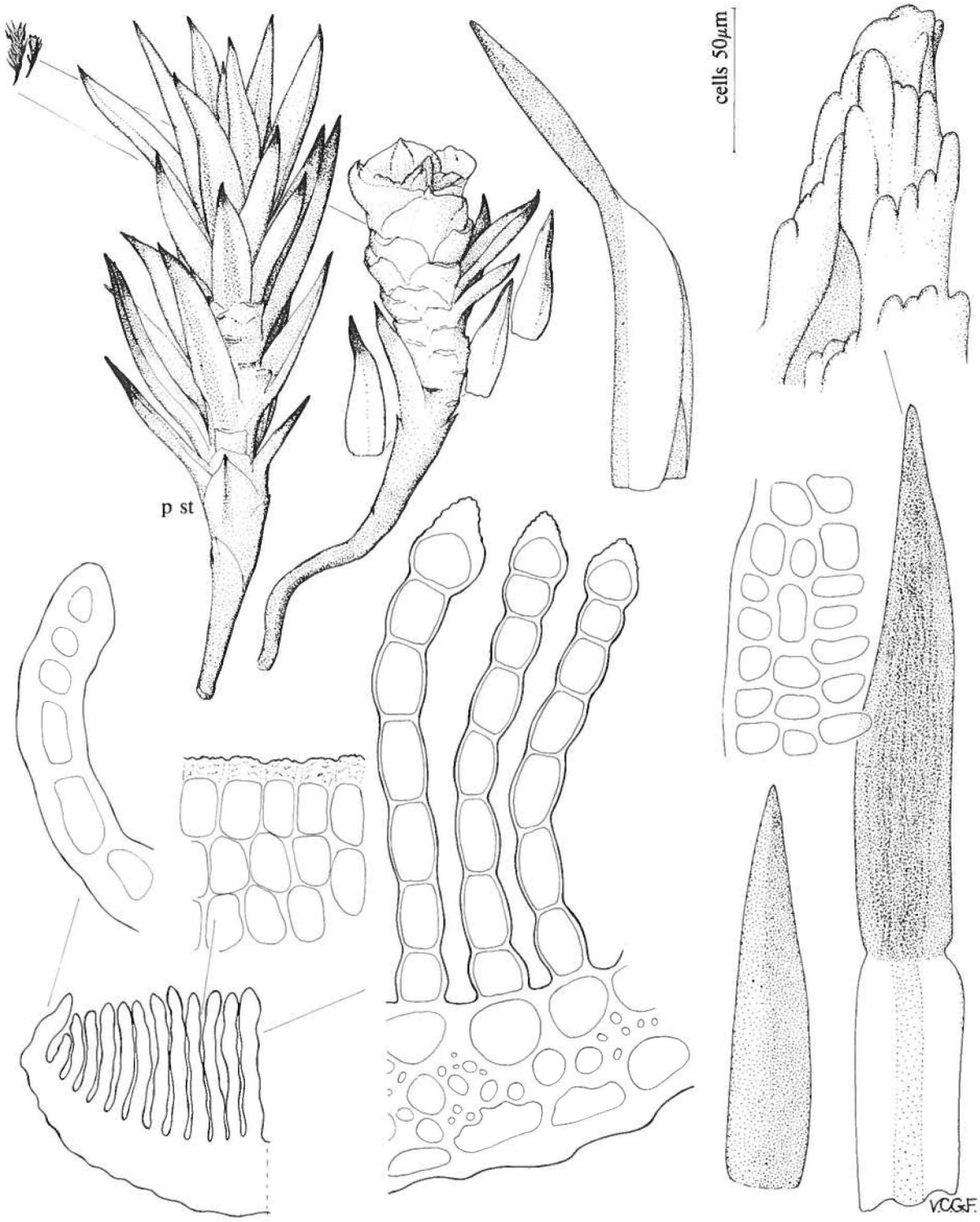
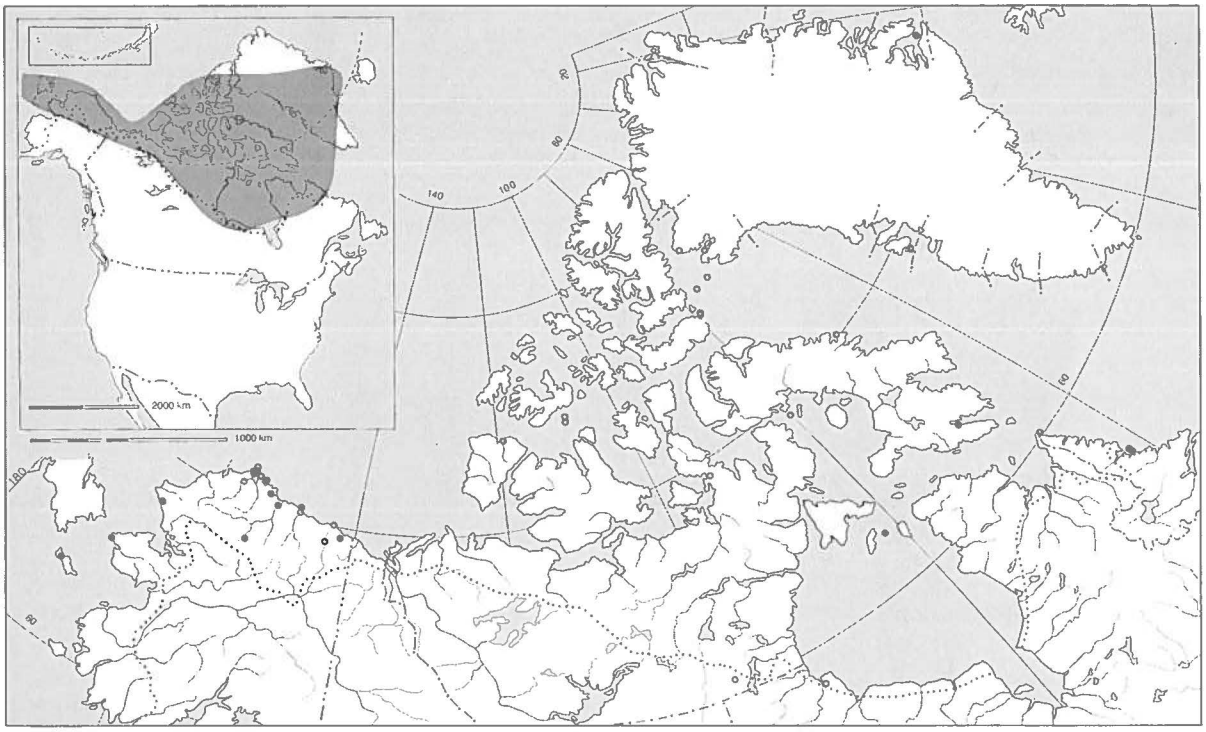
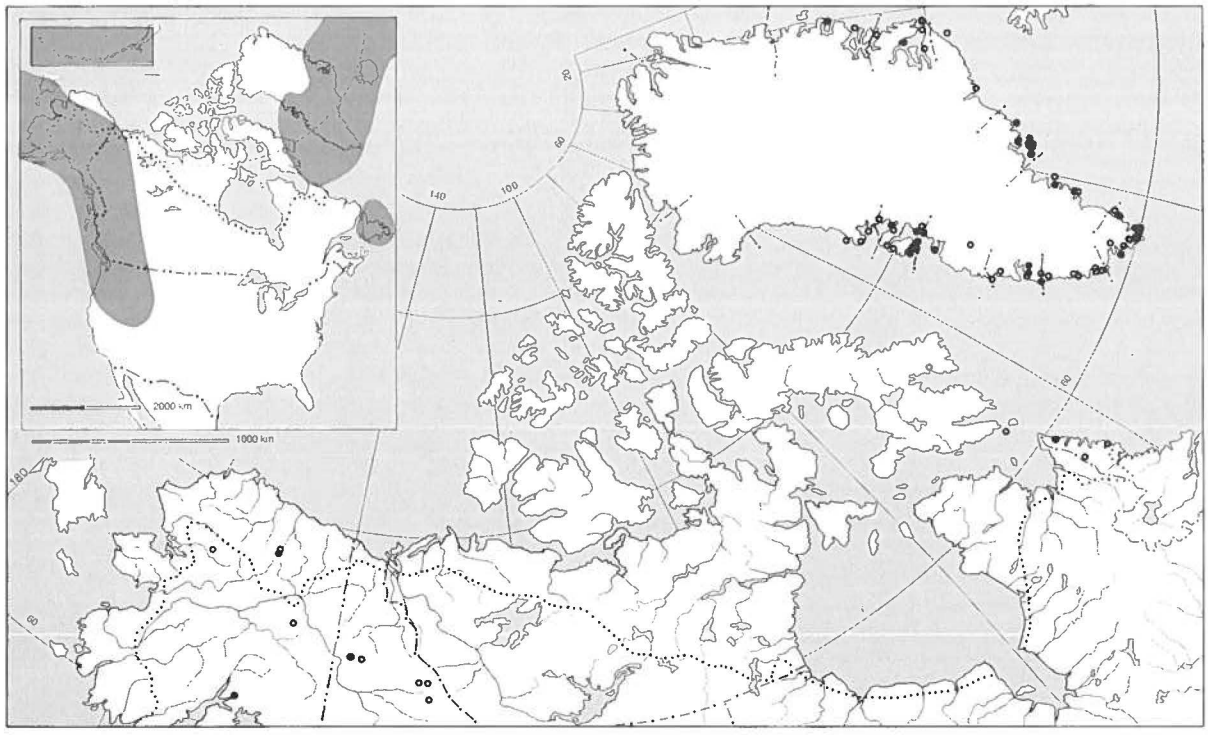


Fig. 9. *Polytrichastrum alpinum* var. *fragile*, Flakkerhuk, Disko, W-Greenland; leg. 1977 Mogensen 77-764, (C).



Map 11. *Polytrichastrum alpinum* var. *fragile*.



Map 12. *Polytrichastrum sexangulare*.

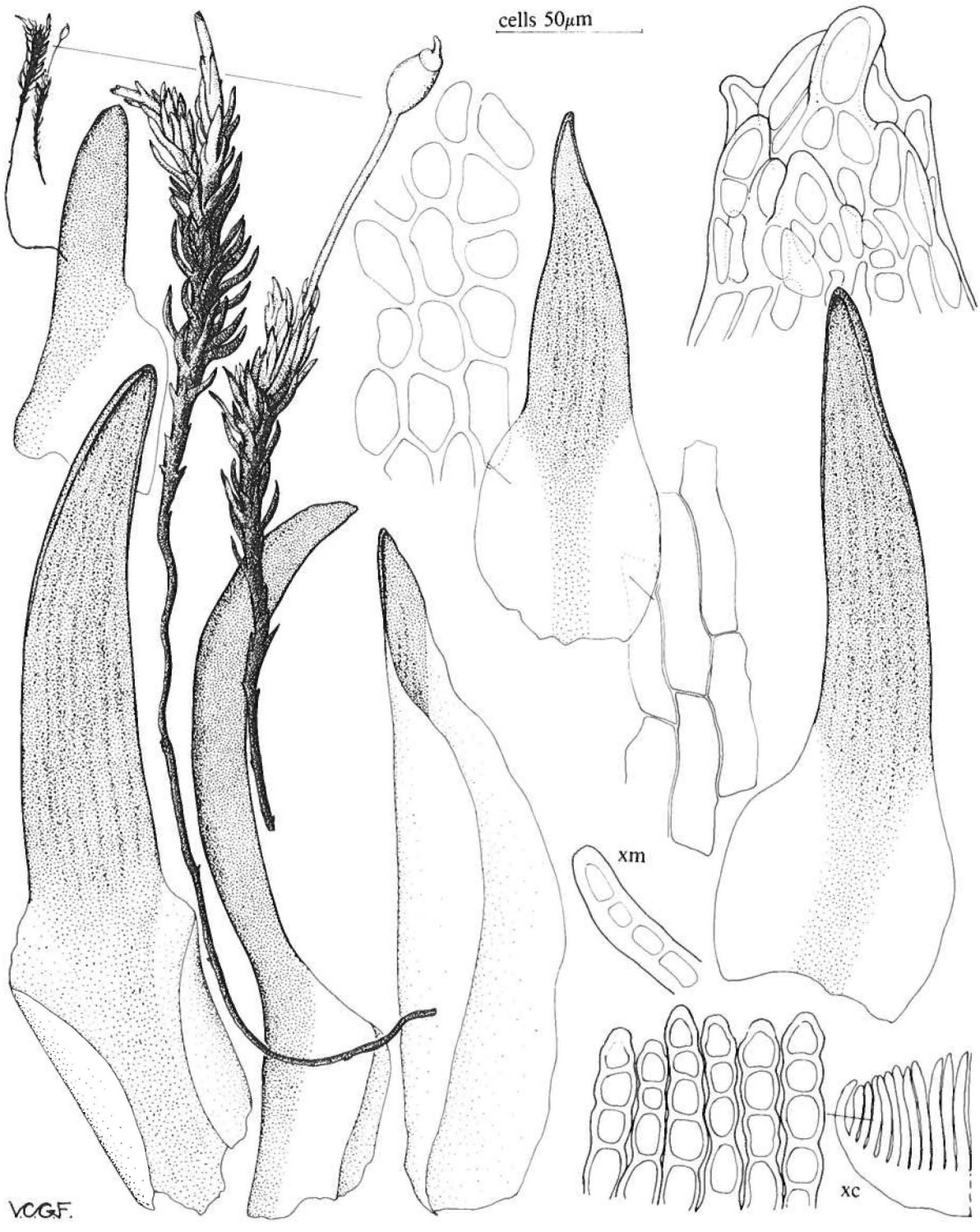


Fig. 10. *Polytrichastrum sexangulare*, Orpit qaqait, Disko, W-Greenland; leg. 1977 Mogensen and Brassard 77-201, (C).

capsules. Without detailed study of this variation it is impossible to clearly define infraspecific taxa other than var. *fragile*, and they are therefore retained as a single broad 'var. *alpinum*'. The var. *fragile* has been treated as a species by several authors. It may, however, prove to be merely another habitat modification of the species found in very wet habitats, but it is readily recognizable in most cases (unlike the other varieties) and it appears to be much more restricted geographically. Further study on its status is desirable.

The generic placement of *Polytrichum alpinum* has been a much-debated problem, now satisfactorily resolved by the creation of the genus *Polytrichastrum*. Earlier authors often placed it in *Pogonatum* on account of its terete capsules, but the presence of stomata and smooth exothecial cells exclude it from that genus. Sporophytes are common and serve to readily distinguish *P. alpinum* from other *Polytrichum* and *Polytrichastrum* species. Gametophytically, however, *P. alpinum* often resembles *Polytrichum* species in habit and stature, but in that genus the end-cells of the ventral lamellae are never finely papillose. The arctic species of *Pogonatum* have finely papillose end-cells; they differ as discussed under that genus. Similarly, some populations of *Polytrichastrum sexangulare* can also display this character and may be troublesome to name; such plants are treated under the latter species.

2. P. sexangulare (Brid.) G. L. Smith

Fig. 10. Map 12.

Mem. New York Bot. Gard. 21(3): 37. 1971. – *Polytrichum sexangulare* Brid., J. Bot. (Schrader) 1800, 1,2: 285. 1801. – Syntypes: Austria; Salzburg, leg. Flörke; Tyrol, leg. Hoppe, not seen.

Polytrichum norvegicum auct. *non* Hedw. 1801.

Polytrichum septentrionale auct. p.p., *non* Brid. 1801.

Stems loosely to densely aggregated, simple, 1–3(–6) cm. Leaves loosely arranged, when moist erect–spreading , when dry erect, imbricate but with limbs incurved, flexuose or somewhat falcate–secund, 3.0–4.7 mm, from broad, rectangular sheathing bases suddenly contracted to linear concave limbs; apices cucullate, blunt or subacute, margins strongly incurved towards apices, with limb almost tubular when dry, entire or serrulate below apices. Costae ending in apices or percurrent as a short entire or toothed point, dorsally smooth or commonly with a few sharp teeth towards apices. Ventral lamellae 25–36, 5–8 cells high, in side view almost flat-topped, in transverse section end-cells ovoid–conical with much thickened, smooth or minutely papillose apices. Median cells of leaf-bases elongate–rectangular, 25–60 × 5–8 μm, thin-walled. Limbs of laminae with broad, unistratose, incurved wings 3–4 cells broad in lower part, becoming up to 8–10 cells broad towards apices, with isodiametric to transversely rectangular cells 9–15 μm broad, equally thick-walled. Marginal teeth few, shallow, 1-celled, or absent. Perichaetial leaves slightly longer than stem leaves, 4.5–5.0 mm.

Setae brown, 1.4–2.8(–4.0) cm. Capsules erect or slightly inclined; urns 2.6–3.2 mm, shortly cylindric–ovoid, 5–6-angled, rarely subterete; exothecial cells not pitted; hypophyses distinct. Peristome teeth 64, unequal, narrowly lanceolate, acute, whitish, 130–260 μm, borne on basal membrane 90–120 μm tall. Spores 18–21 μm, finely papillose.

Forming dark green mats on damp soil, gravel and rocks, typically in snow-bed communities, close to snow-melt streams or on lake margins. In Alaska and Yukon Territory restricted to montane habitats between 1100 and 1800 m, in Greenland as low as 50 m. In arctic America and Greenland displays a disjunct distribution similar to that of *Oligotrichum hercynicum*, in the west relatively rare in Alaska, commoner on the mountains of southern Yukon Territory; in the east common in southern Greenland, with outlying localities on Baffin I. and in Labrador. An arctic–alpine species found in the mountains of central Europe, Pyrenees, Yugoslavia, Turkey, Scotland, Scandinavia, Faroes, Svalbard, Iceland, Siberia and Japan; in western North America in Alaska, Aleutian Is, Yukon Territory, British Columbia, Washington, Alberta, Montana and Wyoming, and in eastern North America from Labrador south to Newfoundland.

Selected specimens seen:

Greenland. W 2: Ivigtut, 61°13′N, 48°10′W; 1946 Holmen 5097 (C, FH). – W 3: Kangamiut, 65°50′N, 53°20′W; 1946 Holmen 5015 (C, CANM). – W 5: Jakobshavn, 69°13′N, 51°06′W; 1867 Brown *s.n.* (BM). – E 5: Langelandelv, Scoresby Sund, 70°32′N, 23°38′W; 1971 Halliday B48a (C, E). – E 3: Angmagssalik, W Sømandsfjeld, 65°35′N, 37°40′W; 1968 Daniels & Molenaar 68271B (ALTA, C).

Canada. Labrador, Crater Lake, WSW of Hebron, 58°02′N, 64°02′W; 1954 Gillett 8986 (C, CANM). – Yukon Territory, Tombstone Mt, 64°28′N, 138°32′W; 1973 Vitt 8004. (ALTA).

Alaska. Circle Quad, Eagle Summit, 65°29′N, 145°25′W; 1972 Murray & Steere 72-13 (ALA). – Philip Smith Mountains Quad., "Mt Steere", 68°29′N, 149°25′W; 1982 Long 11303 (E). – Ambler R. Quad., source of Cooper Creek, 67°17′N, 157°00′W; 1976 Lewis 2426 (NY).

Polytrichastrum sexangulare is a distinctive species unlikely to be confused with other species, especially when bearing sporophytes, except for stunted phenotypes which may bear only faintly 5–6-angular or almost terete capsules. Such forms have been confused both with *P. alpinum* (Hedw.) G. L. Smith and *Polytrichum sphaerothecium* (Besch.) C. Müll.

The very variable *P. alpinum* can be distinguished by its finely-pointed leaves without the cucullate apex of *P. sexangulare* and by the densely papillose end-cells of the ventral lamellae.

P. sphaerothecium, not yet known from the Arctic, but occurring on volcanic rocks in Iceland and the Aleutian Islands, is gametophytically very similar to *P. sexangulare* but its leaves have a narrower sheathing base gradually tapering into the limb, its capsules are terete and subglobose, borne on short curved setae, and it has much shorter peristome teeth. Some extreme forms of *P. sexangulare* have much shorter setae, and in three collections (Lewinsky 70-22 (C) from eastern Greenland and Horton 10729 and Vitt 20552 (ALTA) from

southern Yukon) the setae are very short and curved, closely resembling those of *P. sphaerothecium*. However, the capsules are ovoid rather than subglobose, the peristome is similar to that of *P. sexangulare* and the habitat is on soil in late snow areas. *P. sphaerothecium* probably belongs to *Polytrichastrum* but further study is needed to ascertain its exact status.

Some arctic populations of *P. sexangulare* differ from the typical European form in having the end-cells of the ventral lamellae finely papillose, and have sometimes been confused with *P. alpinum*. They differ from the latter in their linear, strongly channelled limb distinctly hooded at the apex, broader and more strongly inrolled lamina wings, and relatively broader sheath which narrows abrubtly into the limb; in small forms of *P. alpinum* the limb is always narrowly lanceolate, the apex, though channelled, gradually tapers to a fine point and is not hooded, and the leaf sheath is narrow and more gradually contracting into the limb. In the dry condition the leaves of *P. sexangulare* are usually somewhat flexuose or curved and blackish green, whilst those of *P. alpinum* are straight and brown.

Polytrichastrum papillatum G.L. Smith, known from southern Alaska (Valdez Quad., Herman 21622 (NY)) and the Himalaya, is similar to the papillose form of *P. sexangulare*, but in side view its ventral lamellae are both strongly crenate and finely papillose; in *P. sexangulare* they are flat-topped in side-view.

3. P. longisetum (Brid.) G. L. Smith

Fig. 11. Map 13.

Mem. New York Bot. Gard. 21(3): 35. 1971. – *Polytrichum longisetum* Brid., J. Bot. (Schrader), 1800, 1,2: 286. 1801. – Type: Sweden, leg. Swartz, isotype in E, seen.

Polytrichum aurantiacum Brid., J. Bot. (Schrader), 1800, 1,2: 286. 1801, *nom. illeg.* – Type: *Polytrichum longisetum* Brid.

Polytrichum gracile Menzies, Bot. Zeitung (Regensburg) 1: 74. 1802. – Type: Scotland, leg. Dickson, lectotype in E, seen.

Atrichum anomalum Milde, Hedwigia 8: 161. 1869. – *Polytrichum gracile* Menzies var. *anomalum* (Milde) Hag., Tromsø Mus. Aarsh. 21 & 22(3): 265. 1899. – *Polytrichastrum longisetum* (Brid.) G. L. Smith forma *anomalum* (Milde) Schljakov, Nov. Syst. Pl. non Vasc. 19: 209. 1982. – Type: Czechoslovakia/Poland, not seen.

Stems loosely aggregated, simple, 2.5–5(–10) cm. Leaves crowded towards stem apices, erect–spreading to weakly recurved when moist, erect and slightly flexuose when dry, 5.0–7.5(–9.0) mm, from rectangular sheathing bases gradually contracted into flat, narrowly lanceolate limbs; apices subulate, weakly channelled with incurved margins; margins strongly serrate throughout. Costae excurrent as serrate brown aristae, dorsally with scattered teeth in upper half of limbs. Ventral lamellae 36–50, 5–7 cells high, in side view flat-topped, smooth, in transverse section end-cells weakly differentiated, slightly thickened, rounded. Median cells of leaf bases rectangular, 30–65 × 10–18 µm, thin-walled. Laminae of limbs with unistratose, erect wings 4–7(–12) cells broad at mid-limb, with quadrate slightly incrassate cells 12–21 µm broad. Marginal teeth ascending, acute, of 1 enlarged cell. Perichaetial leaves slightly longer than stem leaves.

Setae yellow–brown, 2.5–5.5 cm. Capsules erect or inclined, urns 3.0–4.5 mm, ovoid–cylindric, with 5–6 rounded angles, almost terete when moist; exothecial cells not pitted; hypophyses distinct. Peristome teeth 64, irregularly developed, some confluent, obtuse, pale yellow, (85–)180–310 µm, borne on low basal membrane 25–40 µm. Spores 20–26 µm, almost smooth.

Forming dark green patches or as scattered stems in moist, acidic to basic peaty habitats, frquently on hummocks in rich fens, wet meadows, lake margins and tussock-tundra, also as a colonist on moist eroded or disturbed peat, occasionally submerged in pools. In the Arctic typically at lower altitudes from sea-level up to 1400 m.

Rare in South Greenland and arctic Canada, although frequently collected around Hudson Bay and in Labrador, commoner in arctic Alaska. A very widely distributed species ranging from New Zealand and South America to Japan, Korea, New Guinea through northern Asia, Turkey, Europe, Svalbard, South Greenland and North America (widespread in Alaska, Canada, northern USA, southwards at higher altitudes to California, Arizona and Florida).

Selected specimens seen:

Greenland. S 1: Narssaq, "Narssaqsund", 60°56′N, 46°03′W; 1962 Steere 62-1037 (C, CANM, NY). – W 2: "Puiatna", 61°42′N, 49°03′W; 1965 Damsholt 65-324 (C). – W 3: Godthåbsfjord, Itivnera, 64°22′N, 50°25′W; 1960 Nielsen 1668a (C).

Canada. Québec, Sud du Lac Fusil, 58°20′N, 72°12′W; 1977 Morin 70-2 (CANM). – Northwest Territories, Sawmill Bay, Great Bear Lake, 65°43′N, 118°50′W; 1948 Steere 10385 (CANM, NY). – Parry Penins., 67°38′N, 123°27′W; 1978 Scotter 26249 (NY).

Alaska. Sagavanirktok Quad., Kavik River Camp, 69°46′N, 147°10′W; 1973 Steere, Inoue & Iwatsuki 945 (NY). – Philip Smith Mts Quad., Slope Mountain, 68°47′N, 148°48′W; 1976 Murray 76–455 (ALA, ALTA, C, NY). – Umiat Quad., Gubic Test Well, 69°28′N, 151°30′W; 1951 Steere 15959 (CANM). – Point Hope Quad., Cape Thomson, 68°06′N, 165°45′W; 1966 Smith A276 (C, NY).

When bearing sporophytes recognizable by the rounded–angular capsules not constricted between the urn and hypophysis; vegetatively the broad, strongly serrate lamina wings are characteristic, as are the smooth, undifferentiated end-cells of the ventral lamellae. Records of the closely allied *Polytrichastrum formosum* (Hedw.) G. L. Smith from the Arctic have not been substantiated; most are based on misidentifications of *P. longisetum* and *Polytrichum swartzii*. *P. formosum* differs in its more angular capsules, the narrower lamina wings 2–4 cells broad, these cells smaller, 8–14 µm broad, and by the narrowly rectangular median cells of the leaf-sheaths. In very wet habitats the leaves of *P. longisetum* bear fewer lamellae and correspondingly broader lamina-wings. The most extreme forms have been named forma *anomalum* (Milde) Schljakov but frequent intermediates link it to the typical form and it is very likely only a habitat modificattion.

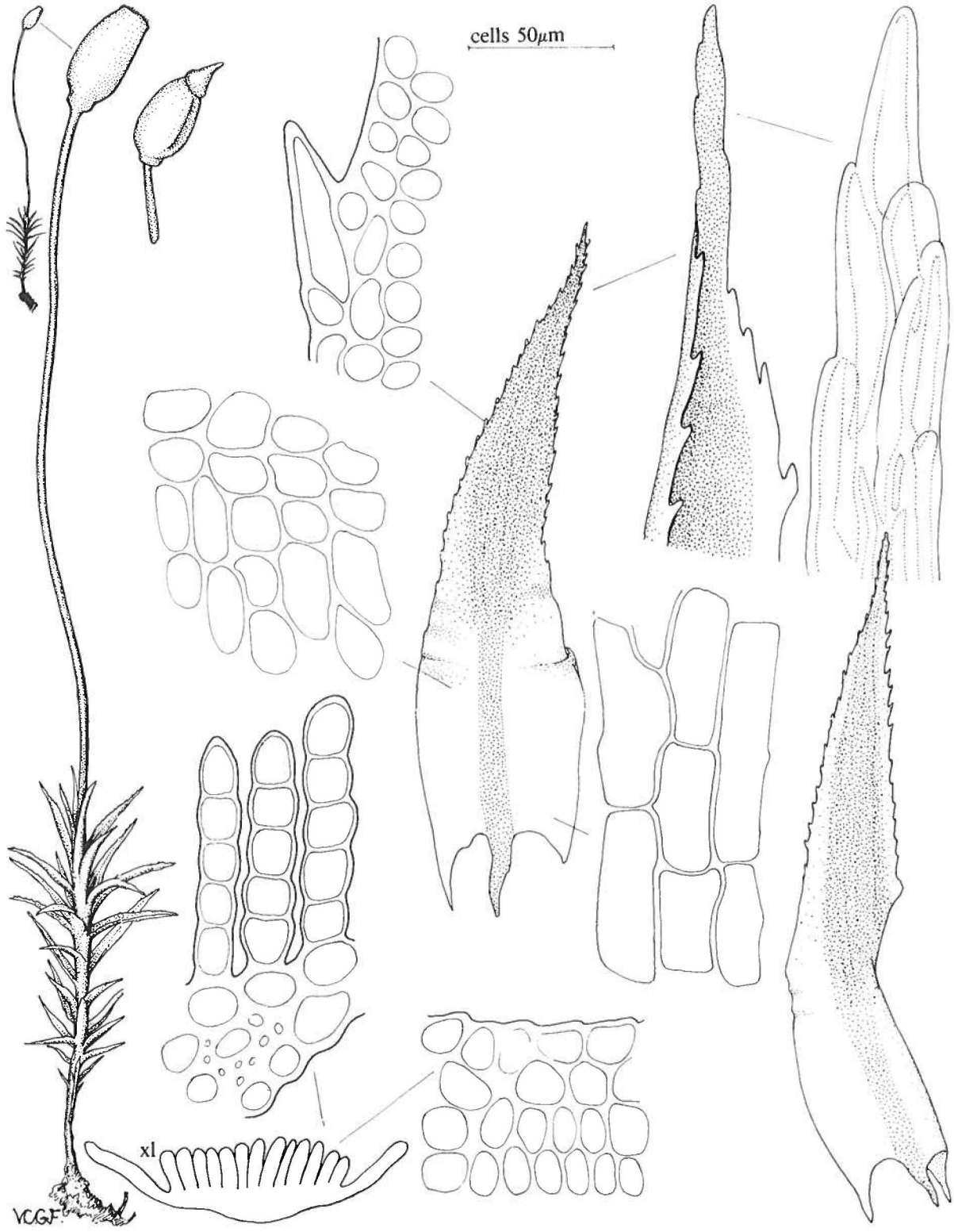
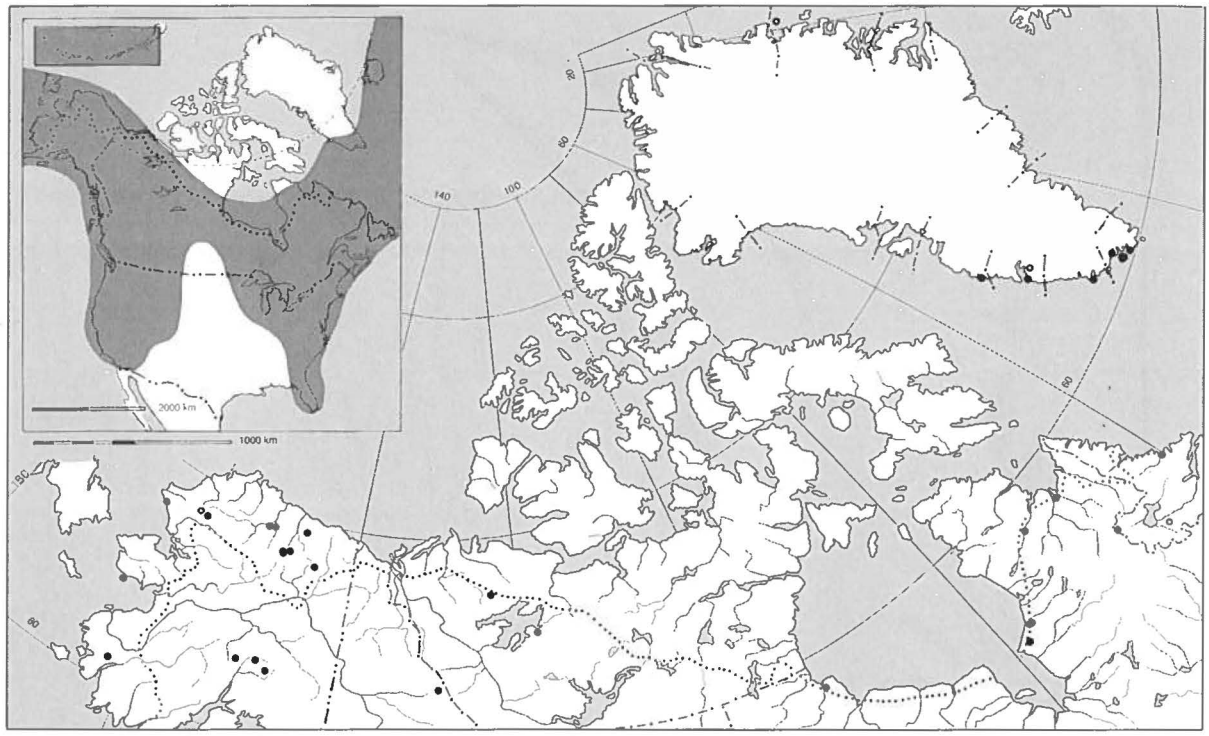
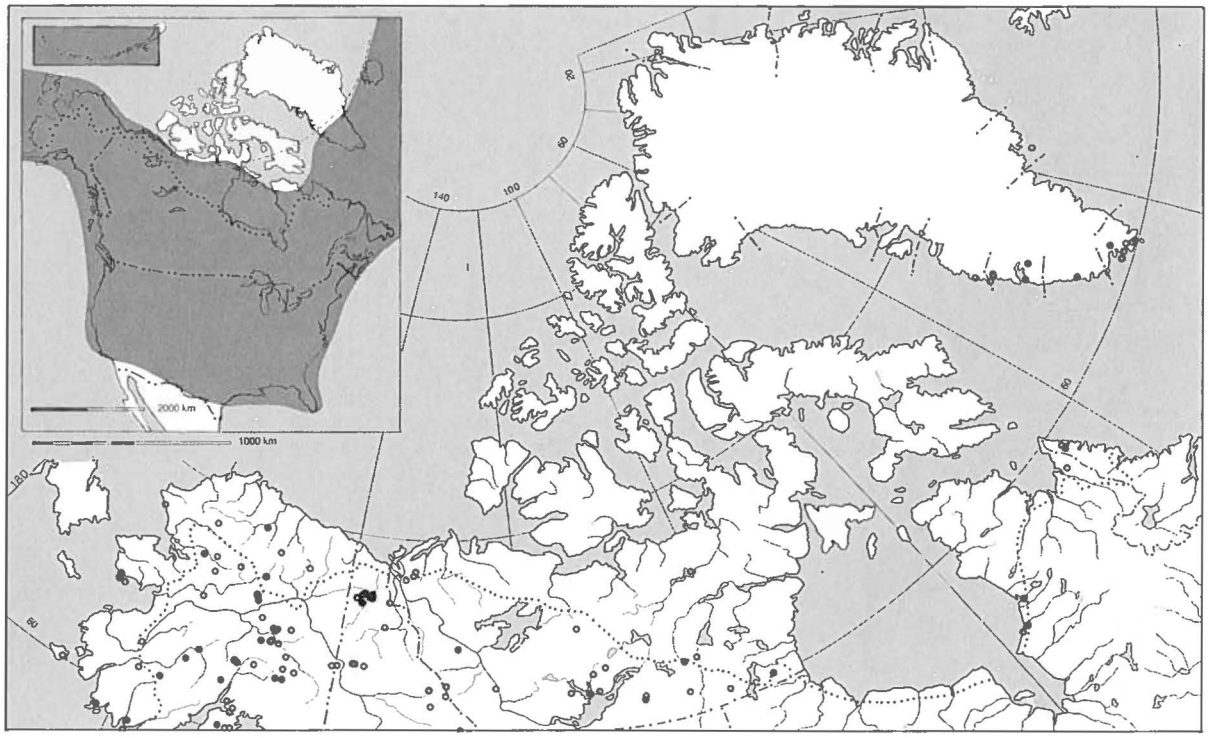


Fig. 11. *Polytrichastrum longisetum*, head of Amitsuarsuk Fjord, S-Greenland; leg. 1974 Holmen 74-364, (C).



Map 13. *Polytrichastrum longisetum*.



Map 14. *Polytrichum commmune* var. *commune*.

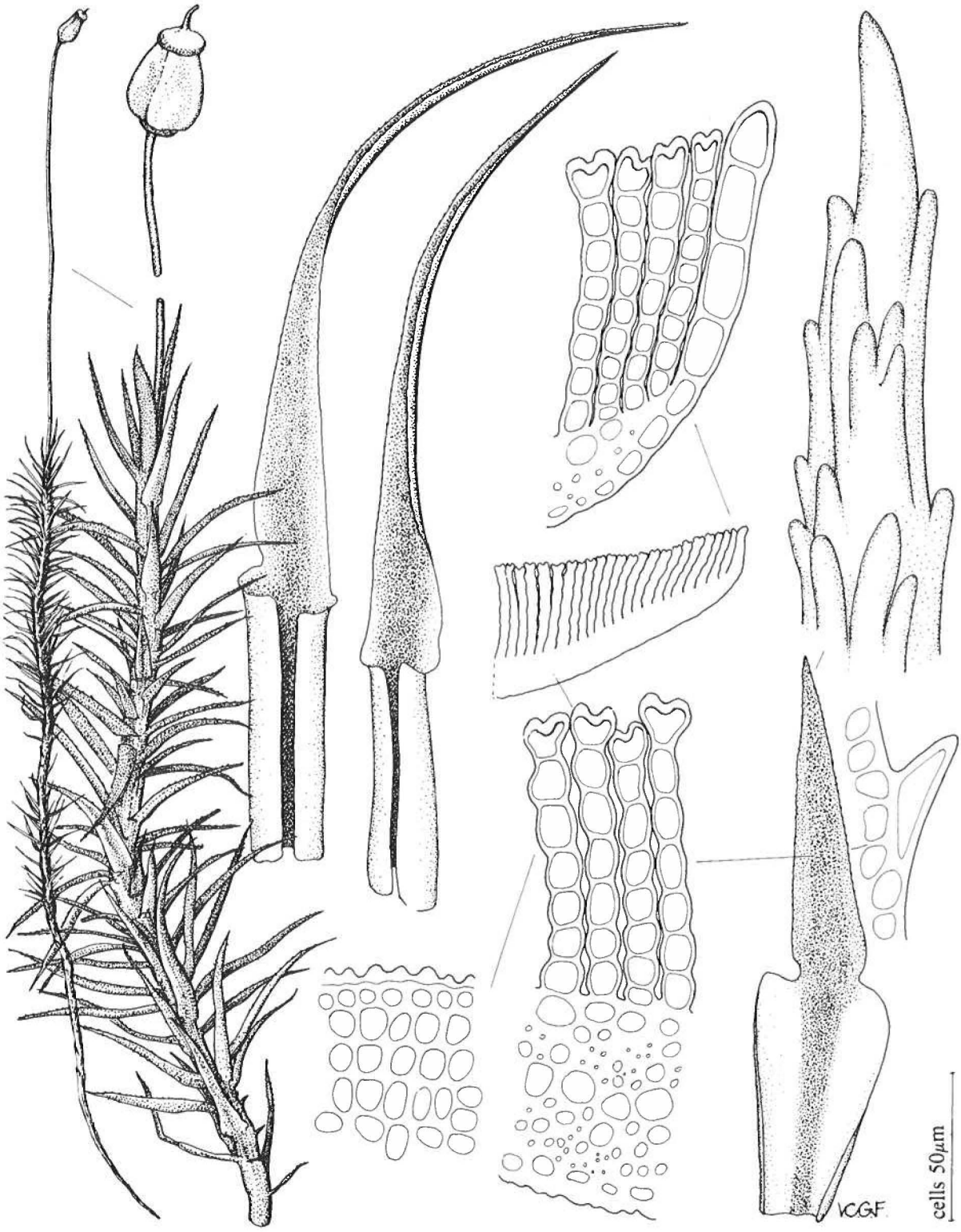


Fig. 12. *Polytrichum commune* var. *commune*, Narssarssuaq, S-Greenland; leg. 1974 Holmen 74-198, (C).

5. Polytrichum

Polytrichum Hedw., Sp. Musc. Frond. 88. 1801. – Type: not designated.

Stems short or more often tall, rigid, often gregarious, simple or rarely branched. Lower leaves distant, scale-like, appressed; upper leaves crowded, sometimes caducous, erect–spreading to squarrose when moist, appressed to erect–spreading, straight or flexuose when dry, with thin, well-defined sheathing bases; limbs linear–lanceolate, opaque, flat or strongly channelled and tubular, apices subulate or aristate, toothed or entire; margins erect or strongly inrolled, serrate or entire, not bordered. Costae narrow and well-defined in sheaths, broad but poorly defined in limbs, shortly to long-excurrent as a coloured or hyaline hair-point, dorsal surface smooth or toothed near apices. Ventral lamellae numerous, covering costae and half to most of laminae; end-cells strongly differentiated, weakly to strongly thickened, never finely papillose, in side view shallowly to deeply crenate, in transverse section end-cells rounded, flat-topped or with median groove. Leaf bases unistratose, median cells linear to rectangular, thin-walled. Laminae of limbs bistratose with narrow to broad unistratose wings; cells of wings subquadrate or transversely elongate–rectangular, thick- or thin-walled; marginal teeth when present of a single large cell. Dioicous. Perigonia discoid; perigonial leaves with enlarged broad sheaths and much-reduced limbs. Perichaetial leaves similar to stem leaves but with longer sheaths.

Sporophytes frequent. Setae elongate, erect. Capsules erect to horizontal, sharply 4(–5)-angled, symmetric, hypophyses strongly differentiated, with constriction between them and urns, bearing stomata. Exothecial cells mamillose, with a median pit. Peristomes of 64 simple teeth, each winged internally. Epiphragms thin, membranous, with sac-like lobes on ventral margin. Lids rostrate. Spores (under S.E.M.) with minute pointed "Christmas tree" projections. Calyptrae densely covered with long hairs.

A large world-wide genus of about 80 species. Closely allied to *Polytrichastrum* but differing in its sharply 4(–5)-angled capsules with a deep constriction between urns and hypophyses, the pitted exothecial cells, the thin epiphragms with sac-like ventral marginal lobes, and the minute projections on spores (visible only with S.E.M.).

1. Lamina wings serrate to entire, erect when moist, not infolded over ventral lamellae; cells of lamina wings isodiametric or up to 2 times as wide as long (Sect. *Polytrichum*).
   2. End-cells of ventral lamellae in transverse section single or paired, usually broader than tall, sometimes isodiametric, flat-topped or shallowly grooved, without papilla-like thickenings, often oblique towards leaf margins; in side view lamellae flat-topped or shallowly crenate, without papilla-like thickenings. . . . . 2. *P. swartzii*
   2. End-cells of ventral lamellae in transverse section single, not broader than tall, with 2 papilla-like thickenings and deep U-shaped sinus between, not oblique; in side view lamellae strongly crenate, each end-cell with a papilla-like thickening.
      3. Stems 4–30(–45) cm; leaves squarrose-recurved when moist, not caducous, margins strongly serrate; urns rectangular, 3–5 mm. . . . . 1. *P. commune* var. *commne*
      3. Stems 2–12 cm; leaves straight or weakly recurved when moist, often caducous, margins entire or distantly serrulate; urns cubic or shortly rectangular, 2.5–3.5 mm . . . . . 1. *P. commune* var. *diminutum*
1. Lamina wings entire or minutely crenulate, abruptly infolded over ventral lamellae; cells of lamina wings transversely elongate–rectangular, 3–5 times as wide as long (Sect. *Juniperifolia*).
   4. Leaf bases ovate; limbs abruptly contracted at apices into long hair points 1.1–3.0 mm, which are hyaline throughout. . . . . 3. *P. piliferum*
   4. Leaf bases rectangular; limbs gradually tapering into short hair points 0.3–1.1 mm, which are brown throughout or hyaline above and brown below.
      5. Stems commonly branched; hair points hyaline in upper 0.5–0.8, brown below, densely spinose–toothed near bases, with fewer teeth towards apices; end-cells of median ventral lamellae ovoid, not thickened, usually larger than cells below. . . . . 4. *P. hyperboreum*
      5. Stems simple; hair points brown throughout or hyaline at extreme apices, shortly toothed throughout to almost smooth; end-cells of median ventral lamellae conic or pyriform, thick-walled and with papilla-like apices, smaller than or equalling cells below.
         6. Stems naked below, with pale brown tomentum only at bases; leafy shoots 8–11 mm broad when moist; leaves often weakly curved, 4–8 mm; urns 2.8–4.8 mm, 1.5–2.0 times as long as broad; peristome teeth 200–250 µm. . . . . 5. *P. juniperinum*
         6. Stems not naked below, densely whitish tomentose in lower parts; leafy shoots 2–7 mm broad when moist; leaves straight, 2.5–5.0 mm; urns 2.5–3.2 mm, 1.0–1.3 times as long as broad; peristome teeth 150–180 µm. . . . . 6. *P. strictum*

1. P. commune Hedw.
Sp. Musc. Frond. 88. 1801. – Syntypes: Europe, not seen.

Stems usually aggregated, simple, erect, rigid, 2–30 (–45) cm, in lower part sparsely to moderately whitish tomentose. Leaves green, densely arranged, when moist erect–spreading and straight to squarrose and recurved, when dry appressed to stems with tips erect or spreading, rarely flexuose, 6–12 mm, from pale, rectangular sheathing bases little narrowed or with short abrupt constriction into flat, linear–lanceolate limbs, sometimes caducous from bases of limbs; apices subulate to aristate, towards apices weakly channelled; margins sharply serrate to entire. Costae excurrent as short brown, entire or toothed point, in young leaves often with slender, elongate, caducous, hyaline aristae, dorsally with low teeth in upper 0.3 of limbs to smooth. Ventral lamellae 26–48, mostly 6–9 cells high, in side view strongly crenate with a papilla-like thickening on each end-cell; in transverse section end-cells always single, not broader than tall, with two papilla-like thickenings and deep U-shaped groove between. Median cells of leaf bases rectangular to narrowly rectangular, 60–130 × 9–22 μm. Laminae of limbs with narrow erect unistratose wings 3–7 cells broad at mid-limb, with quadrate or commonly transversely rectangular cells 1.5–2 times as broad as long, 10–16 μm broad, moderately thick-walled. Marginal teeth ascending, of 1 large, acute cell, sometimes small or absent. Perigonial bracts with broad, obovate sheaths and short limbs. Perichaetial leaves with slightly to greatly elongated sheathing bases and short, subulate limbs.

Setae reddish brown, 1.5–8 cm. Capsules erect or weakly inclined, often becoming nearly horizontal when old, urns 2.5–5 mm, rectangular or cubic, 1–2 times as long as broad, sharply 4-angled; exothecial cells mamillose, each with a large rounded to shortly elliptic pit; hypophyses distinct, disc-like, with deep constriction above. Peristome teeth oblong, obtuse, equal, whitish, 200–260 μm, borne on basal membrane 60–100 μm. Spores 9–12 μm, almost smooth.

Var. **commune**

Fig. 12. Map 14.

Polytrichum perigoniale Michaux, Fl. Bor. America 2: 293. 1803. – *Polytrichum commune* Hedw. var. *perigoniale* (Michaux) Hampe, Linnaea 13: 44. 1839. – Syntypes: Europe, North America, not seen.

Polytrichum commune Hedw. var. *maximoviczii* Lindb., Act Soc. Sci. Fenn. 10: 224. 1872. – Type: Japan, 1865, leg. Maximovicz, holotype in H-SOL, seen.

Polytrichum commune Hedw. var. *nigrescens* Warnst., Verh. Bot. Ver. Brandenburg 41: 65. 1899. – Type: Germany, Spandau, 1897, leg. Präger, topotypes in B, C, seen.

Stems usually tall, 4–30(–45) cm. Leaves when moist widely spreading, often squarrose–recurved, when dry usually appressed to stems but with spreading tips, occasionally erect–spreading and flexuose, 7–12 mm, not caducous, margins strongly serrate in upper 0.5–0.8 of limbs, rarely only near apices, costae dorsally with low teeth in upper 0.3 of limbs; median cells of leaf bases linear–rectangular, 80–130 × 9–15 μm. Perichaetial leaves with elongated basal sheaths usually exceeding upper stem leaves.

Setae 4–8 mm. Urns rectangular, 3–5 mm long.

Typically forming extensive green carpets in damp *Picea* and *Betula* forests, but commonly in muskeg swamps, amongst *Salix* scrub, in damp meadows, stream banks, lake margins, *Sphagnum* bogs, tussock tundra and in damp hollows in alpine tundra. Common from sea level up to 1800 m in Yukon Territory.

Widespread and abundant in the boreal forests of Alaska and Canada but much less common north of the tree-line, apparently absent from the Canadian Arctic Archipelago, in Greenland rare, only in the south and west coasts north to Disko Island. An almost cosmopolitan temperate variety, found throughout Europe, Iceland, northern Asia and Japan; also reported from Australasia, Pacific Islands, Africa and South America; in North America south to California, Texas and Florida.

Selected specimens seen:
Greenland. S 1: Igdlorssuit, 60°11′N, 44°03′W; 1966 Gravesen & Hansen 66–779 (C, NY). – W 2: Nigerdleq, 62°05′N, 49°20′W; 1963 Holmen 63-147 (C, NY). – W 3: Taserssuaq, 65°47′N, 52°40′W; 1958 Christensen *s.n.* (C).
Canada. Labrador, Nachvak Fiord, 59°02′N, 64°03′W; 1975 Weber 1607 (NFLD). – Northwest Territories, Inuvik, 68°21′N, 133°40′W; 1963 Steere 63-720 (NY). – Yukon Territory, Old Crow Airstrip, 67°03′N, 138°36′W; 1972 Marsh 2597 (ALTA, CANM).
Alaska. Arctic Quad., Arctic Village, 68°08′N, 145°32′W; 1974 Steere & Iwatsuki 74-218 (NY). – Bettles Quad., No Name Creek, 66°09′N, 150°10′W; 1976 Murray 76-730 (ALA, ALTA, NY). – Ambler River Quad., Upper Ambler River, 67°20′N, 156°56′W; 1976 Lewis 2318 (ALA, C). – Point Hope Quad., Ogotoruk Creek, 68°05′N, 165°32′W; 1959 Johnson *et al.* 404 (ALA, ALTA).

Var. **diminutum** (Hag.) Long, *comb. nov.*

Fig. 13. Map 15.

P. commune Hedw. var. *diminutum* (Hag.) Long, *comb. nov.* – Basionym: *Polytrichum jensenii* Hag. var. *diminutum* Hag., Kongel. Norske Vidensk. Selsk. Skr. 1913(1): 56. 1914. – Type: Norway, Opdal, leg. Kiær, isotype in S, seen.

Polytrichum commune Hedw. var. *brevifolium* C. Jens., Meddr Grønland 3: 354. 1887, *hom. illeg. non* Geheeb 1879. – Type: West Greenland, leg. Rink, holotype in C, seen.

Polytrichum jensenii Hag., Meddr Grønland 15(7): 444. 1898. – *Polytrichum commune* Hedw. var. *jensenii* (Hag.) Frye, in Grout, Moss Fl. North America 1: 125. 1937. – Type: Northeast Greenland, Agpalisiorfik, leg. Ryder, holotype in C, seen.

Polytrichum yukonense Card. & Thér., Proc. Wash. Acad. Sci. 4: 329. 1902. – *Polytrichum commune* Hedw. var. *yukonense* (Card. & Thér.) Frye, in Grout, Moss Fl. North America 1: 125. 1937. – Type: Alaska, Yukon River, 1867, leg. Dall, holotype in PC, seen.

Stems 2–12 cm. Leaves when moist erect–spreading to widely-spreading, straight or weakly recurved, when dry closely appressed to stems, straight or erect–spreading and weakly flexuose, 6–10 mm, often caducous from bases of limbs, margins usually entire or distantly serrulate in upper 0.3–0.5 of limbs, costae dorsally smooth, median cells of leaf bases rectangular, 60–90 × 15–22

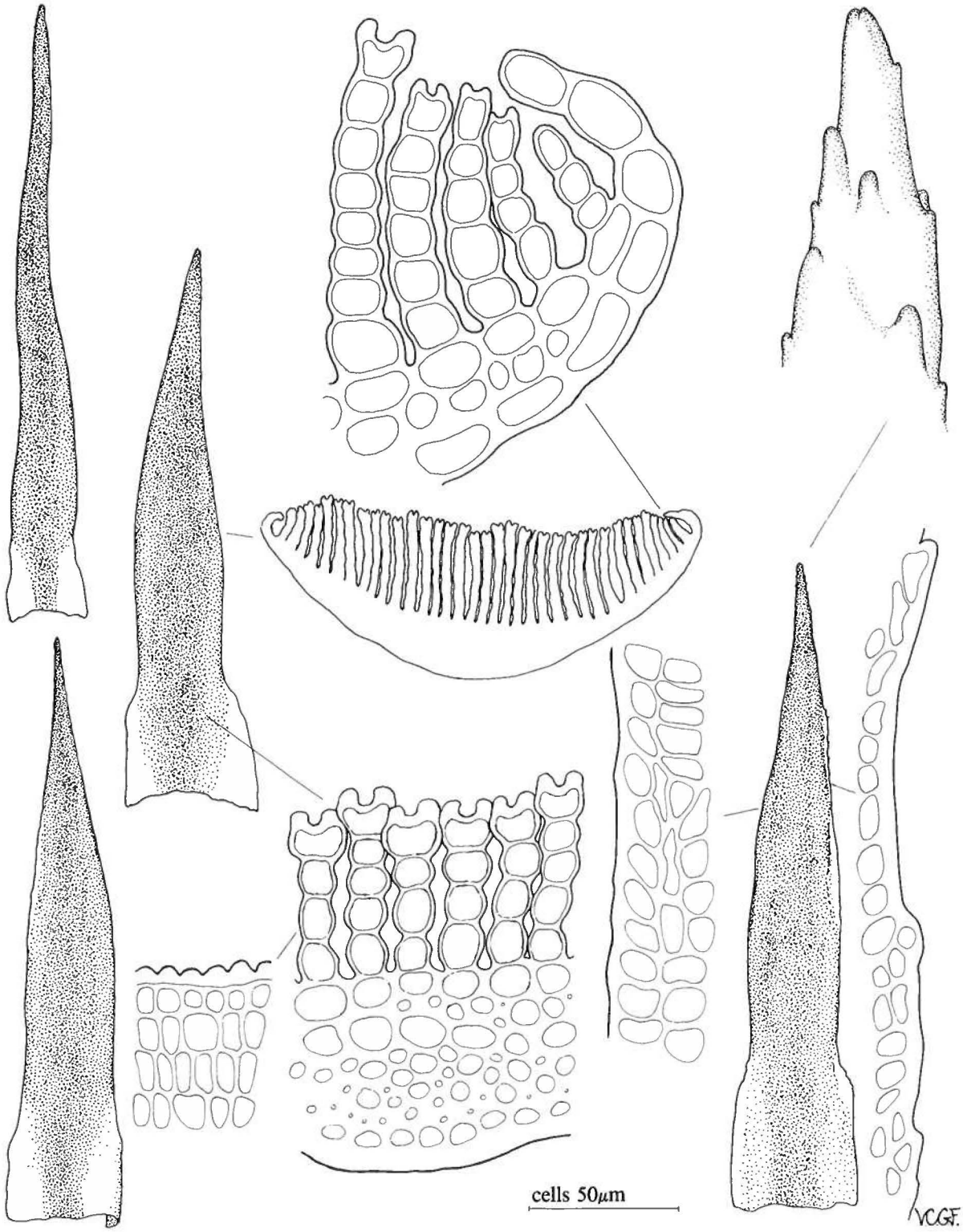
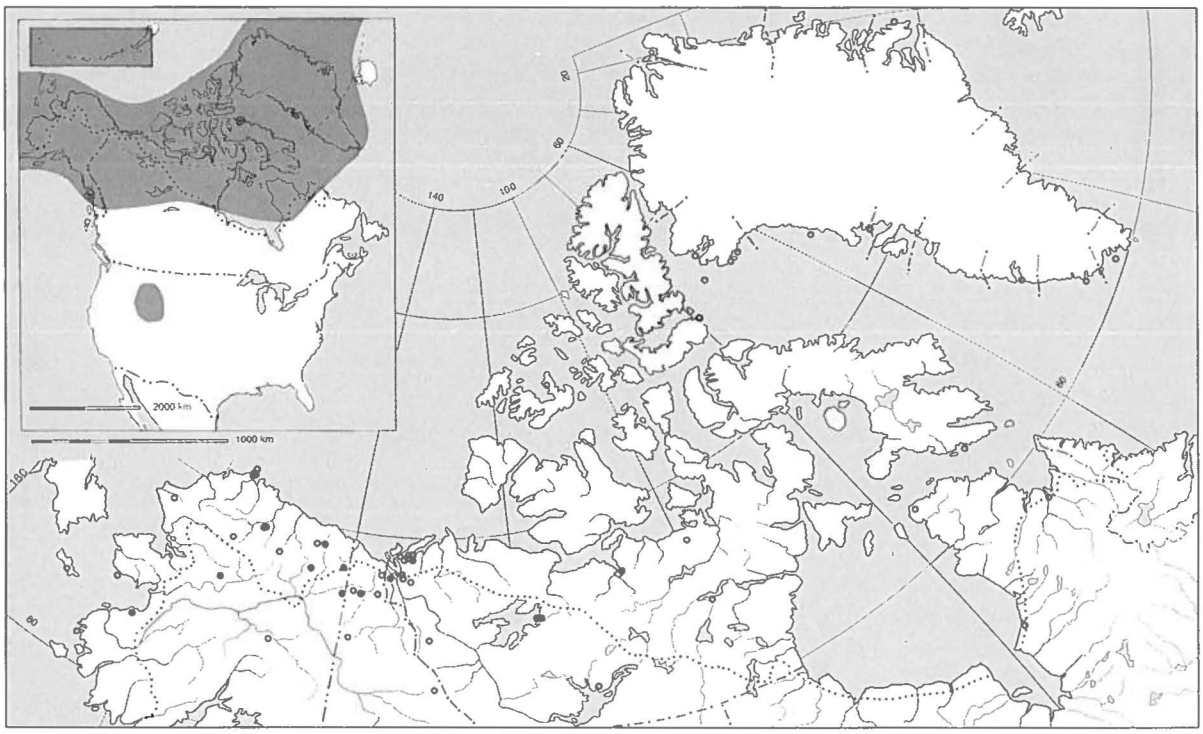
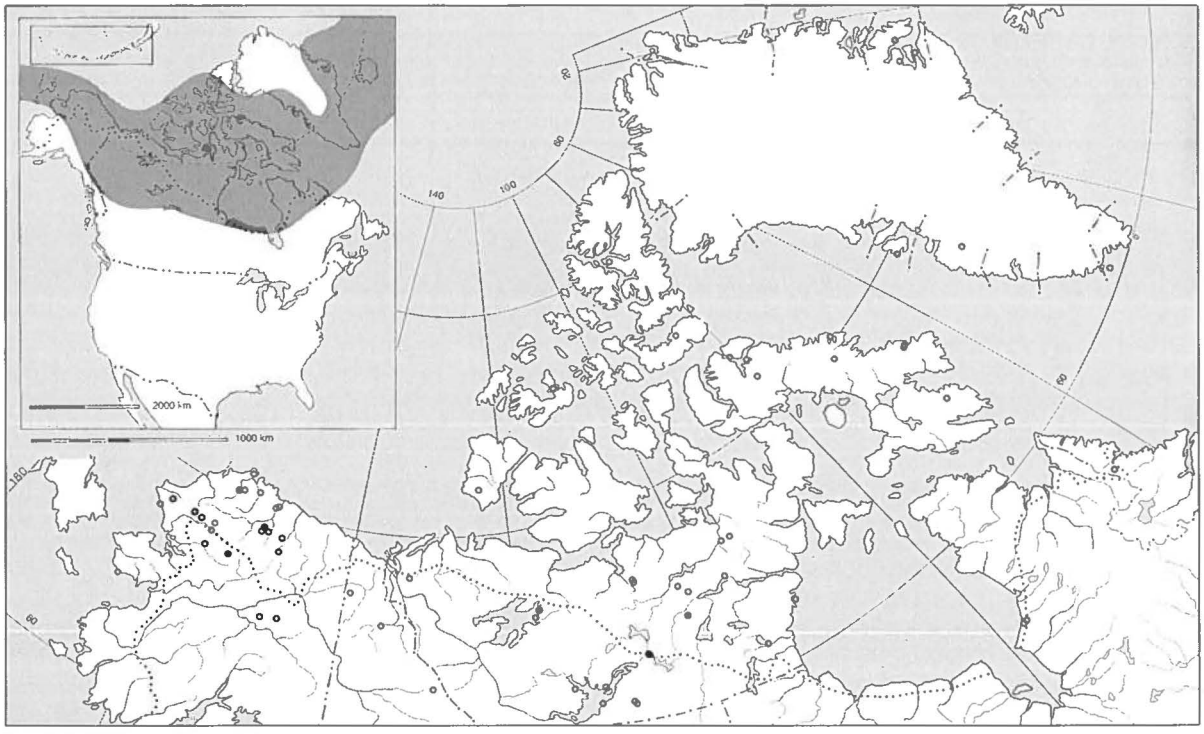


Fig. 13. *Polytrichum commune* var. *diminutum*, Umiat, Alaska; leg. 1960 Steere, Holmen and Mårtensson (Bryoph. Arct. Exs. 34), (C).



Map 15. *Polytrichum commune* var. *diminutum*.



Map 16. *Polytrichum swartzii*.

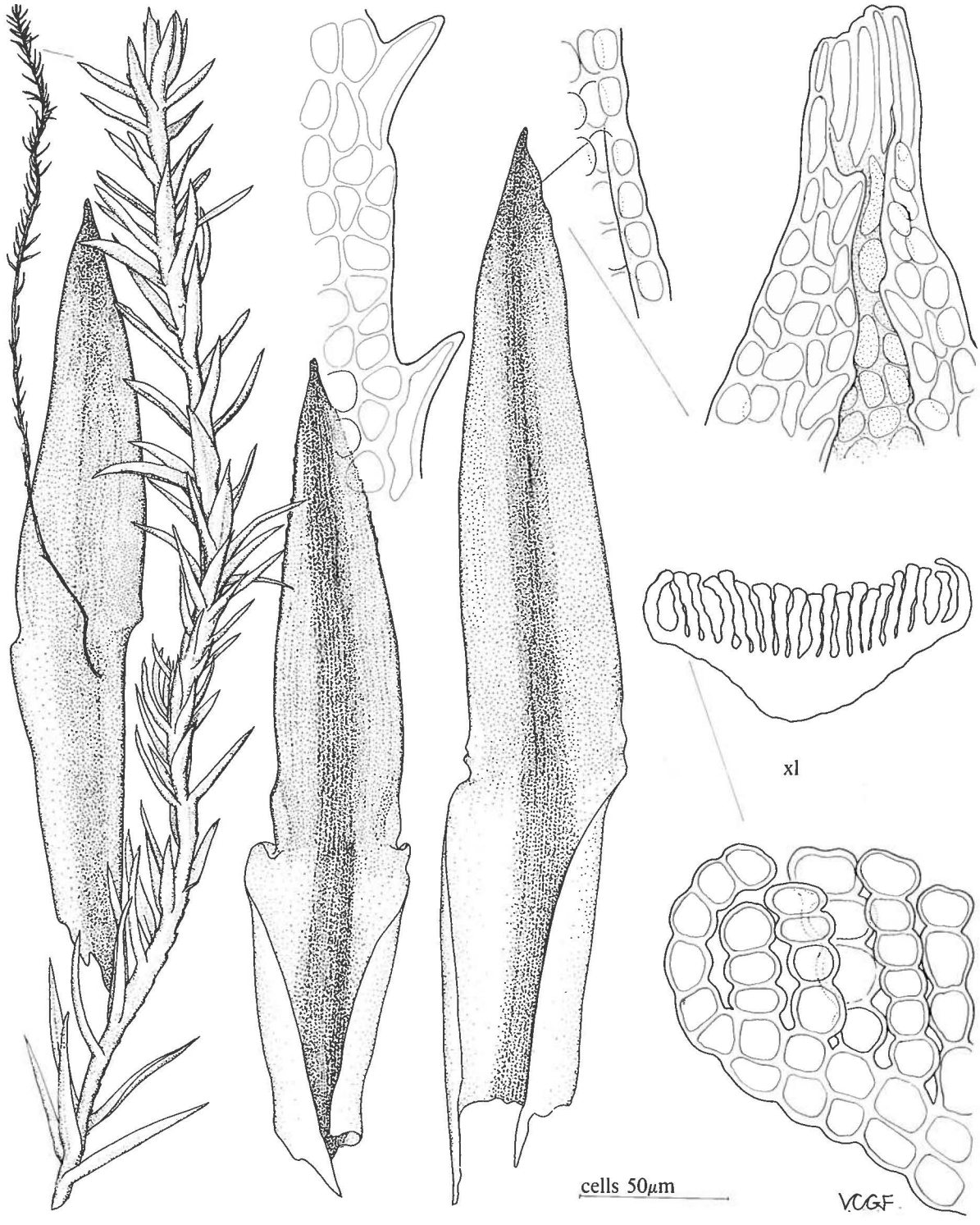


Fig. 14. *Polytrichum swartzii*, Kobberpynten, E-Greenland; leg. 1892 Hartz *s. n.*, (type of *Polytrichum algidum*), (C).

μm. Perichaetial leaves with sheathing bases usually hidden by upper stem leaves.

Setae 1.5–4.5 cm. Urns cubic or shortly rectangular, 2.5–3.5 mm long.

Forming green carpets or more commonly as scattered stems amongst other bryophytes such as *Sphagnum* species, *Calliergon sarmentosum*, and *Aulacomnium palustre* in habitats subject to regular or intermittent inundation, especially in *Sphagnum* bogs, sedge meadows, river and lake margins, also in hollows in open tundra and polygons, more rarely in wet *Picea* forest and muskeg swamps. Found most abundantly at lower altitudes, occasionally up to 1500 m.

In arctic Alaska and Canada this variety essentially replaces var. *commune* north of the tree-line, where it is widely distributed; in Greenland it appears to be more local although widespread. It is largely an arctic taxon, found in arctic Europe, northern Asia, Svalbard, Greenland and arctic America south to Labrador and northern Québec, with an outlying alpine station in the Rocky Mts of Wyoming.

Selected specimens seen:

Greenland. W 6: "Inukavsait Fjord", 71°15′N, 52°22′W; 1956 Holmen 13587 (CANM). – W 7: "Igdloluarssuit", 77°45′N, 70°30′W; 1921 Noe-Nygaard *s.n.* (CANM, NY). – E 5: "Cape Tattershall, Liverpool Coast", 71°10′N, 21°37′W; 1936 Bartlett *s.n.* (CANM, FH, MICH, NY).

Canada. Northwest Territories, Melville I., Hoyle Bay, 76°32′N, 109°49′W; 1977 Maddison & Steen 1834 (ALTA). – Mackenzie district, Eskimo Lake, 69°06′N, 132°37′W; 1957 Cody 10138 (CANM, NY). – Yukon Territory, Summit Lake, 67°43′N, 136°31′W; 1972 Scotter 17790 (C, NY).

Alaska. Table Mt. Quad., Mancha Creek, 68°40′N, 141°00′W; 1958 Sharp 58145 (C, NY). – Mt Michelson Quad., Okpilak Lake, 69°24′N, 144°03′W; 1958 Shushan & Thomson 215 (NY). – Umiat Quad., Umiat, 69°22′N, 152°08′W; 1962 Steere, Holmen & Mårtensson, (Steere & Holmen, 1975: Bryoph. Arct. Exs. 34, ALA, BM). – Barrow Quad., Point Barrow, 71°20′N, 156°39′W; 1951 Steere 16339 (ALA, CANM, NY).

Microscopically, *Polytrichum commune* is one of the most distinctive arctic members of Polytrichaceae, in the structure of the end-cells of the ventral lamellae, in transverse section showing a deep U-shaped sinus and two papilla-like thickenings. The only other species approaching it in this character is *Polytrichum swartzii*, in which the end-cells are flat or shallowly grooved, but without the apical thickenings. The var. *commune* is the largest arctic member of the family, and is easily recognized in the field by its stature, leaves squarrose–recurved when moist and sharply 4-angled rectangular capsules. At higher altitudes the gametophytes become shorter and have less strongly serrate leaves; var. *maximoviczii* is such a form. The length of the perichaetial leaves also varies; the var. *perigoniale* is no more than an extreme of this gradient.

The var. *diminutum* is often a very distinctive taxon, and under the names *Polytrichum jensenii* and *Polytrichum yukonense* has been treated widely as a species. Its relationship to var. *commune* merits further study; it is united with the latter by the unique structure of the end-cells of the ventral lamellae, but differs in its smaller stature throughout, habit, often fragile, entire leaves and broader cells of the sheathing base. It has also been confused with *Polytrichum swartzii*; the differences are summarized under that species.

2. P. swartzii Hartm.

Fig. 14. Map 16.

Handb. Skand. Fl., ed. 5; 361. 1849. – *Polytrichum commune* Hedw. var. *swartzii* (Hartm.) Nyholm, Ill. Moss Fl. Fennoscandia 2: 681. 1969. – Type: Sweden, Stockholm, leg. Swartz, lectotype in UPS, seen.

Polytrichum algidum Hag. & C. Jens., Meddr Grønland 15: 384. 1898. – Type: Greenland, Scoresby Sund, 1892, leg. Hartz, isotype in BM, seen.

Polytrichum inconstans Hag., Nyt Mag. Naturvidensk. 38: 339. 1901. – Syntypes: Norway, Iceland, isosyntype in C, seen.

Stems aggregated or scattered, simple, erect, rigid or sometimes soft, 2–9 cm, in lower part moderately to densely brownish tomentose. Leaves green, often blackish when old, loosely to densely arranged, when moist erect–spreading and straight to widely spreading and weakly recurved, when dry erect–spreading and flexuose, rarely upper leaves appressed to stems, 3–8 mm, from rectangular sheathing bases scarcely narrowed into flat, lanceolate to linear–lanceolate limbs, caducous or not from bases of limbs; apices subulate, weakly channelled, margins entire or serrulate. Costae excurrent as short brown entire to serrulate aristae, dorsally smooth or a few teeth near apices. Ventral lamellae 26–38, 5–10 cells high, in side view flat or shallowly crenulate, end-cells not thickened; in transverse section end-cells single or some paired, usually broader than tall, sometimes isodiametric, thin-walled, flat-topped or shallowly grooved, without papilla-like thickenings, often oblique towards margins of laminae. Median cells of leaf bases linear–rectangular, 75–110 × 3–12 μm. Laminae of limbs with erect, unistratose wings 6–9 cells broad at mid-limb, with usually quadrate cells 9–16 μm broad, with thin or slightly thickened walls. Marginal teeth absent or short, of 1 ascending acute cell. Perichaetial leaves with enlarged sheathing bases and short subulate limbs.

Setae reddish brown, 2.5–5 cm. Capsules erect, becoming inclined or horizontal when old, urns 2.5–3 mm, ±cubic, scarcely longer than broad, sharply 4-angled; exothecial cells mamillose, each with a large rounded to shortly elliptic pit; hypophyses conspicuous, disc-like, with deep constriction above. Peristome teeth oblong, obtuse, equal, pale yellow, 160–210 μm, borne on basal membrane 60–75 μm. Spores 12–15 μm, almost smooth.

Ecologically *Polytrichum swartzii* is quite similar to *P. commune* var. *diminutum* in occurring in very wet or regularly flooded situations. It is very commonly intermixed with *Sphagnum*, in habitats such as muskeg swamps, sedge meadows and fens, wet tundra and lake shores. It grows from sea level up to 1500 m. It is essentially an arctic species distributed throughout the arctic parts of U.S.S.R., Svalbard, Scandinavia, Greenland, Canada and Alaska. South of the Arctic it is rare; in Japan, Scandinavia, Iceland and in North America in southern Alaska, around Hudson Bay and in Labrador.

Selected specimens seen:
Greenland. W 4: E of Søndrestrømfjord, 67°05'N, 50°40'W; 1977 Mogensen & Brassard 77-045 (NY). – W 5: Disko, "Kugsinerssuaq", 69°56'N, 54°25'W; 1902 Porsild 557 (CANM). – E 6: Mt Zackenberg, Wollaston Foreland, 74°28'N, 20°35'W; 1950 Holmen *s.n.* (ALA, CANM, E, NY).
Canada. Northwest Territories, Baffin I., Clyde River 70°20'N, 68°20'W; 1936 Polunin 2604a-9 (FH, MICH). – Devon I., Sparbo-Hardy lowland, 75°45'N, 84°02'W; 1972 Vitt 7013 (NY). – Hornby Bay, Great Bear Lake, 66°35'N, 117°50'W; 1948 Steere 10477 (CANM, MICH, NY). – Yukon Territory, Old Crow, 67°34'N, 139°44'W; 1972 Marsh 2550 (CANM).
Alaska. Survey Pass Quad., Alatna River, 67°53'N, 149°30'W; 1973 Murray 5480-B (ALA). – Barrow Quad., Point Barrow, 71°20'N, 156°39'W; 1951 Steere 15192 (ALA, CANM, NY). – Meade River Quad., Meade River Camp, 70°39'N, 156°55'W; 1951 Steere 15641 (ALA, C, CANM, MICH, NY).

Polytrichum swartzii as treated here in a broad sense, including *P. algidum* and *P. inconstans*, is a variable taxon, particularly in habit and stature of the plants and in the degree of differentiation of the end-cells of the ventral lamellae. Intermediates between the extremes appear to be frequent and suggest that the variation is, at least in part, phenotypic. It is, however, possible that *P. swartzii* in the narrow sense (with serrate leaves and end-cells ±isodiametric), is distinct at varietal or even specific rank from *P. algidum* (including *P. inconstans*, with entire leaves and end-cells broader than tall). Without more detailed study it is impossible to know which characters are stable and which are modified by environment.

P. swartzii has often been confused with *P. commune* var. *diminutum*, but differs in its softer texture, with leaves not rigid and appressed when dry, its brown tomentum, leaves often blackish when old, and most strikingly by the end-cells of the ventral lamellae which in both side view and transverse section lack the papilla-like thickenings of *P. commune*. In both taxa fragile-leaved plants are common.

3. P. piliferum Hedw.

Fig. 15. Map 17.

Sp. Musc. Frond. 90. 1801. – Type: Europe, not seen.
Polytrichum pilosum Lindb., Acta Soc. Sci. Fenn. 10: 23. 1871. *nom. superfl.* – Type: *P. piliferum* Hedw.
Polytrichum hoppei Hornsch., Fl. 2(1): 106. 1891 ("hoppii"). – *Polytrichum piliferum* Hedw. var. *hoppei* (Hornsch.) Hall, Fl. Belgii Septentr. 2: 126. 1832. – Type: Austria, Gösnitz bei Heiligenblut, holotype in B, seen; isotype in E, seen.

Stems loosely aggregated, simple, erect, rigid, 1–4 cm, naked in lower parts, whitish tomentose only at bases. Leaves crowded in upper 0.2–0.5 of stems, when moist erect–spreading, weakly upwardly curved or straight, when dry erect, closely appressed and slightly incurved, 3–4.5 mm (excluding hair points), from ovate hyaline sheathing bases somewhat abruptly narrowed into green, linear or linear–lanceolate limbs, flat but with broadly infolded wings, not caducous; apices rounded, not channelled, with long aristae; margins minutely crenulate. Costae dorsally smooth, excurrent as long aristae 1.1–3 mm, hyaline throughout but brown at extreme bases, spinulose-toothed, especially near bases, to almost smooth. Ventral lamellae 25–32, borne only on broad costae, 6–9 cells high, in side view and transverse section end-cells of median lamellae pyriform, with lumens smaller than those of cells below, thick-walled, with papilla-like apical thickenings; end-cells of lateral lamellae ovoid, less strongly thickened. Median cells of leaf bases rectangular, 30–70 × 9–15 µm, thin-walled. Laminae of limbs composed of unistratose wings 5–7 cells broad, abruptly infolded over lamellae and almost obscuring them, cells of wings transversely rectangular, 10–15 × 30–45 µm, thick-walled, lumens with rounded ends, towards margins of wings more irregular, shorter, often oblique, thick-walled. Perigonial bracts with broad sheaths and very short limbs. Perichaetial leaves longer than stem leaves, with erect hyaline laminae and longer aristae.

Setae brown, 1.2–2.5 cm. Capsules erect when young, becoming horizontal when mature, urns 2.5–3.2 mm, rectangular, 1.5–2 times as long as broad, sharply 4-angled; exothecial cells mamillose, each with a large rounded or elliptic pit; hypophyses distinct, disc-like with deep constriction above. Peristome teeth oblong, obtuse, equal, whitish, 110–150 µm, born on low basal membrane 35–50 µm. Spores 9–11 µm, smooth.

Polytrichum piliferum is a calcifuge, pioneer species, often growing with *Cladonia*, on dry, sandy or gravelly soil in sun-exposed situations, such as road-cuttings, clearings in forests and dwarf shrub heaths, on exposed, rocky ridges and on moraines, on soil-covered boulders and in dry alpine tundra and late snow areas, from sea level up to 1600 m or higher.

An almost cosmopolitan species widespread in temperate parts of North America, Europe, Asia, Japan, East Africa, Macaronesia, Hawaii, in Australia, Antarctica and South America; in the Arctic it is found in Siberia, Svalbard, Iceland, northern Scandinavia, Greenland, arctic Canada and Alaska; in North America it is widespread south to California, Colorado and Tennessee.

Selected specimens seen:
Greenland. S 1: Niaqornarssuk, 60°17'N, 44°02'W; 1966 Gravesen 66–296 (NY). – W 5: Godhavn, 66°16'N, 53°32'W; 1962 Steere 62-147 (NY). – N 8: Kap Glacier, Independence Fjord, 81°48'N, 31°45'W; 1949 Holmen 7108 (BM, CANM, E, NY).
Canada. Northwest Territories, Baffin I., Clyde Inlet, 69°50'N, 70°40'W; 1950 Wynne-Edwards 9249 (CANM, NY). – Ellesmere I., Otto Fiord, 81°04'N, 86°55'W; 1967 Brassard 2857 (CANM, MICH, NY). – Melville I., Bailey Pt, 75°00'N, 114°58'W; 1965 Mosquin & Martin 6409 (CANM, NY). – Yukon Territory, British Mts, 69°06'N, 140°45'W; 1977 Vitt 18639A (ALTA).
Alaska. Bettles Quad., Koyukuk River, 66°55'N, 151°50'W; 1951 Sherrard 7–10 (CANM, NY). – Meade River Quad., Meade River Post Office, 70°29'N, 157°25'W; 1963 Steere 63-54 (NY). – Chandler Lake Quad., Chandler Lake, 68°12'N, 152°47'W; 1966 Smith A1040 (BM, CANM, NY).

Polytrichum piliferum can be readily recognized in the field by its short, bud-like shoots with conspicuous, long, whitish hair-points. It is most closely allied to *P.*

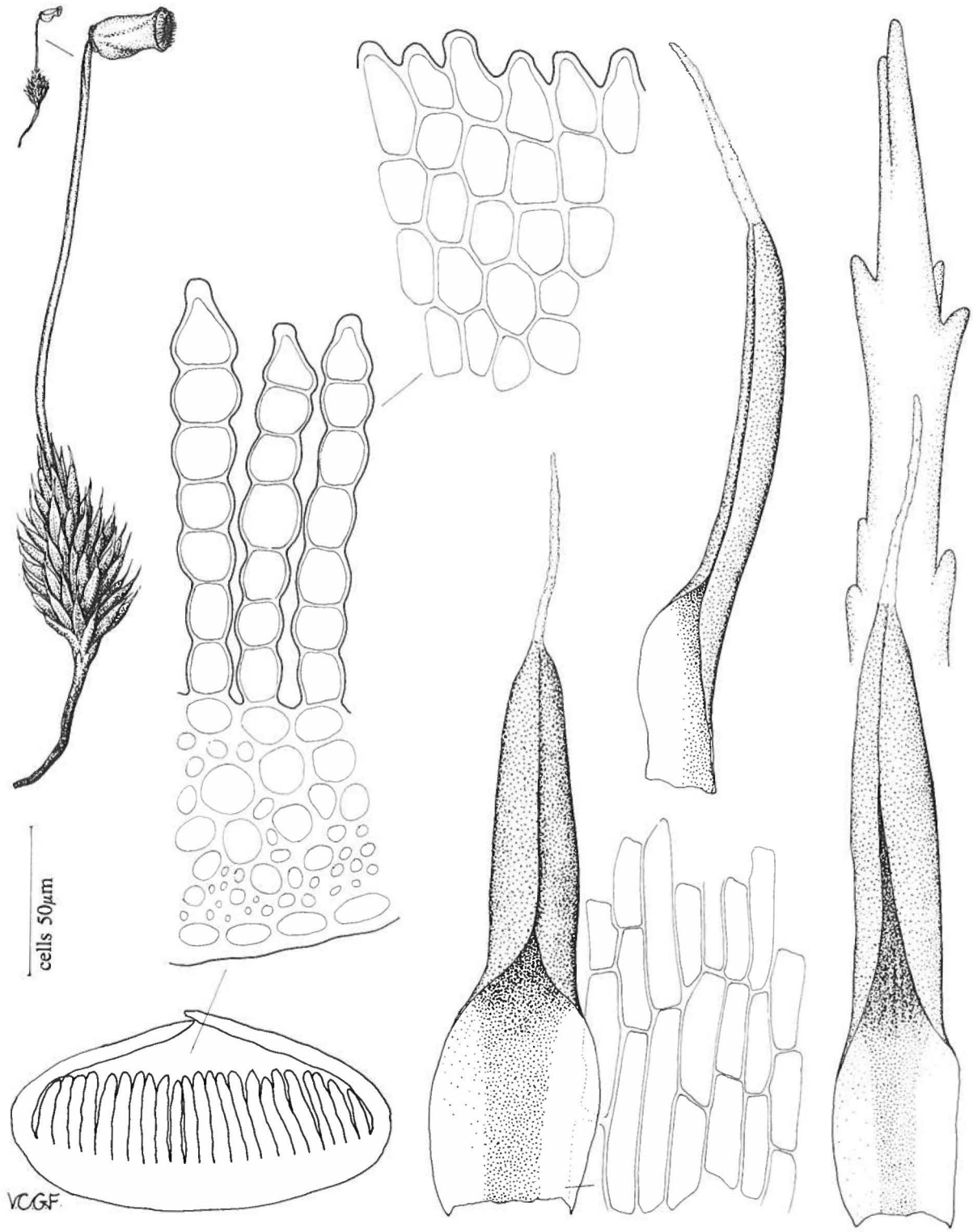
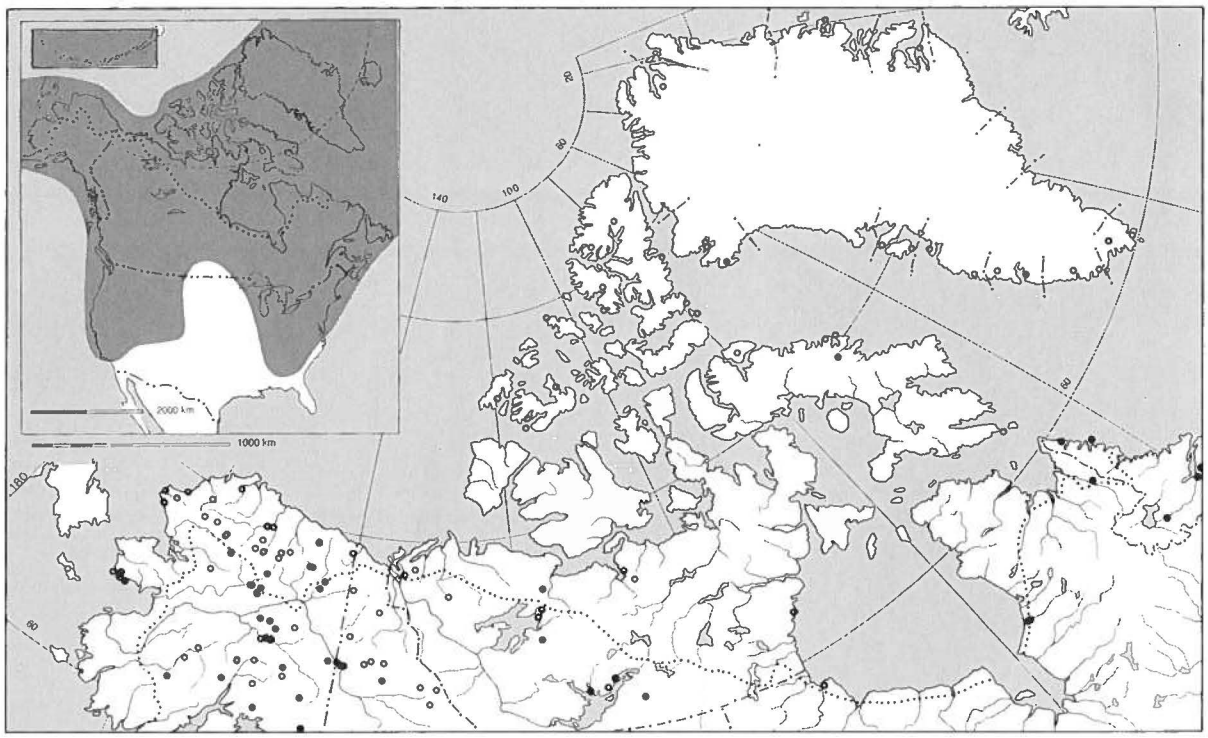
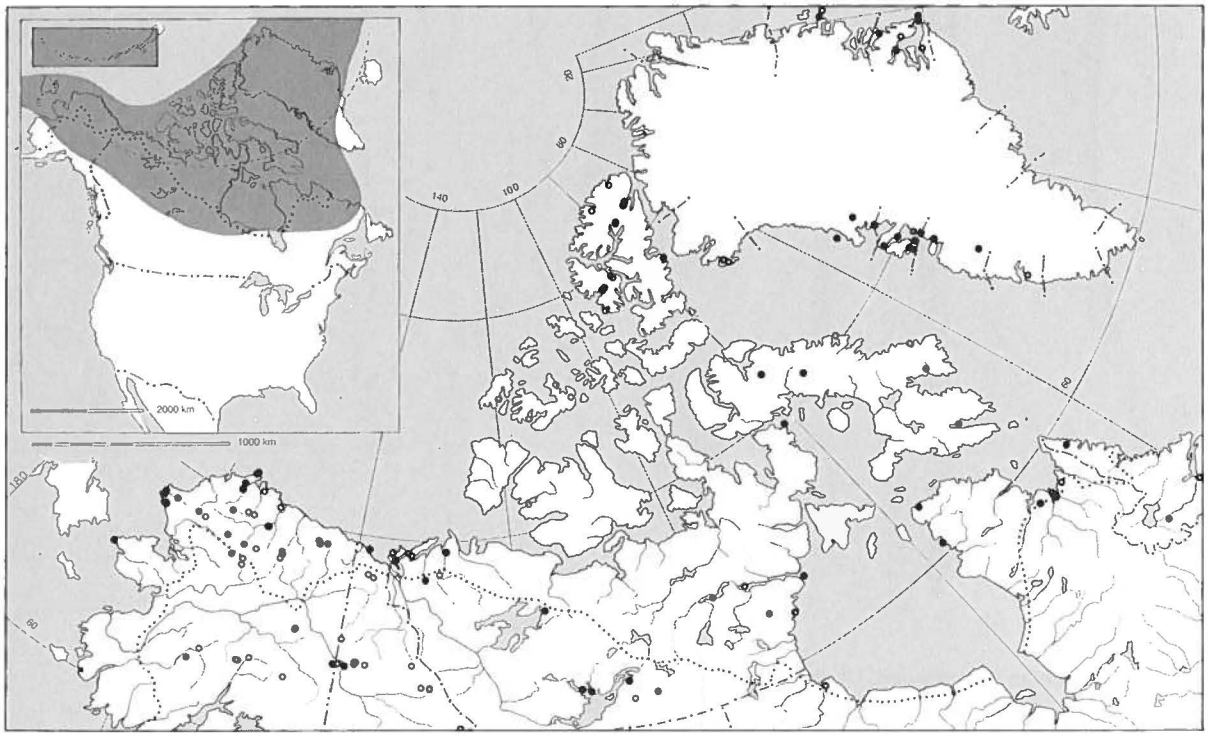


Fig. 15. *Polytrichum piliferum*, Qartuluk, SE-Greenland; leg. 1970 Lewinsky 70-887, (C).



Map 17. *Polytrichum piliferum*.



Map 18. *Polytrichum hyperboreum*.

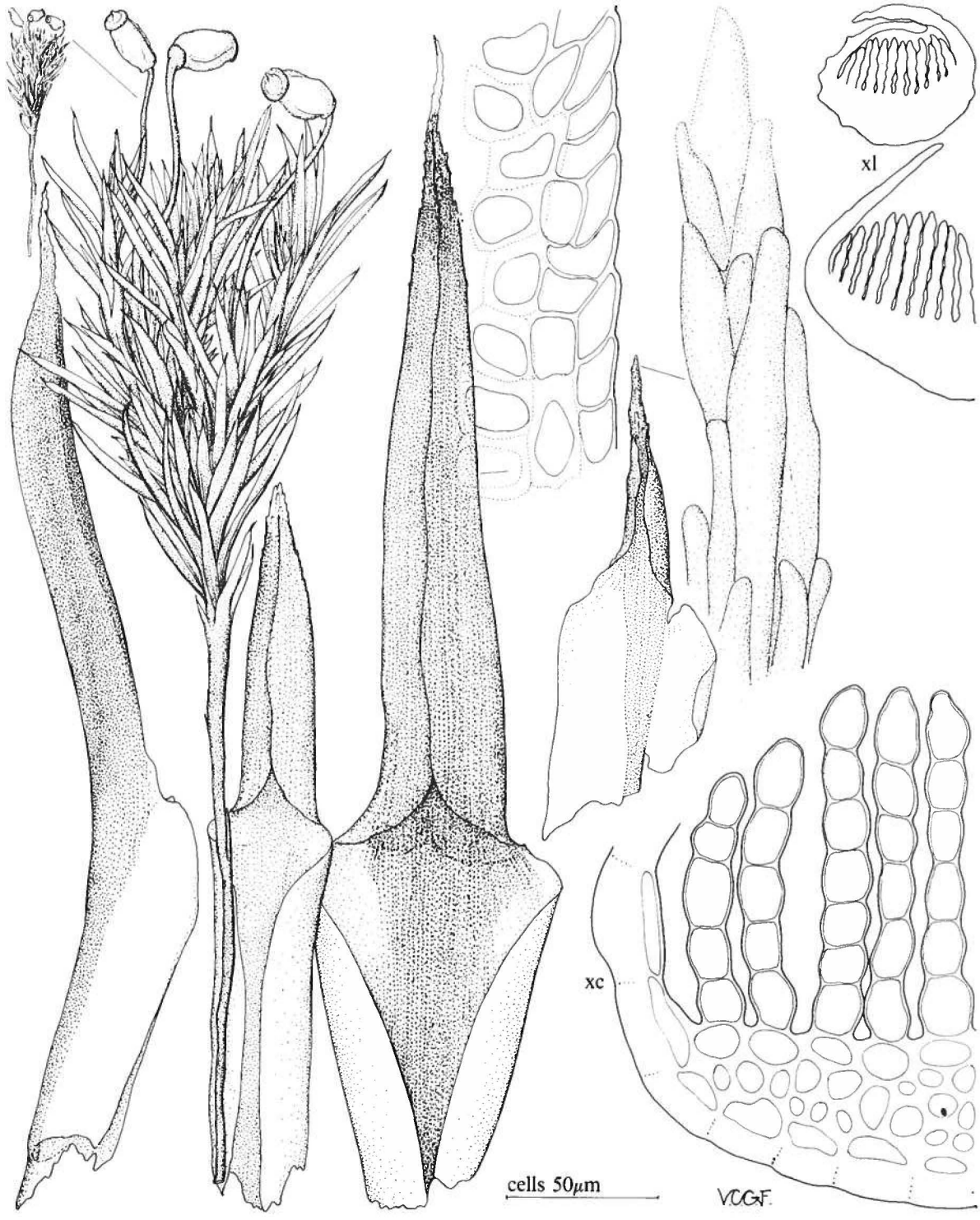


Fig. 16. *Polytrichum hyperboreum*, Ujaragssuit, Disko Ø, W-Greenland; leg. 1977 Mogensen & Brassard 77-735, (C).

juniperinum and *P. strictum* in its strongly thickened end-cells of the median ventral lamellae (it is important that the median lamellae are examined because towards the leaf margin the end-cells become much less thickened, and those on the marginal lamellae resemble the unthickened end-cells of *P. hyperboreum*). *P. piliferum* differs from its relatives *P. juniperinum*, *P. strictum* and *P. hyperboreum* in its flat, not channelled, rounded and abruptly piliferous apex, long, completely hyaline arista, dorsally smooth costa, ovate leaf base with shorter and broader cells, and short peristome 110–150 μm tall.

4. P. hyperboreum R. Brown

Fig. 16. Map 18.

Suppl. App. Capt. Parry's Voyage 294. 1824. – *P. piliferum* Hedw. var. *hyperboreum* (R. Brown) C. Müll., Syn. Musc. Frond. 1: 218. 1848. – Type: Melville I., leg. Ross, holotype in BM, seen.

Polytrichum boreale Kindb., Bih. Kongl. Svenska Vetensk.-Akad. Handl. 7(9): 52. 1883. – Type: Norway, not seen.

Polytrichum juniperinum Hedw. var. *arcticum* Kuc, Bryophyt. Bibl. 2: 42. 1973. – Type: Canada, Axel Heiberg I., Kuc M 168, holotype in CANM, seen.

Stems loosely to densely aggregated, simple or commonly branched, erect, rigid, 2–6(–10) cm, naked in lower parts, whitish tomentose only at bases. Leaves crowded in upper 0.5–0.8 of stems, when moist erect-spreading, straight, when dry erect, closely appressed to stems, straight or weakly incurved, 3–6 mm, from rectangular hyaline sheathing bases abruptly contracted into green linear-lanceolate limbs, flat but with broadly infolded wings, not caducous; near apices becoming channelled and tapering into subulate aristae; margins entire. Costae dorsally with low papilla-like teeth near apices, excurrent as short to long aristae 0.3–1.1 mm, hyaline above, brown in lower 0.2–0.5, densely spinulose-toothed in lower halves, less so near apices. Ventral lamellae 20–32, borne only on broad costae, 5–9 cells high, in side view and transverse section end-cells ovoid, larger than cells below, thin-walled or very slightly thickened at apices. Median cells of leaf bases narrowly rectangular, 45–95 × 12–15 μm, thin-walled. Laminae of limbs composed of broad unistratose wings 7–9 cells broad, abruptly infolded over lamellae, often overlapping each other and completely obscuring lamellae; cells of lamina wings transversely rectangular, 10–15 × 24–45 μm, thick-walled, lumens rounded at ends, towards margins becoming oblique and shorter, thin-walled. Perigonial bracts with short broad sheaths and short limbs. Perichaetial leaves elongate, with erect hyaline laminae and long aristae.

Setae brown, 1.2–3.3 cm. Capsules erect when young, becoming inclined to horizontal when mature, urns 2.3–3 mm, shortly ovoid-rectangular, 1.2–1.4 times as long as broad, broadest at bases, sharply 4–5-angled, exothecial cells mamillose, each with a large rounded pit; hypophyses disc-like, with deep constriction above. Peristome teeth oblong, subacute, equal, pale brown, 125–200 μm, borne on low basal membrane 25–50 μm tall. Spores 15–17 μm, smooth.

Forming mats on open sandy or stony ground, often on banks of lakes, rivers and in ravines, also commonly in a range of other habitats including stony ridges, moraines, open tundra and occasionally in tussock meadows or under *Salix* in wet habitats, from sea level up to 1500 m. Sporophytes are common.

P. hyperboreum is a circumpolar, arctic species reported from Siberia, Svalbard, northern Scandinavia, Greenland, arctic Canada and Alaska; it is common in arctic America but rare south of the arctic circle, to southern Alaska, Yukon Territory, Labrador and Québec.

Selected specimens seen:

Greenland. W 5: Nugssuaq, 70°42'N, 54°42'W; 1962 Steere 62-451 (ALTA, CANM, NY). – W 7: "Parker Snow Bay"; 76°10'N, 68°27'W; 1904 Low *s.n.* (CANM). – E 5: Kap Hope, 70°28'N, 22°22'W; 1925 Pedersen 59 (MICH, NY).

Canada. Northwest Territories, Baffin I., Frobisher Bay, 63°45'N, 68°32'W; 1948 Senn & Calder 3791 (CANM). – Ellesmere I., Tanquary Camp, 81°25'N, 76°55'W; 1967 Brassard 3199 (ALTA, CANM, MICH, NY). – Kamimuriak Lake, 62°57'N, 95°27'W; 1964 Scotter 4388 (CANM, MICH). – Yukon Territory, Herschel I., 69°34'N, 138°55'W; 1972 Scotter 17855 (C, NY).

Alaska. Mt Michelson Quad., Okpilak Lake, 69°25'N, 144°03'W; 1978 Murray 8668A (ALA). – Meade River Quad., Meade River Post Office, 70°28'N, 157°25'W; 1966 Smith A1234 (BM, CANM, FH, NY). – DeLong Mts Quad., Pitmega River, Cape Sabine, 68°54'N, 164°37'W; 1960 Steere, Holmen & Mårtensson, (Steere & Holmen, 1975: Bryoph. Arct. Exs. 4, ALTA, BM, MICH).

Polytrichum hyperboreum has been widely misunderstood and in the Arctic has frequently been misidentified as *P. piliferum* and especially *P. juniperinum*; many of the literature reports of the last two are therefore erroneous or suspect. Although often treated as a variety of *P. piliferum*, it is a distinctive species, in some respects closer to *P. juniperinum* and *P. strictum*; for example in its channelled leaf apex gradually tapering into the hair point and oblong leaf sheath with long narrow cells. It differs from *P. piliferum*, *P. juniperinum* and *P. strictum* in its commonly branched stems (resembling *Polytrichastrum alpinum*), unthickened ovate end-cells of the median lamellae, very broad lamina wings which usually overlap and completely obscure the lamellae, the marginal cells of the wings thin-walled, and larger spores.

The hair-point of *P. hyperboreum* is hyaline above and brown below, whereas in *P. piliferum* it is hyaline throughout, and in *P. juniperinum* and *P. strictum* typically brown throughout. However, in forms of the last two species the extreme apex of the arista is pale or hyaline, especially in the uppermost leaves, and in stunted forms of *P. hyperboreum* the hair-points may be brown almost to the apex. Over-reliance on this character has probably led to much of the confusion. In *P. hyperboreum*, the base of the arista always has very charac-

teristic dense spinulose teeth which decrease in density towards the apex; in *P. juniperinum* and *P. strictum* the teeth are shorter and more evenly distributed, or those species not uncommonly have the arista weakly roughened or almost smooth.

The dorsal surface of the costa in *P. hyperboreum* bears low papillae only near the leaf apex; in *P. piliferum* it is quite smooth, whilst in *P. juniperinum* and *P. strictum* it is usually distinctly roughened in the upper 0.3–0.5 of the leaf with conspicuous papillae or low teeth.

5. P. juniperinum Hedw.

Fig. 17. Map 19.

Sp. Musc. Frond. 89. 1801. – Type: Switzerland, not seen.
Polytrichum juniperinum Hedw. var. *alpinum* Schimp., Syn. Musc. Eur. 447. 1860. – Type: Europe, not seen.

Stems loosely aggregated, simple, erect, rigid, 1.5–5(–9) cm, naked in lower parts, pale brownish tomentose only at bases. Leafy shoots 8–11 mm broad when moist, 2.2–4 mm when dry. Leaves crowded in upper 0.5–0.8 of stems, when moist erect-spreading, straight or weakly recurved, when dry erect, appressed, almost straight, occasionally erect-spreading and flexuose, 4–8 mm, from oblong hyaline sheathing bases rather abruptly contracted into green, narrowly lanceolate limbs, flat but with broadly infolded wings, not caducous, near apices becoming channelled and tapering into subulate aristae; margins minutely crenulate. Costae dorsally sharply toothed in upper half or only towards apices, excurrent as aristae 0.4–1 mm, brown throughout or occasionally pale or hyaline at extreme apices, with short teeth throughout, rarely almost smooth. Ventral lamellae 26–38, borne only on broad costae, 6–7 cells high, in side-view and transverse section end-cells of median lamellae pyriform, subequal to lower cells, thick-walled, with large papilla-like apical thickenings; end-cells of lateral lamellae ovoid, less strongly thickened. Median cells of leaf bases narrowly rectangular, 45–100 × 6–12 µm, thin-walled. Laminae of limbs composed of unistratose wings 5–7 cells broad, abruptly infolded over and almost obscuring lamellae, cells of wings transversely rectangular, 9–12 × 25–40 µm, very thick-walled, lumens rounded at ends, towards margins shorter and oblique, thick-walled. Perigonial bracts with broad sheaths and very short limbs. Perichaetial leaves longer than stem leaves, with erect hyaline wings and long hair-points.

Setae brown, 1.3–7 cm. Capsules erect when young, becoming horizontal when mature, urns 2.8–4.8 mm, rectangular, 1.5–2 times as long as broad, sharply 4-angled, exothecial cells mamillose, each with an elliptic pit; hypophyses distinct, disc-like, with deep constrictions above. Peristome teeth oblong, obtuse, equal, whitish, 200–250 µm, borne on basal membrane 50–60 µm high. Spores 10–12 µm, smooth.

Forming loose mats on sandy soil or humus in forest clearings or footpaths and trails, common in dwarf-shrub heaths, lichen and moss heaths and less commonly in more exposed situations on beach ridges, road cuttings, lowland tundra and on mountain ridges and scree slopes, often growing on shallow well-drained soil overlying rock, from sea level up to 1200 m. Records from wet heaths and bogs usually refer to *P. strictum* although *P. juniperinum* may grow on dry hummocks in such habitats; it is much more a xerophytic, pioneer species than *P. strictum*.

Polytrichum juniperinum is an almost cosmopolitan species widely reported from temperate parts of both the Northern and Southern Hemispheres, throughout Europe, Asia, North Africa, Macaronesia, Central and South America, West Indies, Australia, Antarctica, Hawaii; in the Arctic it is found throughout Siberia, northern Scandinavia, Greenland, Canada and Alaska, but not as commonly as literature reports suggest, especially north of the tree-line, due to confusion with other species; it is very common in the boreal forest zone and reported from throughout Canada and the U.S.A.

Selected specimens seen:
Greenland. S 1: Narssarssuaq, 61°10′N, 45°23′W; 1962 Steere 62–630 (CANM, NY). – W 5: "Igdlorssuit", 69°04′N, 50°51′W; 1888 Hansen *s.n.* (NY).
Canada. Northwest Territories, Baffin I., Pangnirtung, 66°09′N, 65°44′W; 1980 Brassard *et al.* 14518 (NFLD). – Melville I., Bailey Point, 75°00′N, 114°58′W; 1965 Mosquin & Martin 6405c (CANM). – Richards I., 69°32′N, 133°44′W; 1966 Scotter 9580 (C, CANM). – Yukon Territory, Mancha Creek, 68°40′N, 141°00′W; 1958 Sharp 58155 (C).
Alaska. Bettles Quad., Fish Creek, 66°32′N, 150°48′W; Anderson 1464 (ALA). – Chandler Lake Quad., Chandler Lake, 68°12′N, 152°47′W; 1966 Smith A858 (BM, CANM, NY). – Survey Pass Quad., Alatna River, 67°53′N, 155°05′W; 1973 Murray 5307 (ALA).

P. juniperinum in the past has often been used in a broad sense to include *P. strictum*, and many published reports are therefore ambiguous; in the High Arctic it is rare and many reports belong to *P. hyperboreum*; for the differences see under that species. Typical, well-grown specimens of *P. juniperinum* are very distinct from *P. strictum* in the shorter, broader, loosely aggregated shoots, with the lower part of the stem naked, with brownish tomentum restricted to the stem base, the longer, often weakly curved leaves, more numerous ventral lamellae, longer, rectangular capsules, longer peristome and smaller spores. Intermediate sterile specimens which are difficult to identify do occur, however, and have led to the two species being reduced to varietal rank by some authors.

6. P. strictum Brid.

Fig. 18. Map 20.

J. Bot. (Schrader) 1800, 1,2: 286. 1801. – *Polytrichum juniperinum* Hedw. var. *strictum* (Brid.) Röhling, Deutschl. Fl. Krypt. ed. 2,3: 58. 1813. – Syntypes: North America, England, Scotland, syntype in E, seen.
Polytrichum alpestre Hoppe, Bot. Taschenb. 1801: 198. 1801. – *Polytrichum strictum* Brid. var. *alpestre* (Hoppe) Rabenh., Deutschl. Krypt. Fl. 238. 1848. – Type: Austria, Salzburg, isotype in E, seen.
Polytrichum affine Funck, Bot. Zeitung (Regensburg) 1: 121. 1802. – *Polytrichum juniperinum* Hedw. var. *affine*

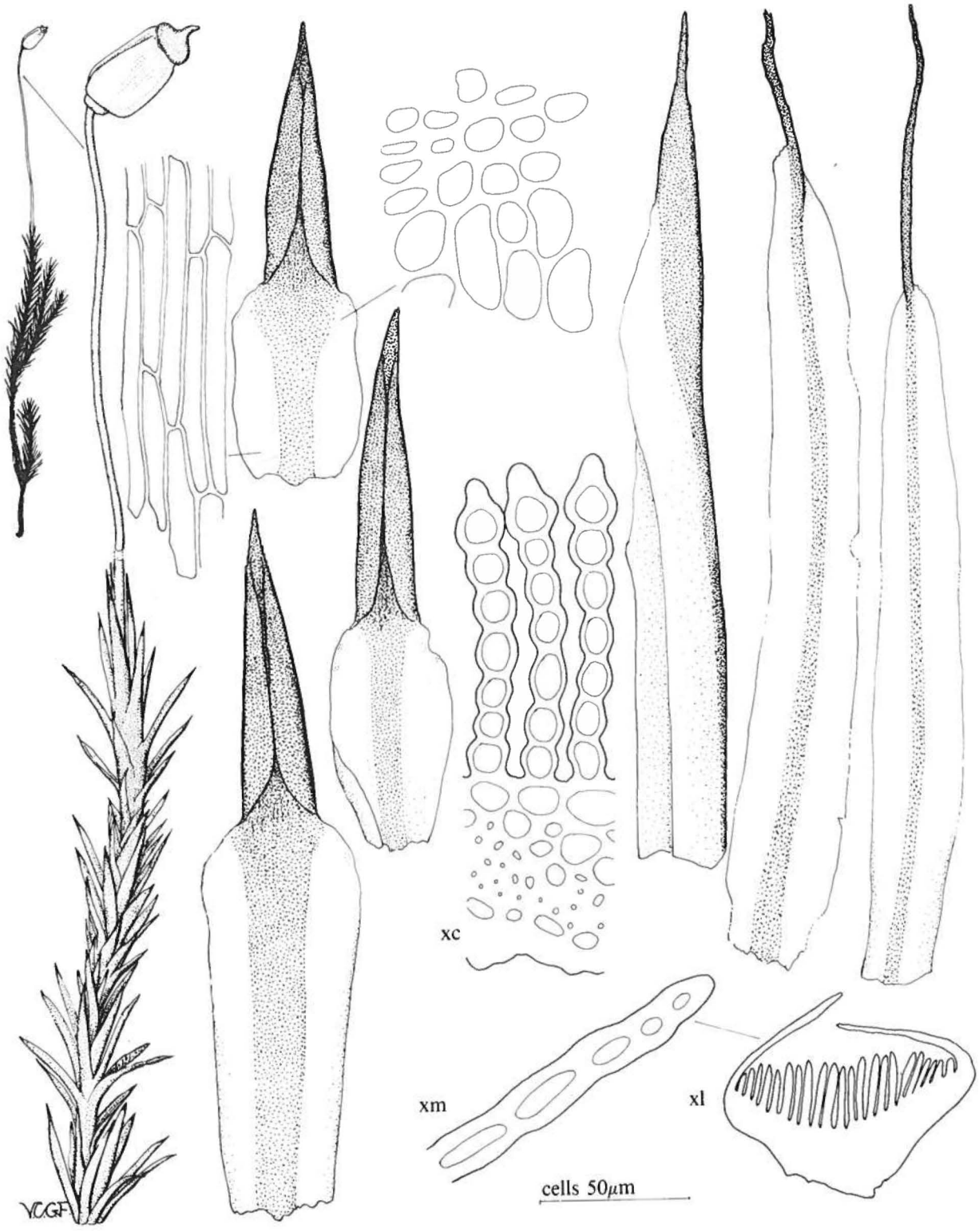
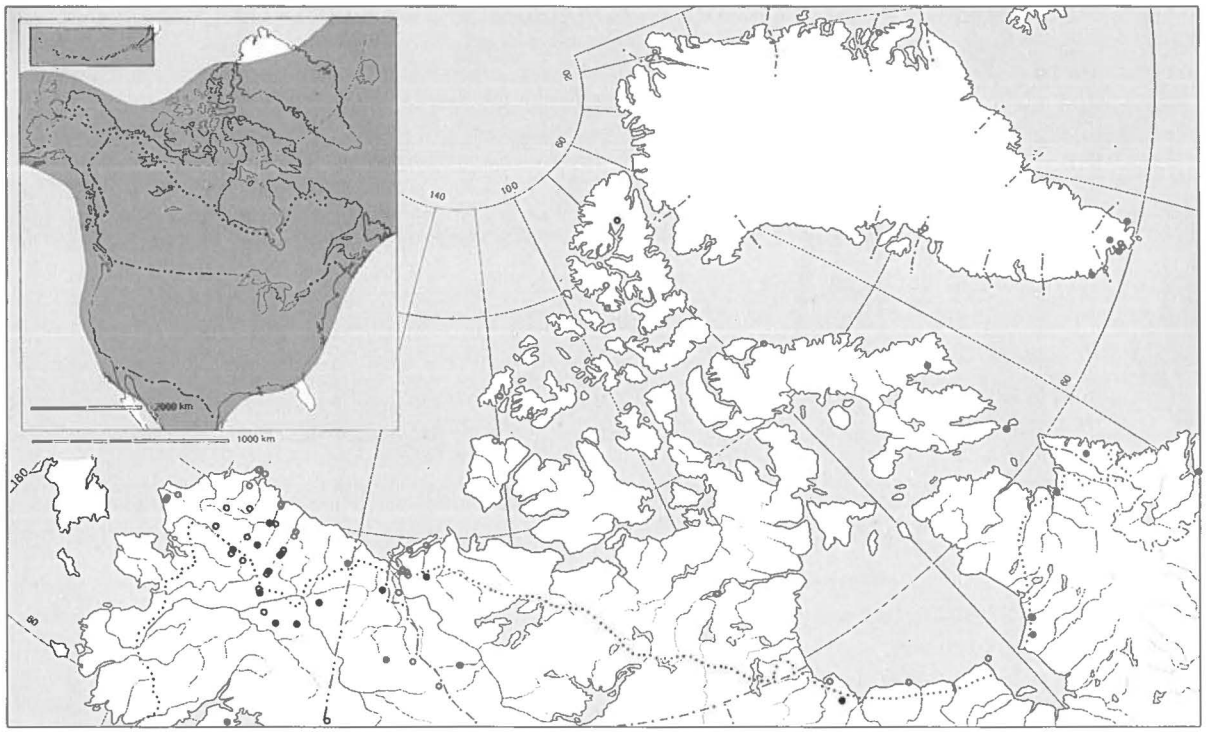
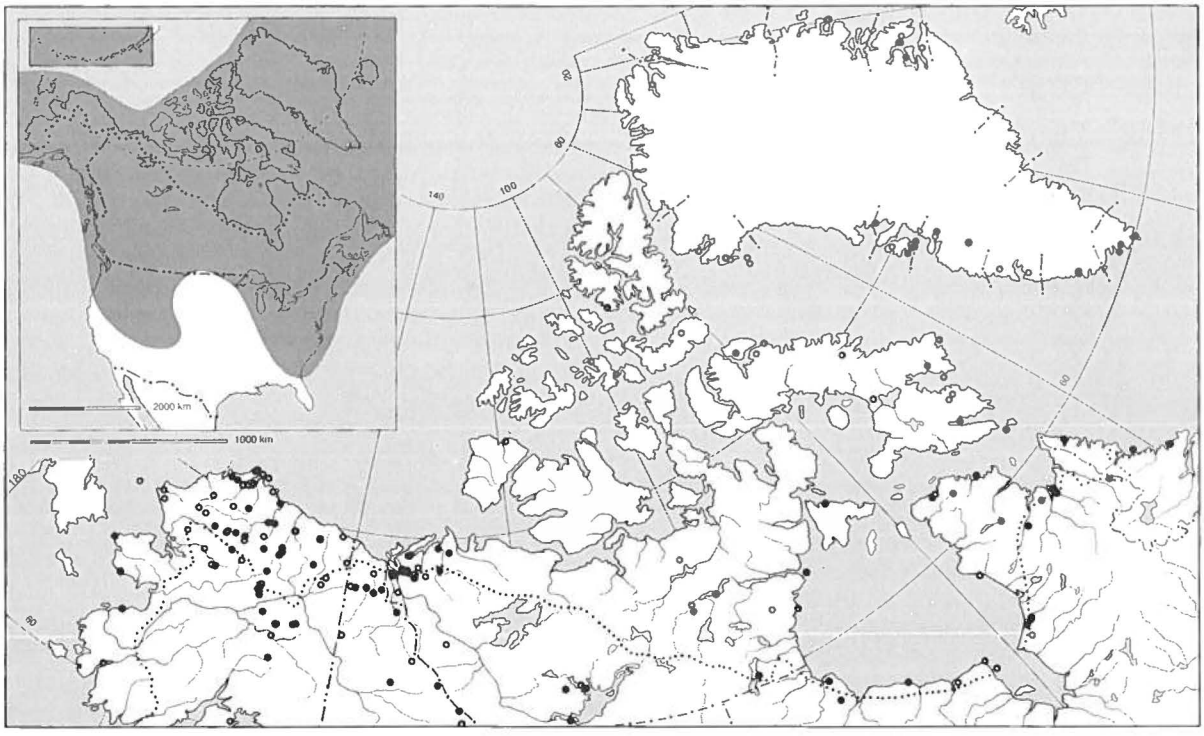


Fig. 17. *Polytrichum juniperinum*, head of Kangerdluarsuk, S-Greenland; leg. 1974 Holmen 74-676, (C).



Map 19. *Polytrichum juniperinum*.



Map 20. *Polytrichum strictum*.

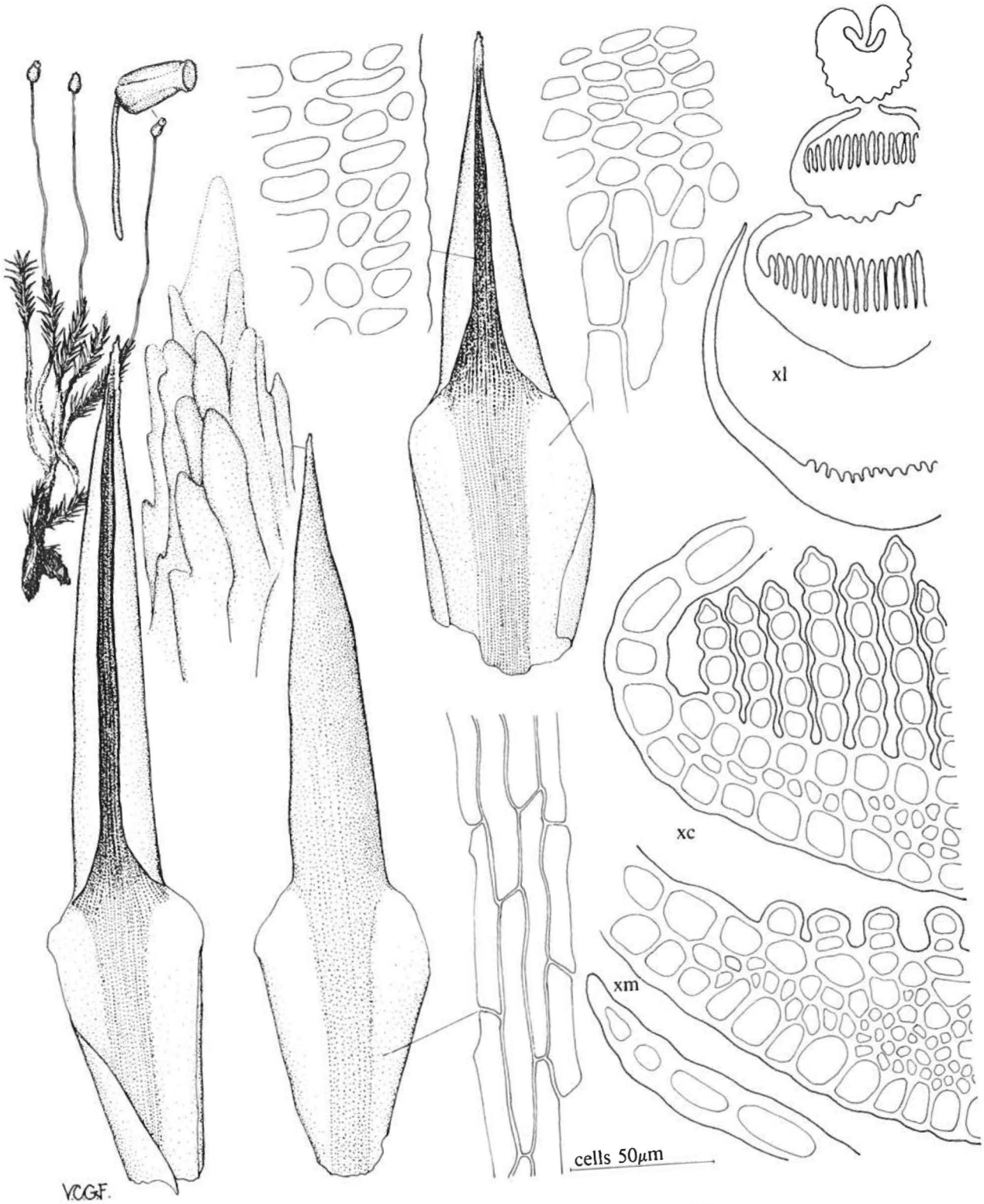


Fig. 18. *Polytrichum strictum*, Tugtutoq I., S-Greenland; leg. 1963 Jakobsen 63-1087, (C).

(Funck.) Brid., Musc. Recent. Suppl. 1: 49. 1806. – Type: Germany, Fichtelgebirge, leg. Funck, holotype in M, seen.
Polytrichum juniperinum Hedw. var. *gracilius* Wahlenb., Fl. Lapponica 344. 1812. – Type: *Polytrichum strictum* Brid.

Stems densely aggregated, simple, erect, 2–7(–12) cm, leafy throughout, densely whitish tomentose in lower part. Leafy shoots 2–7 mm broad when moist, 1–3 mm when dry. Leaves crowded throughout, when moist erect–spreading, straight, when dry closely appressed, rarely spreading, straight, 2.5–5 mm, from oblong, hyaline sheathing bases ±suddenly contracted into green, narrow lanceolate limbs, flat but with broadly infolded wings, not caducous, towards apices becoming channelled and tapering into subulate aristae; margins minutely crenulate. Costae dorsally toothed in upper halves or only near apices, excurrent as aristae 0.3–0.6(–1) mm, brown throughout or hyaline at extreme apices, toothed throughout to almost smooth. Ventral lamellae 21–28, borne only on broad costae, 6–8 cells high, in side view and transverse section end-cells of median lamellae pyriform, subequal to lower cells, thick-walled with large papilla-like apical thickenings; end-cells of lateral lamellae ovoid, scarcely thickened apically. Median cells of leaf bases narrowly rectangular, 45–85 × 7–12 µm, thin-walled. Laminae of limbs composed of unistratose wings 6–7 cells broad, abruptly infolded over and almost obscuring lamellae, cells of wings transversely rectangular, 9–12 × 30–45 µm, very thick-walled, lumens rounded at ends, towards margins shorter, oblique, thick-walled. Perigonial bracts with broad sheaths and very short limbs. Perichaetial leaves elongate, with erect hyaline wings and longer hair points up to 1 mm.

Setae brown, 1.8–4.1 mm. Capsules suberect when young, becoming horizontal when mature, urns 2.5–3.2 mm, cubic or shortly rectangular 1–1.3 times as long as broad, sharply 4-angled, exothecial cells mamillose, each with an elliptic pit; hypophyses distinct, disc-like, with deep constriction above. Peristome teeth oblong, obtuse, equal, whitish, 150-180 µm, borne on basal membrane 40–50 µm tall. Spores 13–15 µm, smooth.

Typically growing in dense patches or hummocks closely interwoven with tomentum, often amongst *Sphagnum*, in bogs, wet heaths and tundra, in wet spruce forests, muskeg swamps, *Salix* scrub, sedge meadows, *Eriophorum* bogs, in damp burnt heaths and in moist alpine tundra, from sea level up to 1400 m or higher, but commoner at lower altitudes.

Polytrichum strictum is a common and widespread species reported from Europe, temperate Asia, North Africa, Japan, South America and Antarctica. In the Arctic it is common everywhere, from Siberia, Svalbard, northern Scandinavia, Faroes, Iceland, throughout Greenland, arctic Canada and Alaska; in North America it is widespread in Canada and in the U.S.A. south to North Carolina, Colorado and Georgia.

Selected specimens seen:
Greenland. S 1: Narssaq, 60°56'N, 46°03'W; 1962 Steere 62-947 (NY). – W 5: Between Sinigfig and Igpik, 69°21'N, 52°55'W; 1898 Porsild *s.n.* (NY). – E 6: Mt Zackenberg, Wollaston Foreland, 74°28'N, 20°35'W; 1950 Holmen *s.n.* (CANM, E, NY)
Canada. Northwest Territories, Devon I., Truelove Lowland, 75°40'N, 84°40'W; 1972 Vitt 5459 (ALA, CANM). – Bathurst I., Davey's Camp, 75°45'N, 98°17'W; 1973 Ireland 16636 (ALA, CANM). – Eskimo Lake. Tuktoyaktuk Penins., 69°10'N, 133°15'W; 1969 Dickson 343 (CANM). – Mackenzie Delta, Reindeer Station, 68°48'N, 134°24'W; 1965 Scotter 5328 (C, CANM).
Alaska. Bettles Quad., Gobbler's Knob, 66°45'N, 150°34'W; 1976 Murray 76-112 (ALA). – Misheguk Mt Quad., Noluck Lake, 68°47'N, 160°00'W; 1966 Smith A655 (BM, CANM, NY). – Point Hope Quad., Cape Dyer, 68°36'N, 166°08'W; 1960 Viereck & Bucknell 4113 (ALA, CANM).

In the past, *Polytrichum strictum* has often been treated as an ecological variant of *P. juniperinum*; however, many of the differences between the two (see under *P. juniperinum*), particularly the sporophyte differences, seem to be relatively stable and constant. *P. strictum* is one of the commonest low arctic members of Polytrichaceae, and its slender shoots bound together by dense whitish tomentum, straight, appressed leaves, and short, cubic capsule render it easily recognizable in the field.

6. Lyellia

Lyellia R. Brown, Trans. Linn. Soc. London, 12: 561. 1819. – Type: *L. crispa* R. Brown.

Plants robust, scattered, or gregarious. Stems simple, rigid, erect. Lower leaves scale-like, appressed; upper leaves crowded, spreading when moist, appressed but weakly curled when dry, with thin, well-defined sheathing bases; limbs linear–lanceolate, opaque, flat, becoming channelled in upper parts, apices narrow, bluntly pointed or truncate, sharply serrate, ending in slender caducous awns; margins erect, incurved near apices, serrate, not bordered. Costae narrow and well-defined in sheath, broader and poorly defined in limbs, ending in apices, in cross-section with a dorsal stereid band and scattered ventral stereids not forming a distinct band, dorsal surface in upper parts with conspicuous lamelliform teeth. Ventral lamellae numerous, straight, covering costae and part of laminae; end-cells not differentiated, not thickened, smooth. Leaf bases unistratose, cells linear, thin-walled. Laminae of limbs bistratose, with 2–4 intramarginal rows unistratose, cells irregularly quadrate, upper layer bulging ventrally; margins bistratose with paired multicellular teeth. Dioicous. Perigonia discoid, perigonial leaves with broad sheathing bases and very short limbs.

Sporophytes unknown in *L. aspera*. (In *L. crispa* setae elongate, rigid; capsules suberect, compressed ovoid; hypophyses short with conspicuous stomata; peristomes absent; lids rostrate; calyptrae glabrous.)

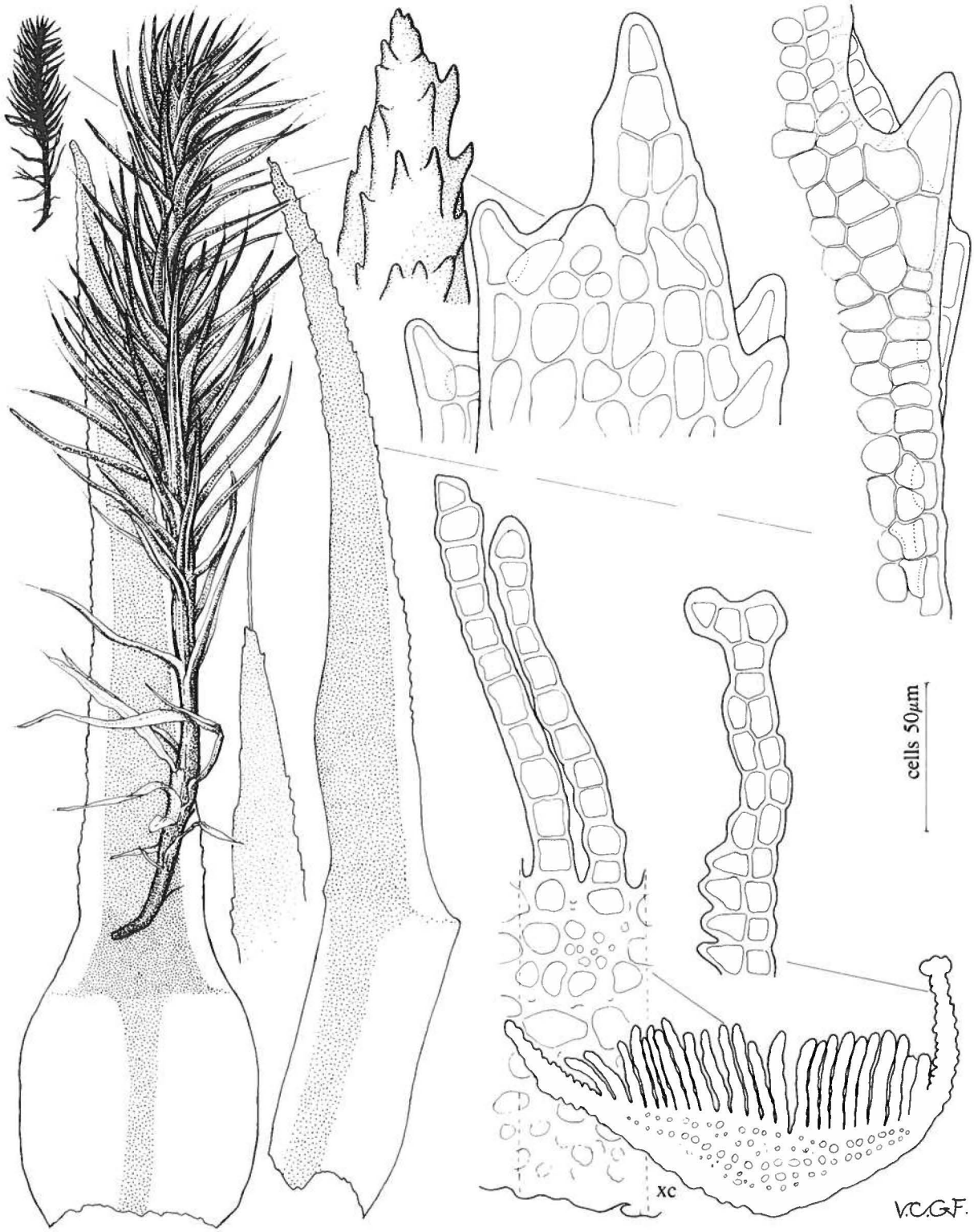
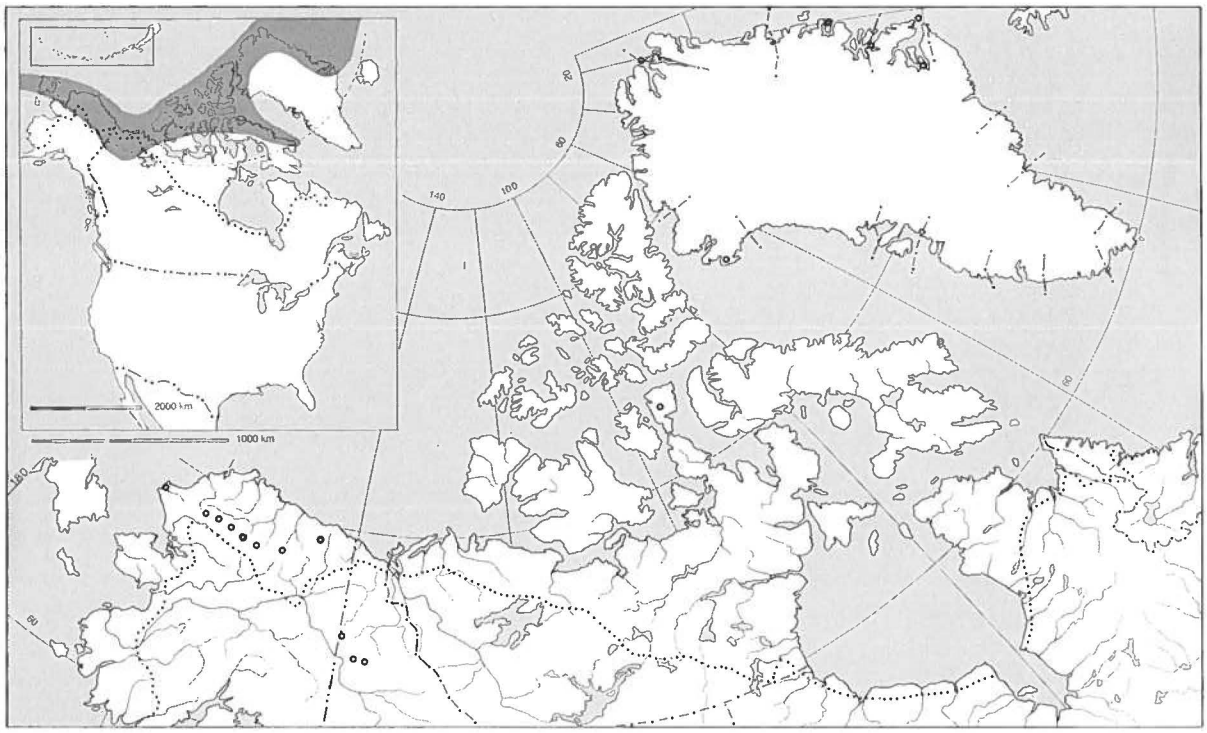


Fig. 19. *Lyellia aspera.*, Runde Fjeld, E-Greenland; leg. Hartz 1892 *s. n.*, (type of *Philocrya aspera*), (C).



Map 21. *Lyellia aspera*.

A relict genus of four species: *L. aspera* restricted to arctic America, Greenland and Siberia, *L. crispa* R. Brown in montane forests in the eastern Himalaya from East Nepal to Assam, *L. platycarpa* Card. & Thér. in Yunnan and *L. minor* Xu & Xiong from Xizang (East Tibet).

Bartramiopsis lescurii (James) Kindb., from oceanic northern Pacific regions was formerly placed in *Lyellia* on account of its bistratose leaf lamina and eperistomate capsules, but is now generally maintained as a monotypic genus distinct in its ciliate leaf margins and terete capsules. Some authors segregate *L. aspera* as a monotypic genus *Philocrya* because of its slender, hygroscopic leaf-awn and purely arctic distribution. Gametophytically the two are otherwise extremely similar and share two unusual characters, paired marginal teeth and a bistratose lamina wing with a unistratose intramarginal band; until sporophytes are discovered the evidence for uniting them greatly outweighs that for segregating them.

1. L. aspera (Hag. & C. Jens.) Frye

Fig. 19. Map 21.

In Grout, Moss Fl. North America 1(2): 111. 1937. – *Philocrya aspera* Hag. & C. Jens., Meddr Grønland 15: 388. 1897. – Type: East Greenland, Scoresby Sund, 1892, leg. Hartz; holotype in C, seen.

Stems 4–7(–13) cm. Upper leaves often crowded, widespreading when moist, 6.0–8.5 mm, from broad rectangular sheathing bases somewhat abruptly contracted into linear–lanceolate limbs, subulate and channelled towards apices; apices when young bearing delicate hygroscopic, caducous, smooth, hyaline awns 1–2 mm; margins strongly serrate. Costae conspicuously ribbed dorsally in upper parts with lamelliform teeth. Ventral lamellae 25–35, 7–11 cells high, in side-view flat-topped or weakly crenulate, in transverse section end-cells undifferentiated, rounded, smooth, not thickened. Median cells of basal sheaths linear, 45–75 × 9–12 μm. Lamina wings broad, 18–24 cells wide at mid-limb; cells 7–9(–12) μm broad, equally thick-walled. Marginal teeth mostly paired, ascending, 3–7-celled with apical cell larger than others.

In loose to dense turves or as scattered stems, usually mixed with other bryophytes, grasses or dwarf shrubs, in sheltered hollows and amongst rocks and screes, often on north-facing mountain slopes and cliffs, on open tundra or by streams, from 100 to 1450 m altitude. Favours peaty substrates but apparently tolerating both acidic and basic conditions.

Very local or undercollected in Northeast, North and Northwest Greenland, Queen Elizabeth Islands, Baffin Island and Yukon Territory, locally abundant only on Brooks Range in Alaska. Elsewhere reported only from a few localities in eastern Siberia.

Prior to 1953 when Steere first found the moss in Alaska, *L. aspera* was known only from the type locality in Northeast Greenland, from Northwest Greenland and from Baffin Island. Now it is known to be locally abundant in arctic Alaska but elsewhere it is still known only from isolated localities, par-

ticularly in Greenland where it may prove commoner than present data suggest. Grows as low as 100 m alt. on Bathurst Island, at Dundas Air Base in Northwest Greenland and in Peary Land, North Greenland, but generally found on higher ground on mountains which may restrict its range in lowland arctic Canada.

Selected specimens seen:

Greenland. W 7: "Thule", 1 mi. NE of Nunatarssuaq Pt, 76°34′N, 68°48′W; 1953 Benninghoff 7588 (NY). – N 8: Herlufsholm Strand, 82°40′N, 21°00′W; 1949 Holmen 7168 (C). – E 6: Clavering I., Djævlekløften, 74°19′N, 20°30′W; 1947 Holmen 447 (C, NY).

Canada. Northwest Territories, Ellesmere I., Van Hauen Pass, 81°07′N, 86°55′W; 1967 Longton 2780 (C, CANM, NY). – Somerset I., 73°23′N, 94°30′W; 1975 Woo F35c (ALTA). – Bathurst I., 1 mi. N of Bracebridge Inlet, 75°40′N, 100°25′W; 1976 Maddison 1478 (ALTA). – Yukon Territory, SE slope of Mt Klotz, 65°22′N, 140°06′W; 1973 Vitt 7536 (ALTA, C, NY).

Alaska. Mt Michelson Quad., Peters Lake, 69°22′N, 145°03′W; 1965 Steere 650726–33 (ALTA, NY, male). – Philip Smith Mountains Quad., "Mt Steere", 68°29′N, 149°25′W; 1982 Long 11291 (E). – Point Hope Quad., Cape Lisburne, 68°52′N, 166°15′W; 1953 Steere & Crum 20925 (ALTA, NY).

In the field *Lyellia aspera* is similar in habit to other robust Polytrichaceae such as *Polytrichum commue* and *Polytrichastrum alpinum*, and has undoubtedly been overlooked for that reason, in addition to the absence of sporophytes. With a lens, however, the fine hyaline leaf awn, dorsal rib-like teeth on the upper part of the costa and paired marginal teeth are diagnostic.

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Book: Marsden, W. 1964. The lemming year. – Chatto & Windus, London: xxx pp.

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