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A TAXONOMIC STUDY OF

THE GENUS *Dicranum* (DICRANACEAE, MUSCI)

IN THE PROVINCE OF QUEBEC

Gilda Bellolio de Trucco

A thesis

submitted to the

University of Ottawa

in partial fulfillment of the requirements for the degree

Master of Science

_____

Candidate

Supervisor

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ABSTRACT

A total of 21 species and 2 varieties of Dicranum are recognized for the province of Quebec. Dicranum brevifolium (Lindb.)Lindb., D. fuscescens var. flexicaule (Brid.)Wils. and D. majus var. orthophyllum A.Braun ex Mild. were not previously recognized for the province. Dicranum angustum Lindb. is included in the synonomy of D. spadiceum Zett. sensu lato. A key to the Dicranaceae and to the Dicranum of Quebec is provided, together with a Table of Species Comparison. A diagnosis, illustrations of diagnostic characters, distribution maps and a discussion of their variability is presented for each species.

RESUME

Cette étude reconnait un total de 21 espèces et 2 variétés de Dicranum pour la province de Québec. Dicranum brevifolium (Lindb.)Lindb., D. fuscescens var. flexicaule (Brid.)Wils. et D. majus var. orthophyllum A.Braun ex Mild. n'étaient pas antérieurment reconnues pour la province. Dicranum angustum Lindb. est inclue dans la synonymie de D. spadiceum Zett. sensu lato. On pourvoi une clé pour l'identification des Dicranum et des Dicranaceae du Québec, et une Table de Comparaison des Espèces. On donne des diagnoses, des illustrations, des cartes de distributions et des discussions sur la variabilités de chaque espèce.

I.- INTRODUCTION

A.- Objectives of Study

The Dicranaceae is a large, worldwide family with about 50 genera. Dicranum, the type genus, contains approximately 60 species, the vast majority of which are distributed in the Northern Hemisphere. A total of 24 species is reported for North America, north of Mexico (Crum et al.,1973). In 1945 Ernest Lepage listed 18 species for the province of Quebec, and recently, 21 species were reported in the Checklist of the Mosses of Canada (Ireland, et al.,1977).

Dicranum is a common genus and a significant component of the bryoflora of Quebec. Some species of the genus, such as Dicranum acutifolium, D. fuscescens, D. leioneuron, D. scoparium and most arctic Dicrana, are imperfectly known. The range of variation of the taxa, as well as their geographical distributions have not as yet been adequately established. Furthermore, most of the keys of Dicranum are based primarily on sporophytic and insufficient gametophytic characters. The lack of adequate keys and good illustrations, together with a deficient knowledge of the range of variation of each taxa, have resulted in a poor understanding of the genus.

This work attempts to delimit the taxa of Dicranum in Quebec more clearly by providing a means for their identification with a workable

key, illustrations, a table of species comparison and maps showing their geographical distributions in the province. This study is not intended to be monographic in nature but rather represents a contribution towards a fuller documentation of variability in the genus.

B.- Generic Limits

The genus Dicranum was described by Hedwig (1801) in his monumental book, Species Muscorum Frondosorum. He segregated Dicranum from the other genera on the basis of "peristomium simplex: dentibus sedecim brevioribus, inflexis, bifidis. Flos masculus capituliformis vel gemmiformis terminalis in distincto individuo". In his broad concept of Dicranum he described 33 species, of which only 5 remain in the genus today, i.e. Dicranum condensatum, D. flagellare, D. montanum, D. scoparium and D. spurium. The remainder of the species described by Hedwig are at present placed in other genera (mostly belonging in the family Dicranaceae), such as: Anisothecium Mitt. (1869), Arctoa B.S.G. (1846), Campylopus Brid. (1819), Dichodontium Schimp. (1856), Dicranella (C.Muell.) Schimp. (1848), Kiaeria Hag. (1915), Leucobryum Hampe (1839), Oncophorus (Brid.) Brid. (1826), Paraleucobryum (Limpr.) Loeske (1907), Trematodon Michx. (1803), Ceratodon Brid. (1826, Ditrichaceae) and Desmatodon Brid. (1819, Pottiaceae).

Brotherus (1924), in the second edition of Engler and Prantl's

Die Natürlichen Planzenfamilien, recognized Orthodicranum Loeske as a segregate genus of Dicranum Hedw. It is distinguished from Dicranum mainly on the basis of unicellular alar cells, lower leaf cells not or weakly pitted and capsules erect, slightly furrowed when dry. In this genus, Brotherus includes Orthodicranum flagellare (Hedw.)Loeske and O. montanum (Hedw.) Loeske.

Brotherus characterized the genus Dicranum by the prevalence of bistratose alar cells, lower leaf cells strongly pitted and capsules mostly arcuate, smooth or distinctly furrowed when dry. He divided the genus Dicranum into 3 subgenera:

1.- CRASSIDICRANUM Limpr. (1886): capsules erect and cylindric, smooth when dry, peristome teeth not pitted-striate. Dicranum fulvum Hook. and D. viride (Sull. et Lesq.) Lindb. are included here, as well as others not present in Quebec.

2.- EUDICRANUM Mitt. (1869): capsules arcuate, furrowed when dry, peristome teeth pitted-striate. In this subgenus, he lists the following species that occur in Quebec: Dicranum elongatum Schleich., D. groenlandicum Brid., D. fragilifolium Lindb., D. fuscescens Turn., D. muehlenbeckii B.S.G., D. spadiceum Zett., D. condensatum Hedw., D. spurium Hedw., D. sendtneri Limpr.(= D. elongatum Schleich.ex Schwaegr.), D. bergeri Bland. (= D. undulatum Brid.), D. drummondii C.Muell. (=D. ontariense Peterson in North America), D. angustum Lindb. (= D. spadiceum Zett. sensu lato), D. laevidens Williams (= D. spadiceum Zett. sensu lato), D. bonjeaniiDe Not., D.scoparium Hedw., D. undulatum Ehrh. (=D. polysetum Sw.) and D. majus Smith.

3.- PSEUDOCHORISODONTIUM Broth. (Includes species of Dicranum that do not occur in Quebec).

Although Brotherus includes D. fulvum and D. viride in Dicranum subgenus CRASSIDICRANUM, the two species do not have pitted lower leaf cells; their alar cells are generally unistratose and the peristome teeth are longitudinally pitted-striate. However, other bryologists, such as Roth (1932), have placed these species in Orthodicranum, where they should be on the basis of their morphology.

The genus Orthodicranum Loeske includes the following species from Quebec: Orthodicranum flagellare, O. fulvum, O. montanum and O. viride. The genus is segregated from Dicranum mainly on the basis of the erect, smooth or slightly furrowed capsules, the leaves with unistratose alar cells that reach nearly to the costa and the lower leaf cells that are not pitted. However, some species placed in Orthodicranum possess characters from the EUDICRANUM group and vice-versa. In Orthodicranum, plants of O. montanum and O. fulvum sometimes have arcuate capsules within the same colony, and the lower leaf cells are sometimes with few pits. Orthodicranum fulvum and O. viride have alar cells that may be partly bistratose. The extent of the inflated alar cells, which sometimes reach the costa, is a variable character throughout the genus, and it is not useful for specific or generic differentiation. In the EUDICRANUM group, Dicranum elongatum, D. fragilifolium and D. groenlandicum have capsules that are erect or nearly so, smooth or slightly striated; their alar cells are often partly unistratose.

Orthodicranum is not recognized in the present study as a valid segregate from Dicranum because the characters that have been used to segregate the genus are not consistently present in all species assigned to this genus.

Several systems of classification recognizing subgenera and sections have been proposed by Brotherus (1924), Dixon (1924), Mönkemeyer (1927), Nyholm (1954) and Takaki (1964). CRASSIDICRANUM, as employed by Takaki (1964) may be of some use in an infrageneric system. The inclusion of infrageneric categories in the present study does not seem advisable since this study deals with a small geographical area. Their employment should await a thorough monographic study of the genus Dicranum on a worldwide basis.

C.- The Dicranaceae of Quebec

The following genera of the Dicranaceae are present in Quebec: Arctoa, Bruchia, Cynodontium, Dichodontium, Dicranella, Dicranoweisia, Dicranum, Kiaeria, Leucobryum, Oncophorus, Paraleucobryum, Rhabdoweisia and Trematodon. The main characters that distinguish them are outlined below.

Arctoa

-Stems 1.0-2.5 cm high.
-Leaves lanceolate to subulate, erect-spreading to falcate-secund.
-Perichaetial leaves not differentiated.
-Leaf cells smooth or dorsally papillose.
-Alar cells differentiated.
-Costae lacking stereid bands.
-Autoicous.

-Capsules oblong-ovoid to cylindric, straight or arcuate, erect to inclined, barely exserted, nonstrumose, dehiscent.
-Peristome teeth divided halfway into 2 segments, vertically striate below, papillose above.

Bruchia

-Stems 1-2 mm high.
-Leaves long-subulate from an ovate to lanceolate base, straight, erect-spreading.
-Perichaetial leaves scarcely differentiated.
-Leaf cells smooth.
-Costae with 1 stereid band.
-Alar cells not differentiated.
-Autoicous.
-Capsules pyriform, with a distinct neck, straight, erect, barely exserted to exserted, indehiscent, nonstrumose.
-Peristome teeth lacking.

Cynodontium

-Stems 0.5-3.0 cm high.
-Leaves linear-lanceolate to lanceolate, erect-spreading.
-Perichaetial leaves similar but larger than vegetative leaves.
-Leaf cells smooth to dorsally papillose.
-Alar cells not differentiated.
-Costae with 1 or 2 stereid bands.
-Autoicous.
-Capsules oblong-ovoid to cylindric, straight to slightly arcuate, erect to inclined, exserted, strumose or nonstrumose, dehiscent.
-Peristome teeth divided halfway into 2 segments, or not divided, vertically striate below, papillose above.

Dichodontium

-Stems 1.0-4.5 cm high.
-Leaves ovate-lanceolate to oblong-lanceolate, erect-spreading to nearly squarrose.
-Perichaetial leaves not differentiated.
-Leaf cells mammillose.
-Alar cells not differentiated.
-Costae with 1 row of guide cells, and 2 stereid bands above and below.
-Dioicous.
-Capsules cylindric to ovoid, arcuate, inclined, rarely erect, exserted, nonstrumose, dehiscent.
-Peristome teeth, divided halfway into 2 segments vertically striate and papillose.

Dicranella

-Stems 0.5-5.0 cm high.
-Leaves narrowly lanceolate from a sheathing base or narrowed from a non-sheathing base, erect-spreading to squarrose.
-Perichaetial leaves similar to upper stem leaves.
-Leaf cells smooth.
-Alar cells not differentiated.
-Costae with a row of guide cells and 1-2 stereid bands.
-Dioicous.
-Capsules ovoid, oblong or cylindric, straight or arcuate, erect or inclined, exserted, strumose or nonstrumose, dehiscent.
-Peristome teeth divided halfway into 2 segments, vertically pitted-striolate below, papillose above.

Dicranoweisia

-Stems 0.5-2.0 cm high.
-Leaves ovate-lanceolate, lanceolate to subulate, spreading.
-Perichaetial leaves convolute or not differentiated.
-Leaf cells with cuticular ridges.
-Alar cells differentiated or not differentiated.
-Costae with a row of guide cells, and 1 -2 stereid bands.
-Autoicous.
-Capsules cylindric, straight, erect, exserted, nonstrumose, dehiscent.
-Peristome teeth undivided or split at the apex, papillose, sometimes striate near the middle.

Dicranum

-Stems 0.5-18.0 cm high.
-Leaves lanceolate, often falcate-secund, erect or spreading.
-Perichaetial leaves convolute-sheathing.
-Leaf cells smooth or dorsally papillose.
-Alar cells distinctly differentiated.
-Costae with a row of guide cells and stereid bands above and below.
-Dioicous or pseudomonoicous.
-Capsules cylindric, straight or arcuate, erect to inclined, exserted, nonstrumose or slightly strumose, dehiscent.
-Peristome teeth divided up to 1/2-1/3 their length into 2 segments, vertically pitted-striolate below, papillose above.

Kiaeria

-Stems 1.0-2.5 cm high.
-Leaves lanceolate to subulate, erect spreading to falcate-secund.
-Perichaetial leaves broader at base than vegetative leaves.

-Leaf cells smooth, or dorsally papillose by projecting cell ends.
-Alar cells differentiated.
-Costae lacking stereid bands.
-Autoicous.
-Capsules oblong-ovoid to cylindric, straight or arcuate, erect to inclined, exserted, usually strumose, dehiscent.
-Peristome teeth divided halfway into 2 segments, vertically striolate below, papillose near apex.

Leucobryum

-Stems 2.0-10.5 cm high.
-Leaves oblong-lanceolate, erect-spreading, sometimes falcate-secund.
-Perichaetial leaves scarcely differentiated, clasping at base.
-Leaf cells smooth, some with a large pore.
-Alar cells not differentiated.
-Costae with a central row of chlorophyllose cells and 1-4 rows of hyaline cells above and below.
-Dioicous.
-Capsules oblong-cylindric, arcuate, inclined to horizontal, exserted, strumose, dehiscent.
-Peristome teeth divided halfway into 2 segments, vertically striate below, papillose above.

Oncophorus

-Stems 1.0-2.5 cm high.
-Leaves lanceolate from an erect or clasping base, squarrose or nearly so.
-Perichaetial leaves scarcely differentiated.
-Leaf cells smooth.
-Alar cells not differentiated.
-Costae with 1 row of guide cells and stereid bands above and below.
-Autoicous.
-Capsules cylindric, arcuate, horizontal, exserted, strumose, dehiscent.
-Peristome teeth divided halfway into 2 segments, vertically pitted-striolate below, papillose above..

Paraleucobryum

-Stems 1-4 cm high.
-Leaves lanceolate, falcate-secund, spreading.
-Perichaetial leaves sheathing.
-Leaf cells smooth.
-Alar cells differentiated.
-Costae composed of 3-4 layers of hyaline cells intermingled with green cells.
-Dioicous.

-Capsules cylindric, straight or slightly arcuate, erect, exserted, nonstrumose, dehiscent.
-Peristome teeth divided halfway into 2 segments, obliquely or ± vertically striolate, papillose above.

Rhabdoweisia

-Stems 0.3-1.0 cm high.
-Leaves lingulate to linear-lanceolate, erect-spreading.
-Perichaetial leaves not differentiated.
-Leaf cells smooth.
-Alar cells not differentiated.
-Costae with a row of guide cells, a strong stereid band below and a weak band or no band above.
-Autoicous.
-Capsules ovoid to cylindric, straight, erect, sexserted, nonstrumose, dehiscent.
-Peristome teeth undivided, smooth to obliquely striate.

Trematodon

-Stems 0.5-1.0 cm high.
-Leaves narrowly lanceolate, with oblong-ovate base, erect to erect-spreading.
-Perichaetial leaves scarcely differentiated with a broader base.
-Leaf cells smooth.
-Alar cells not differentiated.
-Costae with a single stereid band.
-Autoicous.
-Capsules cylindric, straight or ± arcuate, erect, neck as long as the urn or longer, exserted, nonstrumose, dehiscent.
-Peristome teeth undivided or divided at tips, perforate, papillose above, longitudinally striate below.

D.- Key to the Dicranaceae of Quebec

1a. Stems less than 2 mm high, capsules indehiscent.... Bruchia

1b. Stems over 2 mm high, capsules dehiscent 2

2a. Costa broad, occupying most of leaf base, composed of hyaline and chlorophyllöse cells 3

3a. Plants glaucous, alar cells not differentiated, costa with a dorsal row of hyaline cells uninterrupted..... Leucobryum

3b. Plants dark green, alar cells differentiated, dorsal hyaline cells interrupted by chlorophyllose cells (giving the costa a striate appearance).....Paraleucobryum

2b. Costa narrow, occupying a small portion of leaf base, lacking hyaline and chlorophyllose cells 4

4a. Leaf cells with longitudinal cuticular ridges....Dicranoweisia

4b. Leaf cells lacking longitudinal cuticular ridges 5

5a. Alar cells differentiated 6

6a. Costa with 2 stereid bands; dioicous .....Dicranum

6b. Costa lacking stereid bands; autoicous 7

7a. Capsules exserted well above the upper leaves, usually strumose .....Kiaeria

7b. Capsules barely exserted beyond the upper leaves, nonstrumose .....Arctoa

5b. Alar cells not differentiated 8

8a. Leaf cells mammillose on both surfaces; stems sometimes with small, yellow, propagula; dioicous .....Dichodontium

8b. Leaf cells smooth or dorsally papillose; stems lacking propagula; autoicous or dioicous 9

9a. Neck of capsule as long or longer than the urn.Trematodon

9b. Neck of capsule not differentiated 10

10a. Peristome teeth undivided, filiform, smooth to faintly papillose .....Rhabdoweisia

10b. Peristome teeth divided, or if undivided not filiform, longitudinally pitted-striolate below, papillose above 11

11a. Leaves not strongly crisped when dry, margins unistratose; dioicous .....Dicranella

11b. Leaves strongly crisped when dry, margins completely or partially bistratose; autoicous 12

12a. Leaf margins entirely bistratose and recurved, upper cells

dorsally roughened by papillose bulges....Cynodontium

12b. Leaf margins bistratose in upper part (sometimes indistinctly so), plane or revolute near the middle, upper cells smooth .....Oncophorus

II.-MATERIALS AND METHODS

A.- Field and Herbarium Studies

During the course of this investigation the following species were collected and observed in the field in Quebec: Dicranum flagellare, D. fuscescens, D. montanum, D. ontariense, D. polysetum. D. undulatum, D. scoparium and D. viride. Other species were collected in northern British Columbia: D. acutifolium, D. elongatum, D. fragilifolium, D. groenlandicum, D. muehlenbeckii and D. spadiceum.

Nearly 3,000 specimens were examined from the following herbaria in Canada and the United States:

- CANM: National Museum of Natural Sciences, National Museums of Canada, Ottawa.
- MICH: University of Michigan, Ann Arbor.
- MTMG: Mc Gill University, Montreal.
- QFA: Herbier Louis-Marie, Faculté d'Agriculture, Quebec.
- QFB: Centre de Recherches Forestières des Laurentides, Quebec.

In addition, specimens were seen from the private herbarium of M.M.Grandtner, R. Gauthier, F. LeBlanc, M. Melançon, P. Grondin and L. Filion.

The following types were examined:

- Dicranum arcticum Schimp. (Kiaeria glacialis (Berggr.) Hag.)

- Dicranum angustum Lindb. (Dicranum spadiceum Zett. sensu lato)
- Dicranum bergeri var. acutifolium Lindb. et Arn.
  (Dicranum acutifolium (Lindb. et Arn.) C.Jens.)
- Dicranum flexicaule Brid.
  (Dicranum fuscescens var. flexicaule (Brid.)Wils.)
- Dicranum laevidens Williams (Dicranum spadiceum Zett. sensu lato)
- Dicranum spadiceum Zett. (Dicranum spadiceum Zett.)

B.- Morphological Studies

The diagnostic characters of the gametophyte and sporophyte are based on specimens seen, inboth the dry and wet state, however, sporpphytes were not present in every collection. The leaves used for descriptive as well as illustrative purposes were taken below the apex of the stems, generally in the upper 1/3. Only healthy looking and fully mature leaves were used.

Leaves and leaf cross-sections were mounted in Hoyer's solution* for permanent use. The cross-sections were made "free-hand" with a razor blade under the stereomicroscope. The descriptions of the cross-sections apply to the middle part of the leaves unless otherwise stated. The cross-sections were drawn from those in Hoyer's solution and were from the apical, middle and sometimes lower part of the leaf as stated in each plate.

* Anderson, L. 1954. Hoyer's Solution as a rapid permanent mounting medium for Bryophytes. The Bryologist 57 (3):242-244.

The measurements of the leaf cells were taken on leaves from several different collections (a minimum of three) mounted in Hoyer's. "Upper cells" refer to those cells of the upper 1/3 of the leaf, "median cells" those of the middle 1/3 of the leaf and the "lower cells" to those of the lower 1/3 of the leaf excluding the alar cells. The average cell width and length are based on a minimum of 12 measurements for each leaf. The measurement of stems, leaves and leaf cells is usually represented by two numbers to show the average range of variation with the minimum and maximum figures shown in parentheses. Some of the specimens used for measurements are cited with an * in the lists of Selected Specimens Examined.

C.- Illustrations and Distribution Maps.

All illustrations were made using a drawing tube on a Wild M 5 stereomicroscope and a Wild M 20 compound microscope. The map of Quebec was traced from a map of Canada, Goode Map Series # 211 (conic projection). The distribution of each taxon is based only on specimens personally examined.

NOTE: A good glossary of terms relating to mosses may be found in H. Crum, Mosses of the Great Lakes Forest, Contributions from the University of Michigan Herbarium, Vol. 10, pp. 365-377. 1973.

III.- TAXONOMIC TREATMENT

A.- Diagnosis of the Genus DICRANUM

Dicranum Hedw., Spec. Musc. 126. 1801.

Plants erect, small to large, (0.5) 2-12 (18.0) cm high, in loose to dense tufts, yellowish green to dark green, dull or shiny. Stems simple or forked, densely tomentose or nearly lacking rhizoids. Leaves generally lanceolate, rarely ovate, lower part concave, rarely flat, upper subula keeled to tubulose, erect-appressed, erect-patent or spreading, straight, weakly curled,crispate or cirrate when dry, generally falcate-secund, less often straight, undulate,rugose or smooth; apices acute to obtuse, the tips sometimes broken off; margins plane or incurved, entire or slightly serrate to strongly dentate above; laminae unistratose or bistratose on margins or sometimes near costa; costae single, ending below the apex to excurrent, smooth or dorsally toothed, sometimes with up to 4 dorsal toothed lamellae; leaf cells pitted or not pitted, smooth or sometimes dorsally, rarely ventrally, papillose; alar cells inflated, uni- or bistratose, rarely more, generally orange to brown, rarely not well-differentiated; basal cells rectangular to linear, median and upper cells short or long, quadrate, rectangular or irregularly angled. Leaves in cross-section with one or two rows of guide cells, two well-developed stereid bands above and below, sometimes slightly differentiated, extending to apex, or

ending below, dorsal and/or ventral row of cells differentiated or undifferentiated, sometimes a few ventral or dorsal cells enlarged, cell wall between cells weakly to strongly bulging, or bulges lacking.

Dioicous or pseudomonoicous. Male plants as large as female plants or dwarf and epiphytic on stem rhizoids of female plants; perigonial leaves ovate, concave, short-acuminate; perichaetial leaves convolute-sheathing, abruptly subulate. Setae erect, long, smooth, yellowish brown to red or reddish brown. Capsules cylindric, straight or arcuate, erect or inclined, smooth, striate or furrowed when dry. Opercula long-rostrate. Peristome teeth sixteen, split 1/2-1/3 their length into two or rarely three divisions, vertically pitted-striolate below, papillose above. Spores spherical, finely papillose, 12-30 μm. Calyptrae cucullate, smooth.

B.- Key to the Genus DICRANUM in Quebec

1a. Leaf tips broken 2

2a. Leaves with lower cells pitted, upper cells rectangular, lamina rarely with bistratose regions ....1.- D. fragilifolium

2b. Leaves with lower cells not pitted (or with few pits), upper cells quadrate, lamina often with bistratose regions ....2.- D. viride

1b. Leaf tips not broken 3

3a. Upper leaf cells usually short (quadrate, rectangular, or irregularly shaped), not sinuose, not pitted (or with few pits).....4

4a. Lower cells of leaf not pitted (or with few pits), alar cells usually unistratose; capsules generally straight; small plants averaging 2-4 cm high 5

5a. Leaf lamina mostly bistratose above, costa usually more than 1/4 the width of leaf base; on rock ....3.- D. fulvum

5b. Leaf lamina unistratose above, costa usually less than 1/4 the width of leaf base; on wood, humus, soil or rock.....6

6a. Flagelliform branchlets (rigid and terete branches with appressed leaves) in the upper leaf axils; leaves tubulose above, slightly papillose above on dorsal surface, curled to crisped when dry; upper lamina cells almost smooth or slightly papillose on back, upper cells short-rectangular to quadrate.. .....4.- D. flagellare

6b. Flagelliform branchlets lacking, usually with weak, slender, brood branches with linear, strongly crisped leaves when dry; leaves semi-keeled above, strongly papillose above on dorsal surface, generally strongly cirrate when dry; upper cells regularly quadrate .....5.- D. montanum

4b. Lower cells of leaf pitted, alar cells usually bistratose; capsules generally arcuate, large plants, averaging 3-8 cm high 7

7a. Leaves tubulose in the upper half, costa not terete; leaf cross-section with ventral row of cells differentiated or some cells enlarged 8

8a. Leaves cirrate to crisped when dry, upper cells short-rectangular to quadrate, with thin walls; ventral row of cells differentiated (seen in cross-section near leaf middle), lower cells 9-12 μm wide; capsules 3-4 mm long ....6.- D. muehlenbeckii

8b. Leaves erect-appressed or slightly curled when dry, upper cells elliptical to rectangular, with thick walls; some ventral cells of costa enlarged; lower cells 5-6 μm wide;capsules 1-2 mm long 9

9a. Lower cells usually less than 40 μm long, median cells pitted below the middle of the leaf, lower leaves with acute apices .....7.- D. elongatum

9b. Lower cells usually more than 40 μm long, median cells pitted well above the middle of the leaf, lower leaves usually with blunt apices .....8.- D. groenlandicum

7b. Leaves keeled in the upper half, costa terete; entire ventral row of cells undifferentiated or a few cells sometimes enlarged 10

10a. Leaves undulate or rugose (D. condensatum indistinctly undulate) 11

11a. Costa percurrent to excurrent 12

12a. Upper-median leaf cells irregularly angled, with unequally thickened walls, leaves not falcate or secund when moist; capsules 1.5-2.0 mm long, slightly contracted below mouth. 13

13a. Leaves ovate to ovate-lanceolate, concave and arched,loosely imbricate when dry..9.- D. spurium

13b. Leaves broadly lanceolate, not arched, slightly crisped when dry, not imbricate ....10.- D. condensatum

12b. Upper-median leaf cells short-rectangular to quadrate, with equally thickened walls; leaves falcate-secund when moist; capsules 2-4 mm long, not contracted below mouth 14

14a. Leaf margins strongly toothed above, lamina with tooth-like projections scattered above on dorsal surface; setae aggregate; capsules not strumose ....11.- D. ontariense

14b. Leaf margins slightly serrate above, lamina smooth to slightly rough above on dorsal surface; setae solitary; capsules ± strumose.....15

15a. Leaves straight to curled when dry, stems not densely tomentose, lower leaf cells often more than 45 µm long ... .12.- D. acutifolium

15b. Leaves strongly crisped to cirrate when dry, stems densely tomentose, lower leaf cells usually less than 45 µm long.. .....13.- D. brevifolium

11b. Costa ending well below the apex ....14.- D. undulatum

10b. Leaves not undulate or rugose 16

16a. Leaves strongly cirrate to crisped when dry; lower cells usually less than 45 µm long; capsules 3-4 mm long ....13.- D. brevifolium

16b. Leaves straight to ± curled when dry, lower cells usually more than 45 µm long; capsules 1.0-2.8 mm long 17

17a. Leaves with upper margins ± involute, lamina with few bistratose regions on margins in the upper part; leaf cells smooth to slightly papillose above on dorsal surface ....12.- D. acutifolium

17b. Leaves with upper margins erect; lamina with one or both upper margins bistratose; leaf cells papillose above on dorsal surface 18

18a. Stems 2-8 cm high; setae 1-2 cm long ....15.- D. fuscescens

18b. Stems 8-18 cm high; setae 2.5-3.5 cm long ....15a.- D. fuscescens var. flexicaule

3b.-Upper leaf cells usually elongate, sinuose, pitted 19

19a. Leaves usually less than 5 mm long; capsules slightly arcuate to erect, 1.5-3.0 mm long ..8.- D. groenlandicum

19b. Leaves over 5 mm long; capsules arcuate, 2-4 mm long 20

20a. Leaves with a double row of guide cells; setae aggregate (rarely solitary in var. orthophyllum).....21

21a. Leaves strongly falcate-secund .....
.....16.- D. majus

21b. Leaves erect-spreading...16a.- D. majus var. orthophyllum

20b. Leaves with a single row of guide cells;setae solitary or aggregate 22

22a. Leaves keeled above, margins strongly dentate in upper half, costa with 2-4 well-developed dentate ridges above on dorsal surface 23

23a. Leaves falcate-secund, not or slightly undulate, dull; setae solitary, rarely 2 per perichaetium .....
.....17.- D. scoparium

23b. Leaves spreading, strongly undulate; shiny; setae aggregate.
.....18.- D. polysetum

22b. Leaves tubulose to weakly tubulose above, margins entire to slightly dentate in upper half; costa without or with less developed dentate ridges above on dorsal surface 24

24a. Leaves with a long, narrow subula, apex obtuse to somewhat acute, without deformed leaves; upper leaf cells 8 x 10-17 μm; cell wall between cells slightly bulging.....
.....19.- D. spadiceum sensu lato

24b. Leaves with a short subula, obtuse apex; stems often with deformed leaves (short and broad); upper leaf cells 10 x 30-64 μm; cell wall between cells not bulging.....25

25a. Leaves usually with twisted apex when dry; with short imbricate leaves in upper part of stem and short and broad leaves in middle or lower part of stem often present; lower margins ± involute .....
.....20.- D. leioneuron

25b. Leaves seldom or never with twisted apex when dry; no deformed leaves in middle or lower part of stems; lower margins flat 26

26a. Leaves rugose-undulate, shiny, smooth cells on dorsal surface .....21.- D. bonjeani

26b. Leaves not or little rugose-undulate, dull, with somewhat rough cells on dorsal surface .....
.....17.- D. scoparium f.

C.- Dicranum Taxa in Quebec

1.- Dicranum fragilifolium Lindb., Bot.Not.1857:147.1857(IX).
Orthodicranum fragilifolium (Lindb.)Podp.,Consp.152.1954.

Plants in compact tufts, green to yellowish brown. Stems 1.5-4.5 cm high, densely tomentose. Leaves straight, erect-spreading, appressed when dry, (5.0) 6-7 (7.5) mm long, most of the leaf tips broken off, from a lanceolate base to a long, slender, acute apex (when present), formed by the excurrent costa; margins entire to somewhat serrulate above; laminae unistratose or some bistratose regions near costa; costae excurrent, 1/3-1/4 the width of the leaves at base, smooth or slightly rough above on dorsal surface; leaf cells smooth; alar cells unistratose, sometimes with some bistratose regions, well-differentiated; lower cells elongate-rectangular, usually pitted or indistinctly pitted, (5) 7-8 (10)µm wide and (25) 39-55 (84) µm long; median cells rectangular, not pitted, (4) 7-8 (10) µm wide and (11) 21-22 (37) µm long; upper cells nearly elliptical, incrassate. Leaves in cross-section with a row of guide cells, two thin stereid bands (2-3 cells thick), no differentiated ventral or dorsal row of cells, sometimes a few cells enlarged, cell walls between cells bulging slightly.

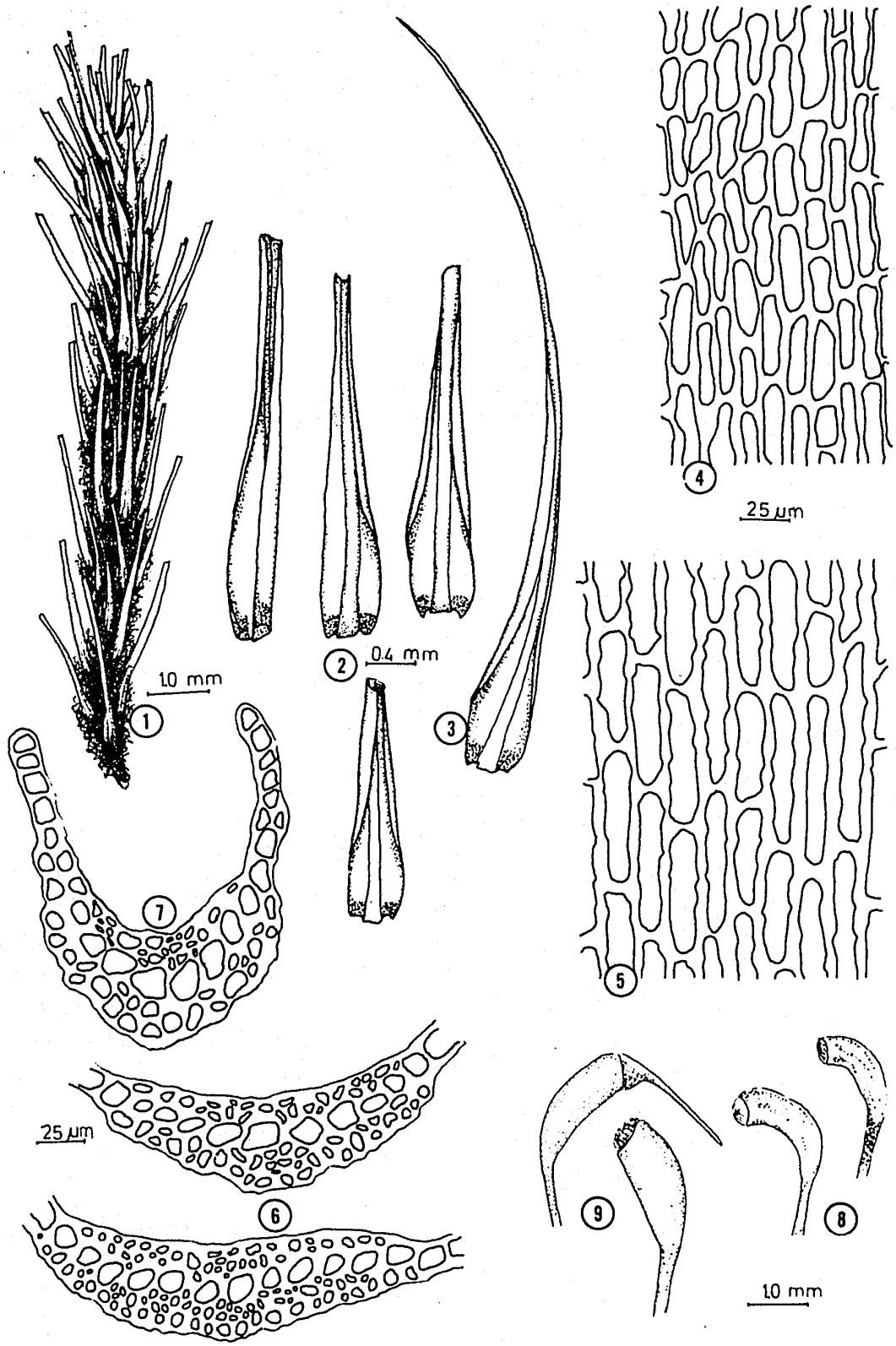
Dioicous. Male plants as large as the females but usually more slender. Setae solitary, 1.5-2.0 cm long. Capsules yellowish brown, arcuate to nearly straight, ± erect, smooth to striate when dry, 1.8-2.0 mm long.

On rotten wood or humic soil. Rare, growing along the east coast of Hudson and James Bay. Greenland to Alaska, Newfoundland, Ontario, Minnesota to Montana, and British Columbia. Europe and Asia.

SPECIMENS EXAMINED

MISTASSINI: Rupert House, Kucyniak & Tuomikoski K68 (CANM)*. NEW QUEBEC: Fort George, Kucyniak & Tuomikoski T459 (CANM)*. Great Whale River, 55°11'N-77°34'W, Kucyniak & Tuomikoski T1635 (CANM)*.

PLATE #1: Dicranum fragilifolium 1.- Habit of upper portion of stem (dry). 2.- Stem leaves. 3.- Stem leaf with subula. 4.- Median leaf cells. 5.- Lower leaf cells. 6.- Lower leaf cells in cross-section. 7.- Median leaf cells in cross-section. 8.- Capsules (dry). 9.- Capsules (wet).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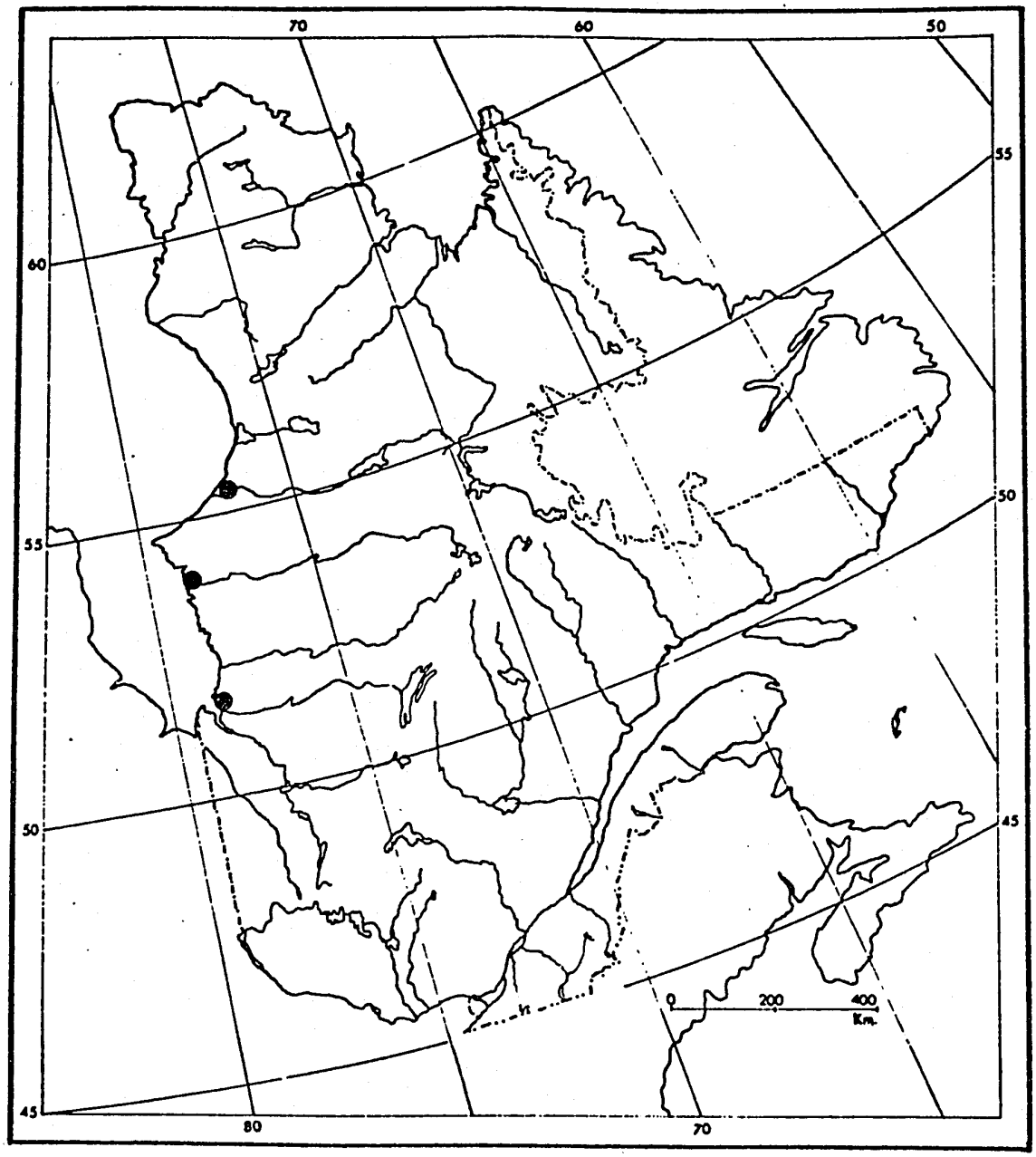


Map # 1: Distribution of Dicranum fragilifolium in Quebec.

2.- Dicranum viride (Sull. et Lesq.) Lindb., Hedwigia 2:70.1863.

Campylopus viridis Sull. et Lesq., Musc.Bor.Amer.18.1856.
Orthodicranum viride (Sull.et Lesq.)Roth in Cas.Gil,Fl.Iber. Musg.176:64 c-e.1932.
Dicranum fulvum Hook var. viride (Sull.et Lesq.)Frye in Grout, Moss.Fl.N.Amer.1:80.1937.
Paraleucobryum viride (Sull.et Lesq.)Podp., Consp.153.1954.

Plants in dense tufts, yellowish to dark green, dull. Stems 1.5-4.5 cm high, tomentose. Leaves erect-spreading or somewhat falcate-secund, rigid, erect below and flexuose above when dry, (3) 4-6 (7) mm long, most of the leaf tips broken off, concave below, subtubulose above, from a lanceolate base to a long-acuminate, deciduous apex; margins entire, slightly denticulate at apex (when present); laminae with some bistratose regions between margin and costa; costae excurrent, 1/4-1/5 the width of the leaves at base; leaf cells usually smooth; alar cells unistratose or with few bistratose regions, well-differentiated; lower cells rectangular to short-rectangular, not pitted or with few pits, (7) 9-10 (13) μm wide and (11) 33-34 (51) μm long; median cells regularly quadrate, not pitted, (5) 7-8 (11) μm wide and (9) 17-18 (26) μm long; upper cells small, quadrate, not pitted. Leaves in cross-section with a row of guide cells, two stereid bands above and below, weakly developed, not extending above the middle of the leaf, no differentiated ventral and dorsal row of cells or with few dorsal and ventral cells enlarged, cell walls between cells weakly or not bulging.

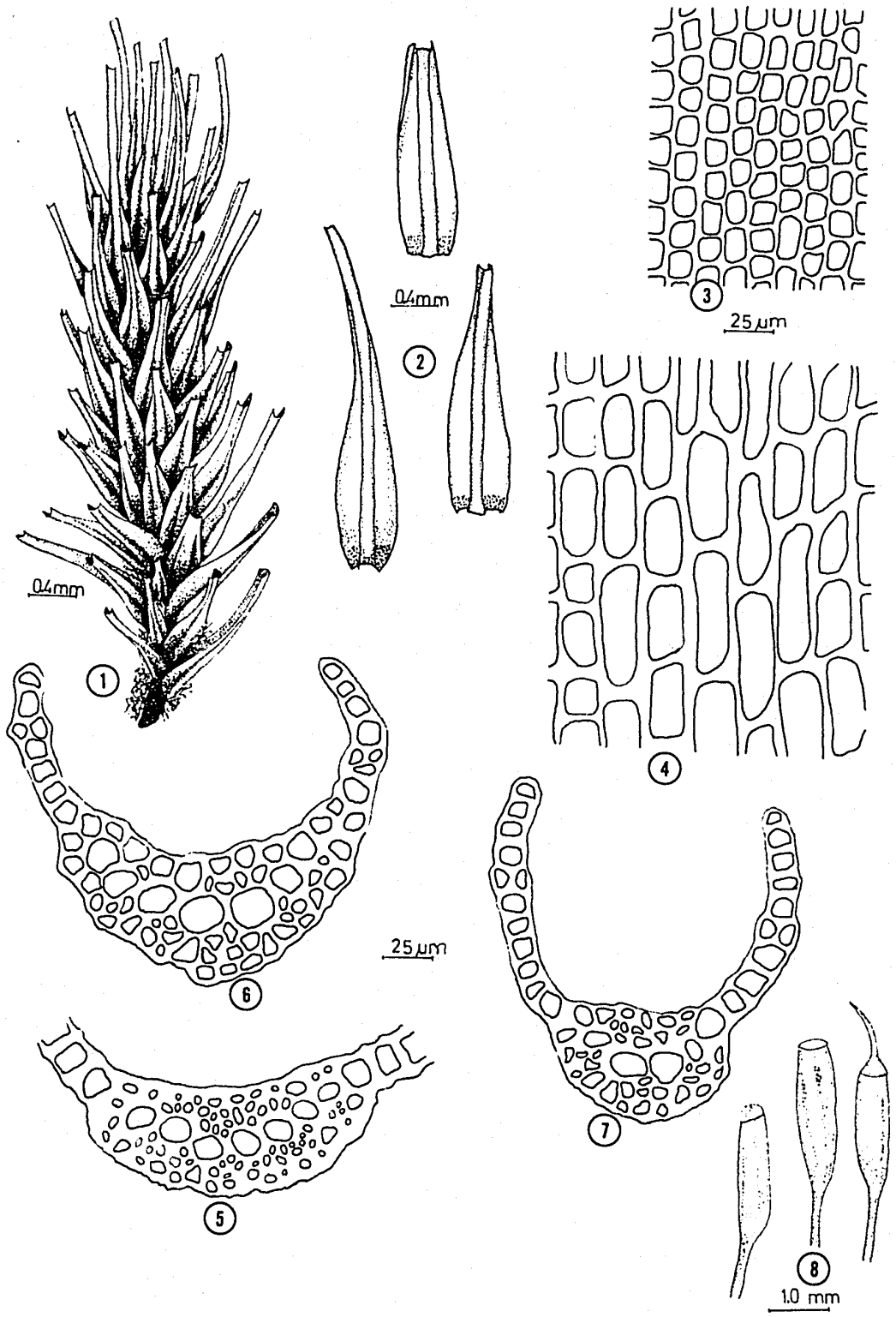
Dioicous. Male plants as large as the females. Setae solitary, 1.0-1.5 cm long. Capsules yellowish brown, straight and erect, slightly furrowed when dry, 1.5-2.5 mm long.

Generally growing on bark at base of trees, rarely on soil. Found in southern Quebec and nearly similar in distribution to D. fulvum, occuring between latitudes 45° and 48°N. Circumpolar. Nova Scotia to Minnesota, south to North Carolina, Tennessee, Michigan and Iowa. Europe.

SELECTED SPECIMENS EXAMINED

BEAUCE: Beauceville, Marie-Anselme 2834 (QFA). DEUX MONTAGNES: La Trappe,Oka, Dupret 4-91925 (QFA)*. DORCHESTER: Sainte-Claire, Gagnon & Masson 8651 (CANM). GASPE WEST: Mont Albert, Crum & Williams 10675 (CANM). Riviere Ste.-Anne des Monts, Collins 5-746-A (MICH). GATINEAU: Gatineau Park, Trucco 137 (GT)*. LAC ST-JEAN WEST: St. Félicien,Marie-Anselme 3170 (CANM, QFA). MATANE: Montagnes du Bonjour, LeBlanc 4469 (QFA). SHEFFORD: Waterloo, Marie-Anselme 1799 (QFA). TERREBONNE: Parc du Mont Tremblant, Crum & Williams 10352 (CANM).

PLATE #2: Dicranum viride 1.- Habit of upper portion of stem (dry). 2.- Stem leaves with tips broken off. 3.- Median leaf cells. 4.- Lower leaf cells. 5.- Lower leaf cells in cross-section. 6.- Upper leaf cells in cross-section. 7.- Median leaf cells in cross-section. 8.- Capsules (dry).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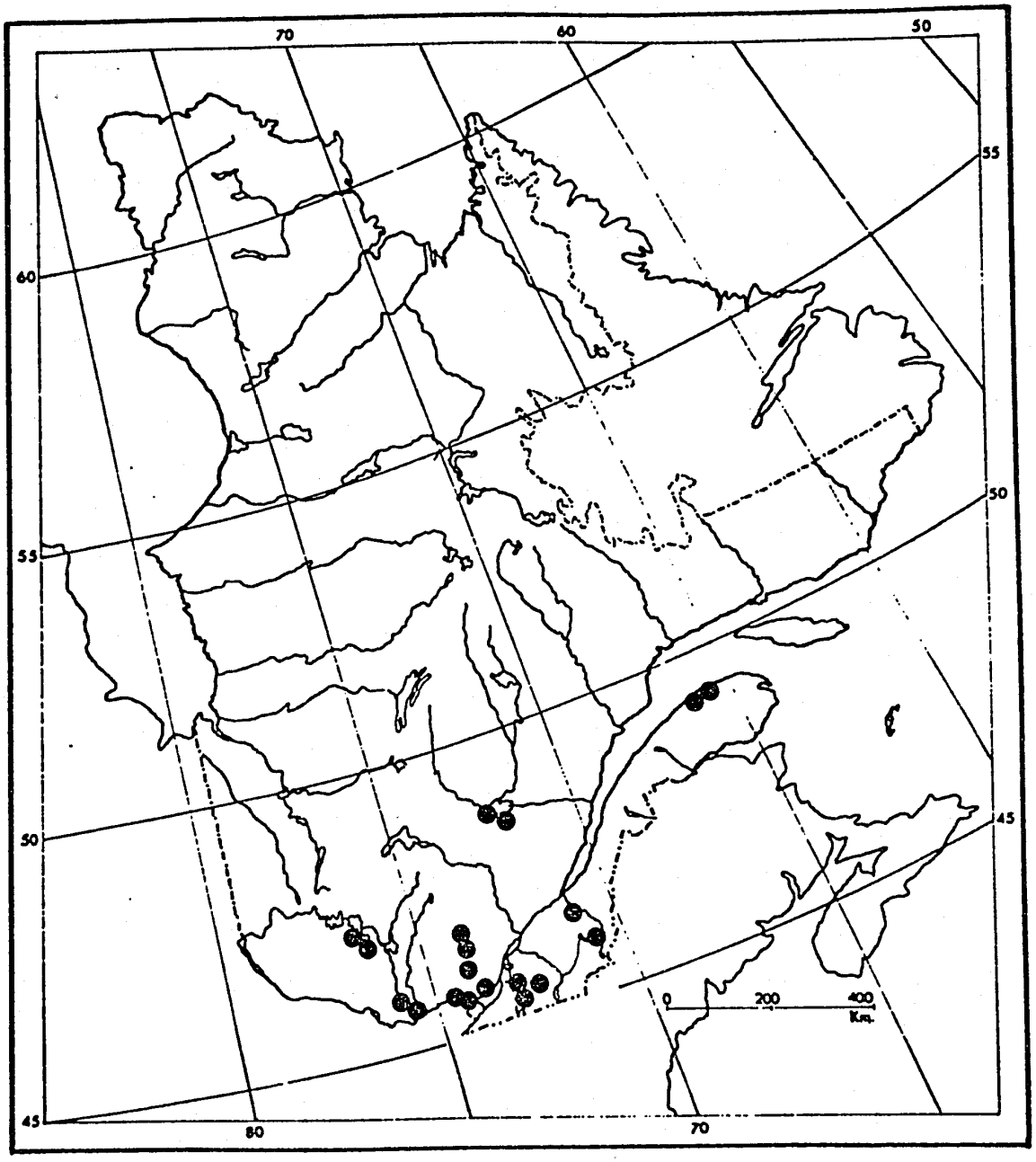


Map # 2: Distribution of Dicranum viride in Quebec.

3.- Dicranum fulvum Hook., Musci Exot.2:149.1819.

Dicranum subfulvum Ren.et Card., Bot.Gaz.22:49.3c.1896.
Dicranum subsubulifolium Kindb., Rev. Bryol. 37:13. 1910.
Orthodicranum fulvum (Hook.)Roth in Cas.Gil,Fl.Iber.Musg.176.1932.
Paraleucobryum fulvum (Hook.)Loeske in Podp., Consp.153.1954.

Plants in dense tufts, dark green above, blackish green below, dull. Stems 1.5-3.5 cm high, tomentose. Leaves erect-spreading, falcate, crisped when dry, (3) 4-5 (7) mm long, concave below, subtubulose above, from a lanceolate base to a long, narrow subula occupied mainly by the excurrent costa; margins smooth to slightly serrulate above; upper laminae mostly bistratose; costae excurrent, 1/3-1/4 the width of the leaves at base, rough on dorsal surface; leaf cells smooth; alar cells mostly unistratose, distinctly differentiated; lower leaf cells elongate-rectangular, not pitted or with few pits, (4)5-6 (9) µm wide and (19) 24-33 (42) µm long; upper cells regularly quadrate to short-rectangular, not pitted, (4) 5-6 (9) µm wide and (5) 10-11 (16) µm long. Leaves in cross-section with a row of guide cells, two stereid bands not extending above the middle of leaf, dorsal and ventral row of cells somewhat differentiated or with few dorsal and ventral cells enlarged, cell walls between cells strongly bulging in upper part of leaf lamina.

Dioicous. Male plants as large as female plants but usually more slender. Setae solitary, 1.5-2.0 cm long. Capsules yellowish brown, straight and erect, slightly furrowed when dry, 1.5-3.0 mm long.

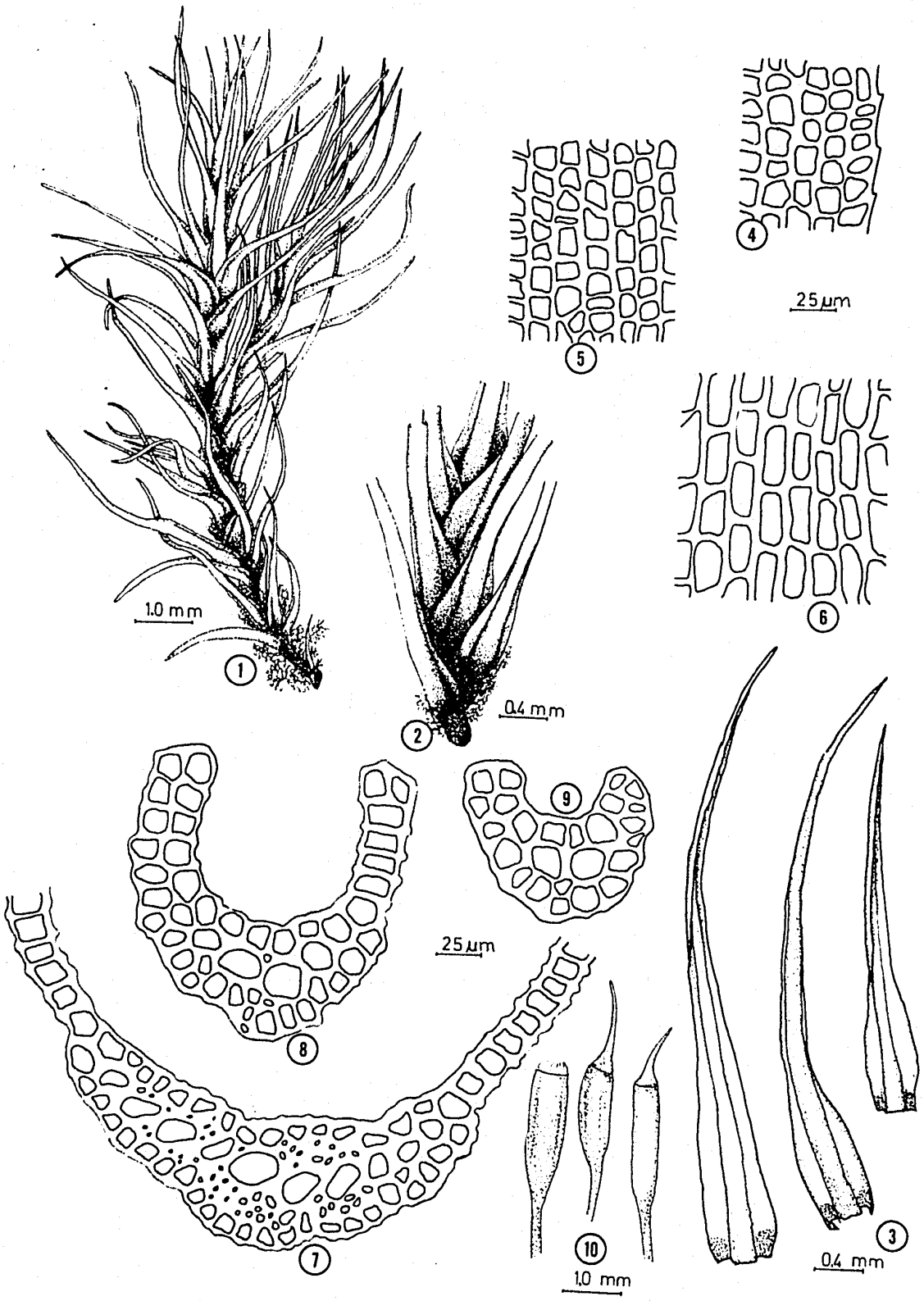
Mainly on rock, rarely on soil or wood. Common only in the southern part of Quebec between latitudes 45°and 47°N. Nova Scotia to Minnesota, south to Georgia and Arkansas. Europe and Asia.

This species is easily recognized by its broad costae, its leaves that are crisped when dry, its blackish green colour on the lower part of the stem, and its preferred habitat on rock.

SELECTED SPECIMENS EXAMINED

BAGOT: St.-Pie, LeBlanc 2623 (QFA). BEAUCE: Beauceville, Marie-Anselme 2820 (CANM)*. CHAMPLAIN: La Tuque, Marie-Anselme 800 (CANM). COMPTON: Megantic Mountain, Marcotte 44-1 (CANM). GATINEAU: Luskville Falls, Trucco 105 (GT)*. IBERVILLE: Mt. Johnson, Marie-Anselme MA13 (CANM). LABELLE: La Conception, Crum & Williams 10409 (CANM)*. MONTCALM: north of Lac Monroe, Parc du Mont Tremblant, Hermann 16595 (CANM). PONTIAC: Parc de la Vérendrye, Crum & Williams 10222C (CANM). ROUVILLE: St. Hilaire, Barnston (MYMG 79393). SHEFFORD: Bowker Lake, Marie-Anselme 829 (CANM). Waterloo, Marie-Anselme 1259 (CANM). VAUDREUIL: Rigaud, Dupret 9-91911 (QFA).

PLATE #3: Dicranum fulvum 1.- Habit of upper portion of stem (wet). 2.- Enlargement of portion of stem (wet). 3.- Stem leaves. 4.- Upper leaf cells. 5.- Median leaf cells. 6.- Lower leaf cells. 7.- Lower leaf cells in cross-section. 8.- Median leaf cells in cross-section. 9.- Upper leaf cells in cross-section. 10.- Capsules (dry).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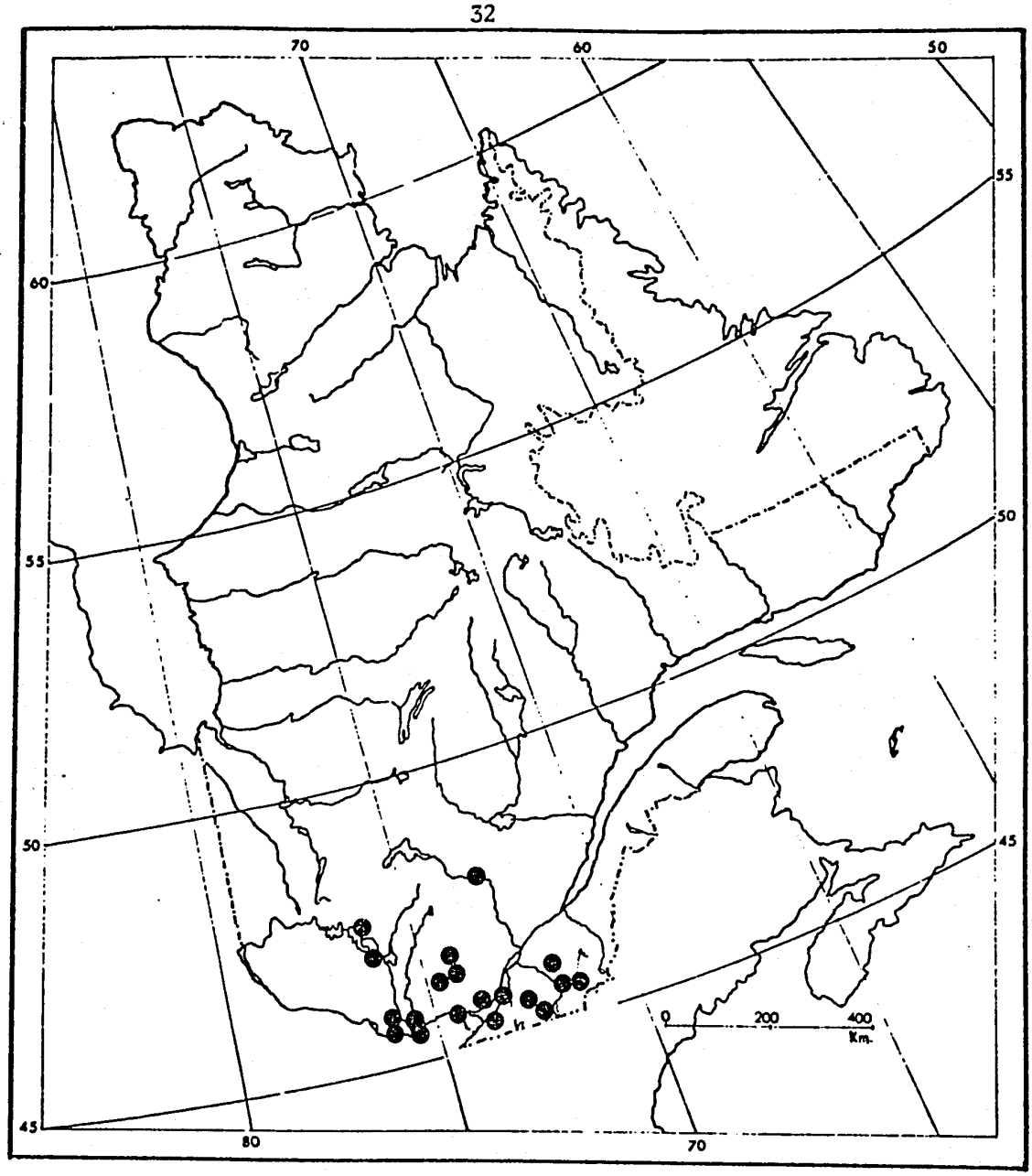


Map # 3: Distribution of Dicranum fulvum in Quebec.

4.- Dicranum flagellare Hedw., Spec. Musc.130.1801.

Dicranum miquelonense Ren. et Card. in Delamare, Ann.Soc.Bot. Lyon 15:106.1888.
Dicranum crispatulum (Roell) Kindb., Eur.N.Amer.Bryin 2:189.1897.
Dicranum miquelonense var. crispatulum Roell, Hedwigia 36:42.;897(II).
Orthodicranum flagellare (Hedw.)Loeske, Stud.Morph.Syst.Laubm.85.1910.

Plants in dense tufts, yellowish green to dark green, generally bearing dark green, stout, terete branchlets in the axils of the upper leaves, each flagelliform branchlet with small, appressed leaves. Stems 0.5-6.0 cm high, tomentose, usually branched above. Leaves falcate-secund, crisped to slightly crisped when dry, ((1) 2-4 (5) mm long, concave below, tubulose above, from a lanceolate base to an acuminate subula, sometimes ovate-lanceolate; margins smooth to serrulate above; laminae unistratose; costae percurrent, often ending slightly below the apex, 1/4-1/6 the width of the leaves at base, smooth to ± rough on dorsal surface near apex; leaf cells smooth to slightly dorsally papillose above; alar cells mostly unistratose, distinctly differentiated; lower cells elongate-rectangular, not pitted or with few pits, (4) 6-7 (9) µm wide and (12) 24-38 (70) µm long; upper cells short-rectangular to quadrate, not pitted, (5)10-11(14) µm wide and (5)12-14(23) µm long. Leaves in cross-section with a row of guide cells, two stereid bands above and below not extending above the middle of the leaf, some dorsal cells enlarged, cell walls between cells not bulging.

Dioicous. Male plants as large as the females. Setae solitary, 1.5-2.5 cm long. Capsules yellowish brown to brown, straight and erect

or nearly so, slightly furrowed when dry, 1.5-3.0 mm long. n =12,23.

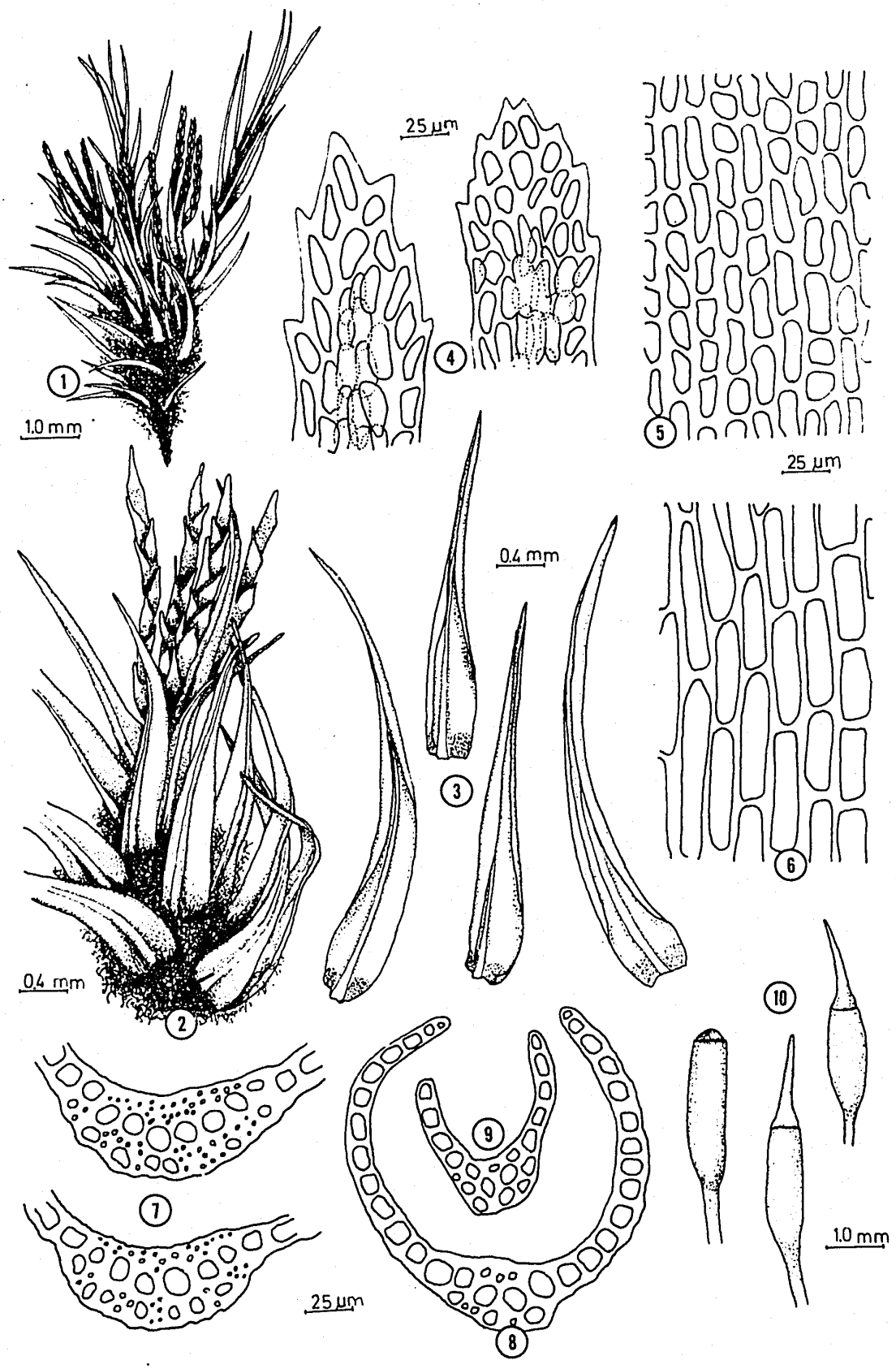
On rotten wood, base of trees and humic soil. Its distribution in Quebec is similar to D. montanum. Common between latitudes 45°and 48°N but not found above 50°N. Circumpolar. Newfoundland to British Columbia, south to Florida, Louisiana, South Dakota and Montana. Mexico, West Indies, Europe and Asia.

When bearing flagelliform branchlets, which at least some plants in each colony possess, D. flagellare is readily distinguished from all other species. It is distinguished from D. montanum by the characters listed in the discussion of that species.

SELECTED SPECIMENS EXAMINED

ABITIBI: 48°49'N-78°20'W, Gaudreau 22-1A (CANM, QFA). FRONTENAC: Mégantic Mountain, Marcotte 66-8 (CANM). GATINEAU: Gatineau Park, 45°36'N-76°06'W, Ireland10103 &Fabiszewski (CANM)*. IBERVILLE: Iberville, Marie-Anselme MA16 (CANM)*. LAC ST-JEAN WEST: 48°47'N-72°28'W, Comeau 303 (CANM). LEVIS: St Chrysostome, Masson 8894 (CANM). MONTCALM: St Théodore, LeBlanc 6981 (QFA)* PAPINEAU: New Buckingham, Macoun 19 May 1885 (CANM 119075). PONTIAC: Parc de la Vérendrye, Crum & Williams10173 (CANM). PORTNEUF: La Tuque, Marie-Anselme MA-15 (CANM). SAGUENAY: 48°30'N-69°13'W, Comeau 224 (CANM)*. TEMISCAMINGUE: Kipawa River, 46°48'N-78°30'W, Brown 130T-3 (CANM). TERREBONNE: Parc du Mont Tremblant, Crum 9846 (CANM).

PLATE #4: Dicranum flagellare 1.- Habit of upper portion of stem (wet). 2.- Enlargement of a portion of stem with flagelliform shoots (wet). 3.- Stem leaves. 4.- Apex. 5.- Median leaf cells. 6.- Lower leaf cells. 7.- Lower leaf cells in cross-section. 8.- Median leaf cells in cross-section. 9.- Upper leaf cells in cross-section. 10.- Capsules (wet).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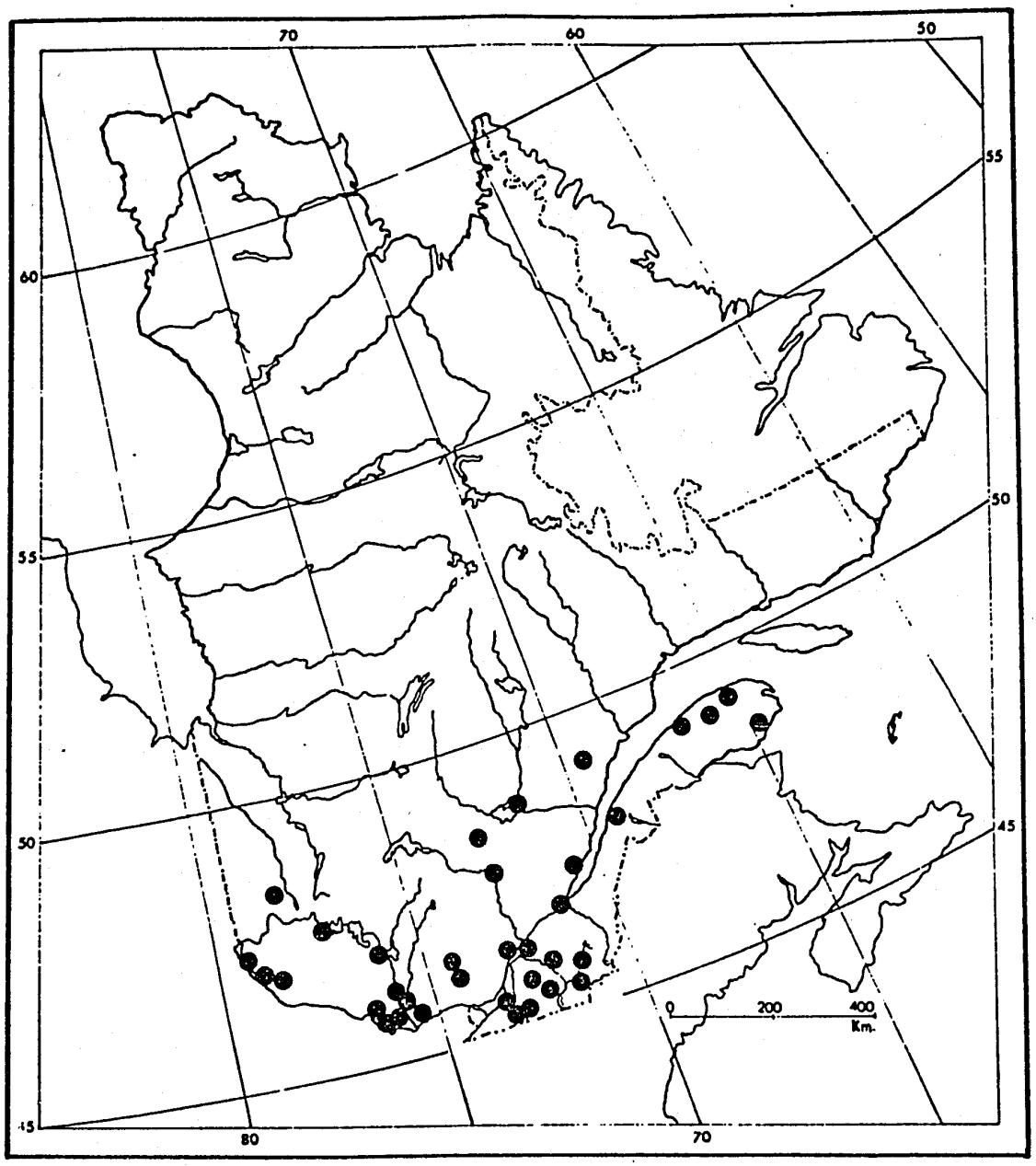


Map # 4: Distribution of Dicranum flagellare in Quebec.

5.- Dicranum montanum Hedw., Spec.Musc.143.1801.

Dicranum interruptum Brid., Spec.Musc.1:179.1806.hom.illeg.
Dicranum hostianum Schwaegr., Spec.Musc.Suppl.1(1):177.44.1811.
Dicranum hostii Lindb., Musci Scand.24.1879.nom.illeg.incl.spec.prior.
Orthodicranum montanum (Hedw.)Loeske, Stud.Morph.Syst.Laubm.85.1910.

Plants in dense tufts, yellowish green to dark green, dull, usually having weak, clustered branchlets near stem apices with small, linear leaves, strongly crisped when dry. Stems 0.5-3.0 (5.0) cm high, densely tomentose. Leaves erect-spreading, cirrate to strongly crisped when dry, (1) 2-3 (4) mm long, concave below, subtubulose above, from a lanceolate base to a gradually acuminate apex; margins irregularly serrate to serrulate in the upper half of the leaves; laminae unistratose; costae percurrent to slightly excurrent, 1/4-1/6 the width of the leaves at base, rough on dorsal surface; leaf cells usually dorsally papillose in the upper half of the leaves, giving a dull appearance to the leaves; alar cells unistratose, sometimes indistinctly differentiated; lower cells rectangular to oblong-rectangular, not pitted or with few pits, (4) 6-8 (13) µm wide and ((14) 23-32 (42) µm long; upper cells usually regularly quadrate with some cells elongated transversally or short-rectangular, not pitted, (5) 7-8 (12) µm wide and (5) 8-10 (26) µm long. Leaves in cross-section with a row of guide cells, two stereid bands above and below, weakly developed, not extending to the middle of the leaf, no differentiated ventral or dorsal rows of cells, or with few dorsal cells enlarged, cell walls between cells not bulging.

Dioicous. Male plants as large as the females. Setae solitary, 0.5-1.3 cm long. Capsules light yellowish brown, straight and erect, some slightly arcuate, slightly furrowed when dry, 1.2-1.8 mm long. n =12,14.

On soil, over rocks, on rotten wood, tree stumps and tree bases (sometimes growing on the base of conifers). Common in southern Quebec, between latitudes 45°and 50°N, but rare above 50°latitude. Circumpolar. Labrador to Manitoba, south to South Carolina, Tennessee and Arkansas; disjunct to British Columbia and Arizona. Europe.

This species is easily recognized by the leaves that are strongly crisped when dry and leaf cells that are papillose on the dorsal surface in the upper half of the leaf. It is also characterized by the presence of small, delicate, clustered branchlets with linear leaves that are easily detachable (probably a means of asexual reproduction) that occur near the stem apices. The leaves when detached leave scars that give a characteristic aspect to these branchlets (see figure 2, Plate # 5). This species often grows mixed with Dicranum fuscescens.

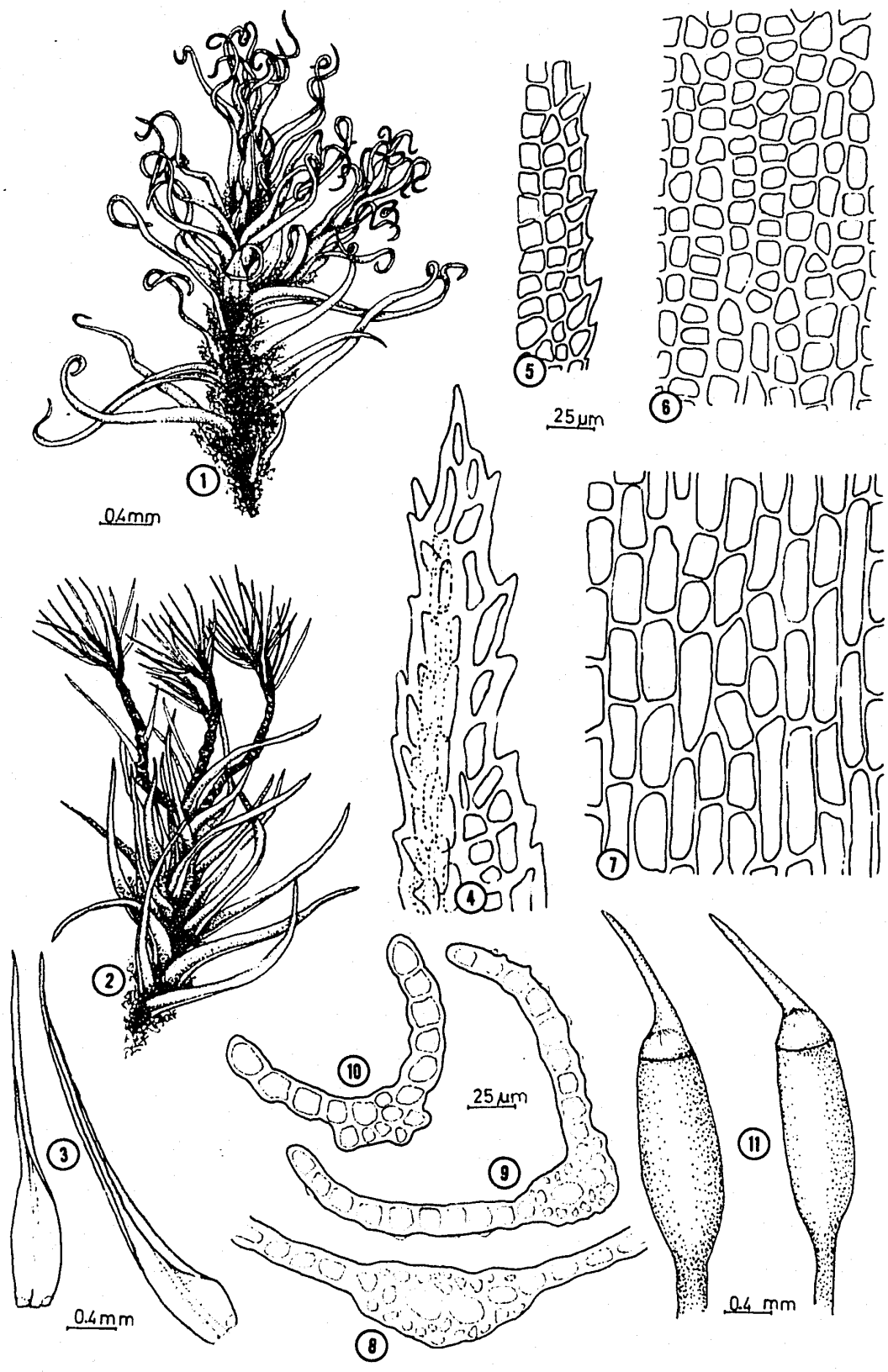
Dicranum montanum can sometimes be confused with its closest species D. flagellare, especially when the latter does not have its typical flagelliform branchlets, but it is distinguish from it by the leaves that have a keeled subula, the leaf cells that are strongly papillose on the dorsal surface, and the upper cells that are more regularly quadrate. When D. montanum grows above 50°N latitude, the plant's

appearance when dry sometimes changes from its characteristic crisped leaved habit to an erect leaved habit.

SELECTED SPECIMENS EXAMINED

ABITIBI: Lac Chicobi, 48°50'N-78°32'W, Gaudreau 8126-14 (CANM, QFA). FRONTENAC: 45°27'N-71°07'W, Marcotte 6-6 (CANM). GASPE: in woods, Macoun 30 August 1882, (CANM 119273). GASPE EAST: Parc Nat. Forillon, 48°58'N-64°28'W, Majcen 8317/M4 (CANM, QFA)*. GASPE WEST: 48°50'N-66°10'W, Ireland 10272 (CANM)*. Rivière au Diable, Crum & Williams 10635 (CANM)* GATINEAU: Cantley, Schofield 14994 (CANM). Luksville Falls, Trucco 34 (GT)*. IBERVILLE: Iberville, Marie-Anselme MA18 (CANM). L'ISLET: Laverrier, 46°46'N-69°58'W Gauthier 9-A (QFA). MATANE: Montagnes du Bonjour, LeBlanc 4403 (QFA). MONTCALM: Parc du Mont Tremblant, Hermann 16668 (CANM). MONTMORENCY: Parc Prov. des Laurentides, Gauthier 3491 (RG). RIVIERE DU LOUP: 47°50'N-69°29'W, Gauthier 5901-12 (RG). SAGUENAY: 49°23'N-67°25'W, Comeau 233 (CANM)*. TEMISCAMINGUE: 46°44'N-78°54'W, Brown 181T-4 (CANM).

PLATE #5: Dicranum montanum 1.- Habit of upper portion of stem (dry). 2.- Habit of stem (wet). 3.- Stem leaves. 4.- Apex. 5.- Upper leaf cells. 6.- Median leaf cells. 7.- Lower leaf cells. 8.- Lower leaf cells. 8.- Lower leaf cells in cross-section. 9.- Median leaf cells in cross-section. 10.- Upper leaf cells in cross-section. 11.- Capsules (wet).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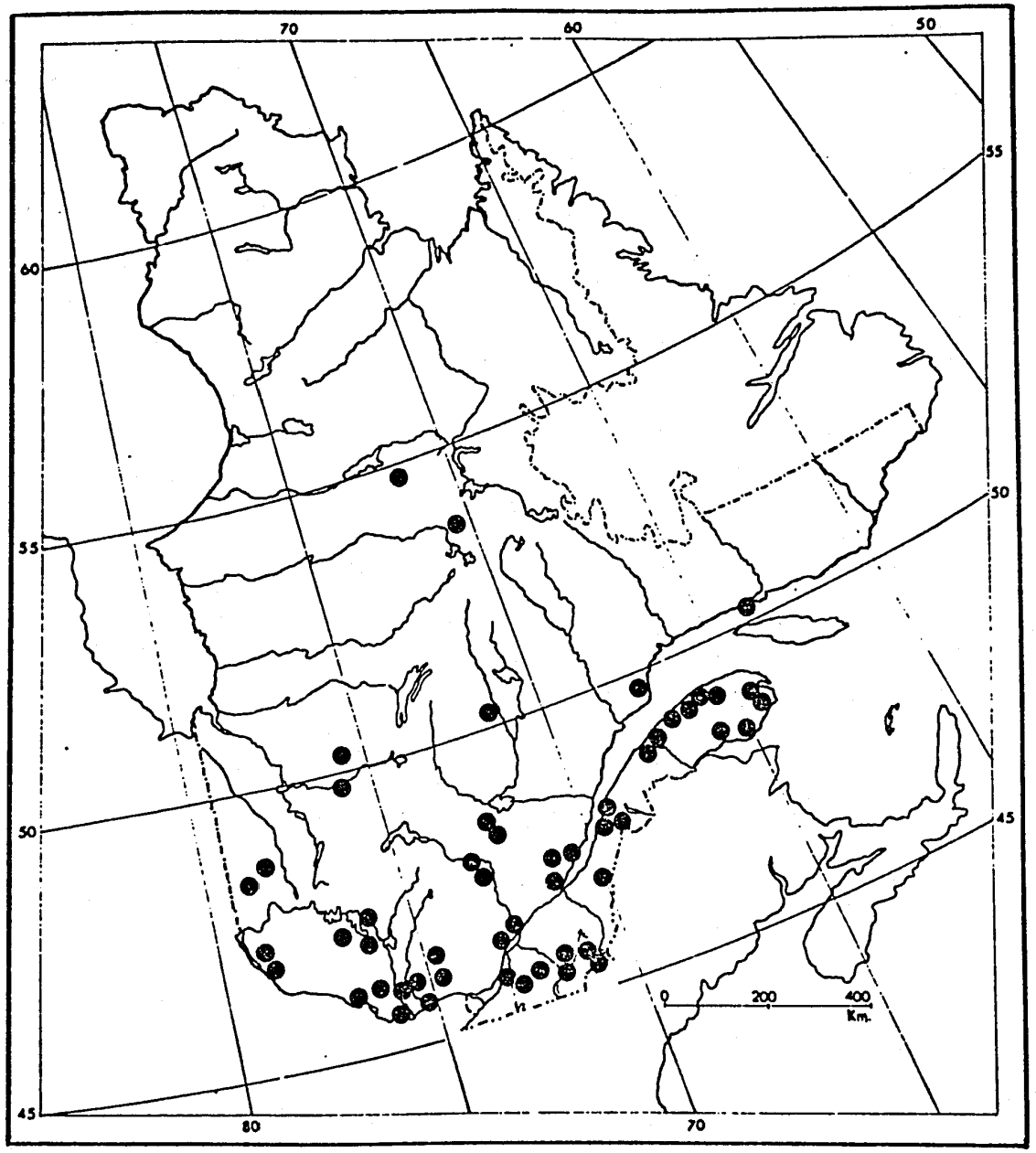


Map # 5: Distribution of Dicranum montanum in Quebec.

6.- Dicranum muehlenbeckii B.S.G., Bryol.Eur.1:142.78.1847.(fasc.37-40.Mon.38.30.).

Dicranum rauei Aust., Bot.Gaz.1:28.1876.(V).

Plants in dense tufts, green to yellowish-green. Stems 3.5-6.0 cm high, densely tomentose nearly to stem apex, the reddish brown rhizoids giving the stems a thick appearance. Leaves erect-spreading, strongly cirrate to crisped when dry, (4.5) 5.0-6.5 (7.5) mm long, concave below, tubulose above, lanceolate, acute; margins entire below, slightly serrate or entire above, laminae unistratose; costae excurrent, 1/4-1/6 the width of the leaves at base, smooth or weakly toothed above on dorsal surface; leaf cells smooth to slightly rough above on dorsal surface; alar cells bistratose, differentiated; lower cells rectangular, somewhat pitted, (5) 9-12 (14) μm wide and (19) 37-55 (73) μm long; upper cells short, irregularly quadrate-rectangular, not pitted, (6) 8-9 (13) μm wide and (7) 11-12 (23) μm long. Leaves in cross-section with one row of guide cells, two stereid bands extending to the apex, dorsal and ventral row of cells differentiated, cell walls between cells weakly bulging.

Pseudomonoicous. Dwarf males on stem rhizoids of female plants. Setae solitary, 1.3-3.0 cm long. Capsules yellowish-brown, long-cylindric, arcuate to ± straight and nearly erect, striate when dry, 3-4 mm long.

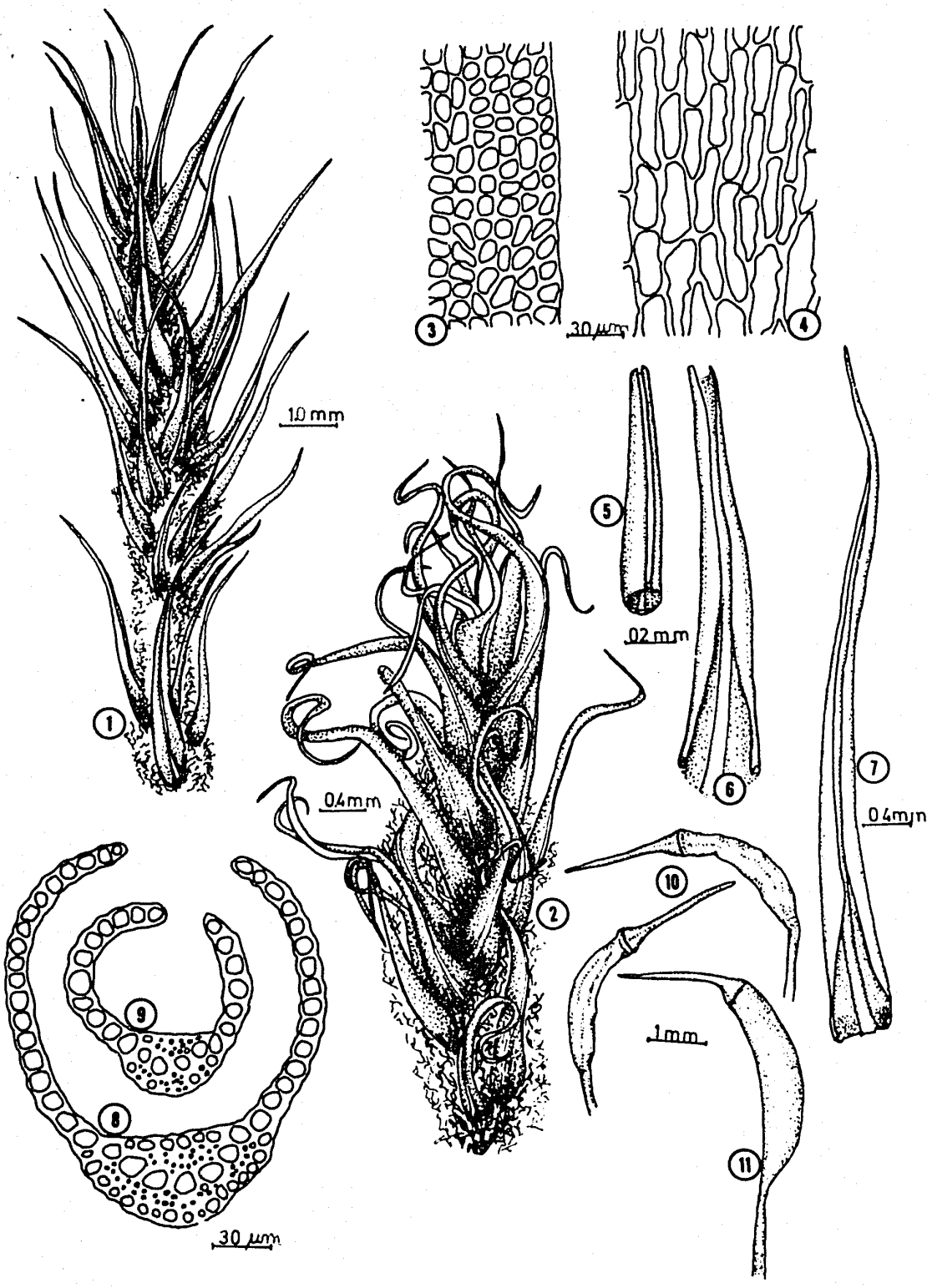
On humus and soil over rocks. Rare in Quebec, with a few collections in Durham (leaves strongly cirrate when dry), and in the Hudson Bay area (leaves slightly crisped when dry). Labrador to Alaska, south to New Jersey, North Dakota, and New Mexico. Europe and Asia.

Plants of D. muehlenbeckii growing in the Hudson Bay region are somewhat different from those in the southern part of the province. The northern plants occur in looser tufts, the stems have fewer rhizoids, and the leaves are only slightly crisped when dry, instead of being strongly cirrate to crisped like the southern populations. However, the characteristic tubular, long apices, as well as the differentiated ventral row of cells of the costa, are still present throughout its range.

SPECIMENS EXAMINED

DRUMMOND: Durham, Marie-Anselme A-119, 118 (CANM, QFA)*. NEW QUEBEC: Great Whale River area, L.Filion 1-1a, 1-2a, 1-3, 1-4b,1-5a, 20-4, 41, 2 (CANM)*.

PLATE# 6: Dicranum muehlenbeckii 1.- Habit of upper portion of stem (wet). 2.- Habit of upper portion of stem (dry). 3.- Median leaf cells. 4.- Lower leaf cells. 5.- Upper portion of leaf (wet). 6.- Lower portion of leaf (wet). 7.- Stem leaf. 8.- Median leaf cells in cross-section. 9.- Upper leaf cells in cross-section. 10.- Capsules (dry). 11.- Capsule (wet).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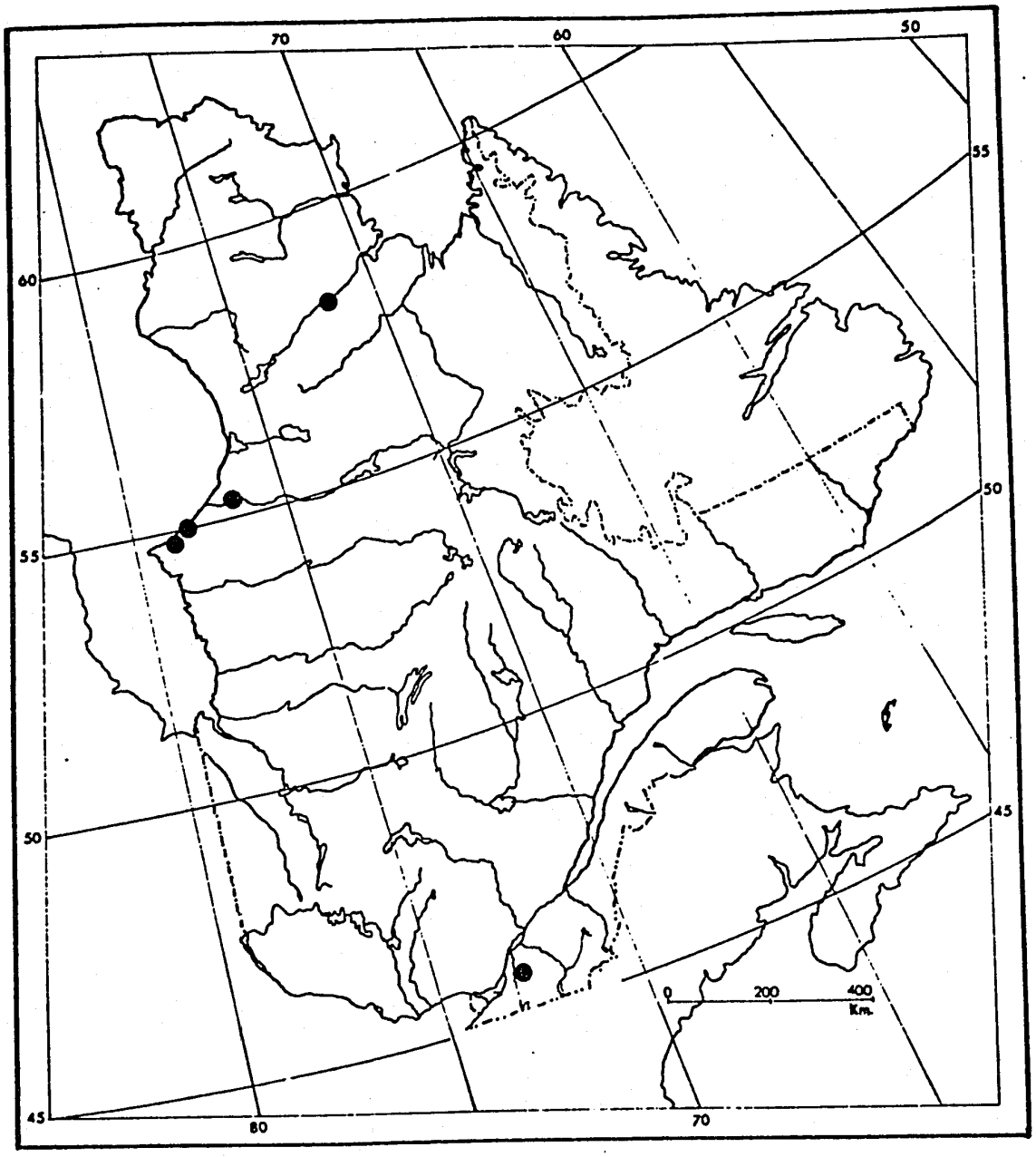


Map # 6: Distribution of Dicranum muehlenbeckii in Quebec.

7.- Dicranum elongatum Schleich.ex Schwaegr., Spec.Musc.Suppl.1(1): 171.43.1811.

Dicranum sphagni Wahlenb., Fl.Lapp.337.1812.nom.illeg.incl.spec.prior.
Dicranum sendteneri Limpr., Laubm.Deutschl.1:360.1886.
Dicranum subflagellare Card. et Thér., Proc.Washington Acad.Sci. 4:298.13.f.3.1902.

Plants in compact tufts, yellowish green to light green, glossy. Stems 2-10 cm high, tomentose throughout. Leaves erect-spreading, erect-appressed to rarely spreading when dry, apex sometimes flexuose, (2.5) 3.0-4.5 (5.5) mm long, from a lanceolate base to a long, fine, tubulose subula, apex usually acute, sometimes apical leaves of stems blunt, julaceous; margins entire, rarely slightly denticulate at apex; laminae unistratose; costae percurrent or slightly excurrent, 1/4-1/6 the width of the leaves at base, smooth or weakly rough above on dorsal surface; leaf cells smooth; alar cells uni- or bistratose, well-differentiated; lower cells usually elongate, pitted, (2) 4-6 (9) μm wide and (14) 24-36 (49) μm long; upper cells short-rectangular, rounded, or quadrate, incrassate, sometimes irregularly shaped, not pitted, (4) 6-8 (9) μm wide and (5) 12-17 (23) μm long. Leaves in cross-section with a row of guide cells, two stereid bands not extending to the apex, no differentiated ventral or dorsal rows of cells, but sometimes some dorsal and ventral cells enlarged, cell walls between cells not bulging.

Dioicous. Male plants as large as the females. Setae solitary, 1.5-2.0 cm long. Capsules yellowish brown, nearly straight and erect to

slightly arcuate, striate when dry, 1.4-1.8 mm long. n= 12.

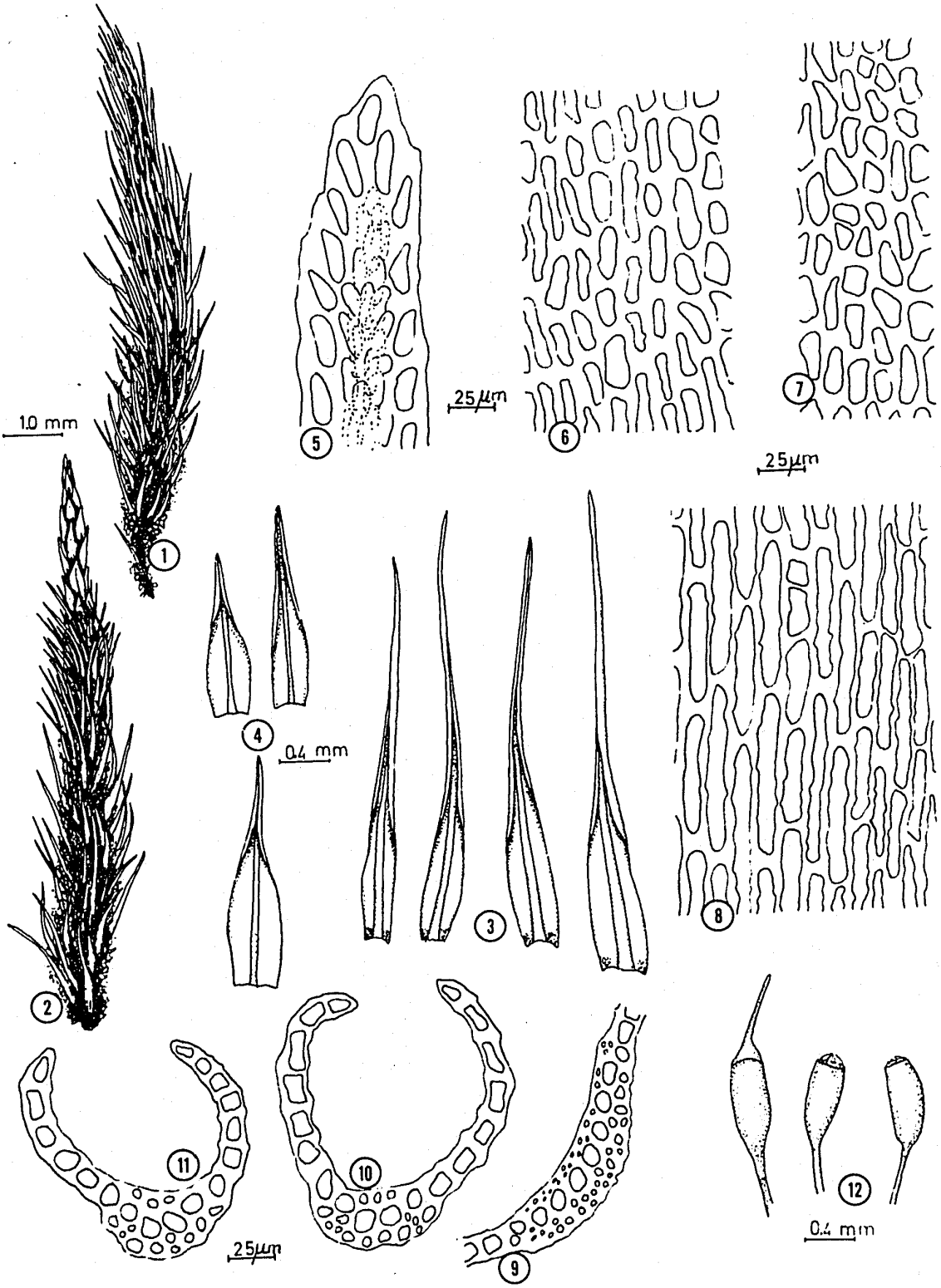
On soil, rocks, soil over rocks, usually in exposed situations. Mainly in the northern part of Quebec above 52°N latitude; common near Ungava, south of Hudson Bay but also found in the Gaspé Peninsula at high altitudes (e.g., Mont Albert, Mt. Jacques-Cartier). Greenland to Alaska, south to New England, Colorado and Montana. Europe and Asia.

This species, which is closely related to D. groenlandicum, often bears at the apex of some stems, small, ovate, broad leaves with blunt apices. Such plants are readily confused with D. groenlandicum. Therefore, it is advisable to examine the leaves in the lower part of the stems to see if they possess the typical acute apices (see discussion under D. groenlandicum).

SELECTED SPECIMENS EXAMINED

CHARLEVOIX: Mt. du Lac-des-Cygnes, Hedley, Raymond & Kucyniak 45-45 (MICH). GASPE WEST: Mt. Albert, Allen, Nat. Mus. Sheet 604 (CANM), LeBlanc 6405 (QFA), Lepage 2125 (QFA). Mont Jacques-Cartier, LeBlanc 6599 (QFA)*. MISTASSINI: Otish Mountains, Shchepanek 71-B-27 (CANM). Baie Coucouche, Rousseau 2164 (MICH). NEW QUEBEC: Greenbush Lake, Grayson 6011 (CANM); Deception Bay, 62°10'N-74°35'W, Bartley 72 (CANM). Causeway Cove, 58°50'N-69°50'W, Ducruc418 (CANM); Great Whale River, 55°17'N-79°50'W, Brisson & Forest 22298 (CANM). Cape Jones, 54°37'N-79°50'W, Kucyniak & Tuomikoski K502 (CANM). Walrus Point, 53°42'N-79°10'W, Kucyniak & Tuomikoski K266 (CANM). Bush Lake, 57°50'N-75°28'W, Taylor 58 (MICH). Eclipse Lake, Grayson 5083 (MICH). SAGUENAY: Sept-Iles. Marie-Victorin & Germain 18-277 (QFA).

PLATE #7: Dicranum elongatum 1.- Habit of upper portion of stem (wet). 2.- Habit with abnormal-leaved shoot (wet). 3.- Stem leaves. 4.- Leaves from julaceous shoot. 5.- Apex. 6.- Median leaf cells. 7.- Upper leaf cells. 8.- Lower leaf cells. 9.- Lower leaf cells in cross-section. 10.- Median leaf cells in cross-section. 11.- Upper leaf cells in cross-section. 12.- Capsules (wet).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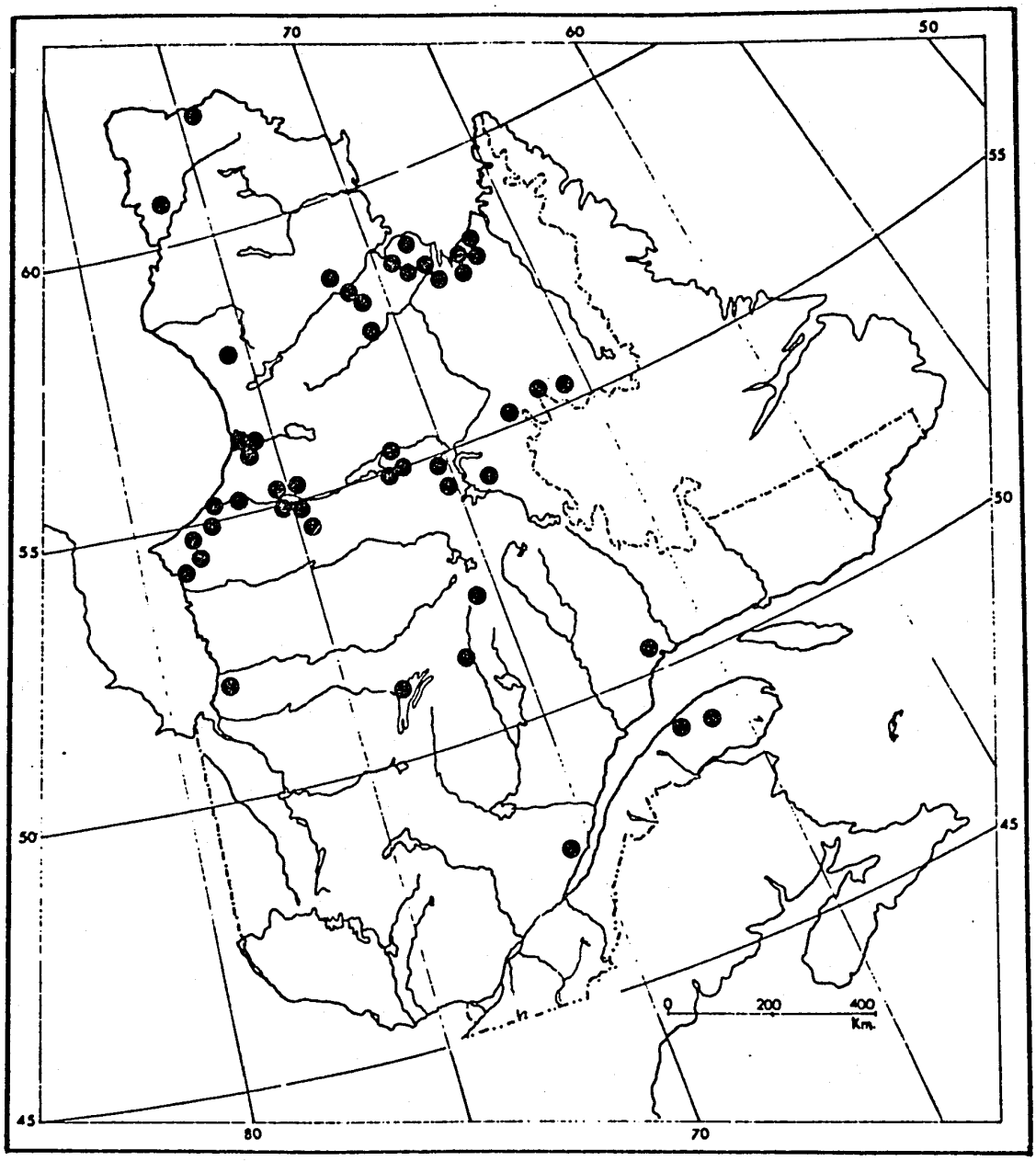


Map # 7: Distribution of Dicranum elongatum in Quebec.

8.- Dicranum groenlandicum Brid., Mant.Musc.4:68.1819.

Dicranum indurescens Brid., Bryol.Univ.1:460.1826.nom.inval.in.synom.
Dicranum tenuinerve Zett., K.Svensk.Vet.Handl.13(13):14.1876.
Dicranum macounii Aust., Bot.Gaz.2:96.1877.

Plants in dense tufts, light green, glossy. Stems 4.5-10.0 cm high, tomentose throughout. Leaves erect-spreading, erect-appressed when dry, (2.5) 3-4 (5.5) mm long, from an ovate-lanceolate base to a tubulose subula, narrow and blunt at apex, sometimes apical leaves of stems julaceous; margins entire, laminae unistratose, occasional bistratose regions near costa in the lower part of the leaf; costae subpercurrent to percurrent, 1/6-1/10 the width of the leaves at base, smooth on dorsal surface; leaf cells smooth; alar cells uni- or bistratose, well-differentiated; lower cells elongate-sinuose, strongly pitted, (2)5-6 (9) µm wide and (36) 54-55 (98) µm long, incrassate throughout; upper-median cells elongate and pitted, (2) 5-6 (12) µm wide and (11)17-26 (42) µm long, apical cells short-elliptical. Leaves in cross-section with a row of guide cells, two well-developed and thick stereid bands (5-6 cells thick), some dorsal cells usually enlarged, cell walls between cells weakly bulging.

Dioicous. Male plants as large as the females. Setae solitary, 1.5-2.0 cm long. Capsules yellowish brown, nearly straight and erect to slightly arcuate, ± striate when dry, 1.5-2.0 mm long. n = 12.

Predominately in bogs and on wet soil. Mainly above 52°N latitude but rarely occuring in the Gaspé Peninsula; also collected on Mingan

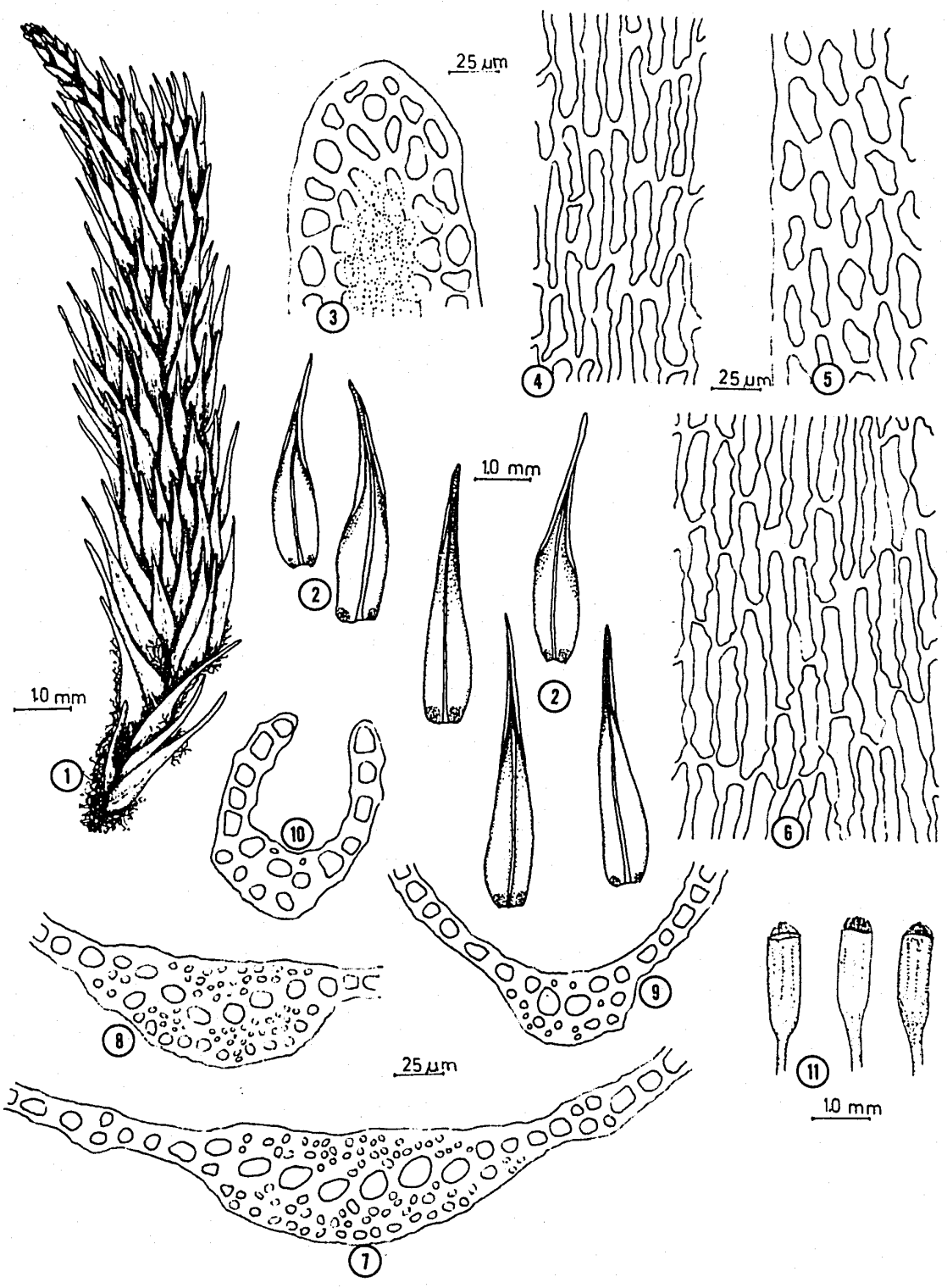
and Magdalene Islands. Circumpolar. Greenland to Alaska, south to New England, Ontario, Manitoba, Montana and British Columbia. Europe and Asia.

Dicranum groenlandicum and D. elongatum in their typical form are easily distinguished but frequently there are many intergradations. Dicranum groenlandicum is a more robust plant with blunt leaf apices and cells that are pitted to well above the middle of the leaf. This contrasts with D. elongatum which is a smaller plant with acute leaf apices and cells that are pitted only up to the middle of the leaf. Julaceous shoots bearing small, broad, blunt leaves, similar to those of D. elongatum are also present in the upper part of the stems of D. groenlandicum. The pits in the leaf are the most reliable means of separating difficult specimens.

SELECTED SPECIMENS EXAMINED

GASPE WEST: Mont Albert, Collins 3958-A (MICH). MADELEINE ISLANDS: Amherst Island, Reilly 162 (CANM). MISTASSINI: Loon Pint, 52°05'N-78°45'W, Kucyniak & Tuomikoski K116 (CANM)*. NEW QUEBEC: Great Whale River, 55°17'N-77°46'W, Brisson & Forest 22300 (CANM)* Lac Tesialucq, 58°22'N- 67°00'W, Ducruc 73-932 (CANM). Port Harrison, 58°13'N-78°07'W, Kucyniak & Tuomikoski T1766 (CANM). Attikuan Point, 54°12'N-79°25'W, Kucyniak & Tuomikoski K423 (CANM). Scoter Lake, 58°30'N-76°44'W, Taylor 95 (MICH).

PLATE #8: Dicranum groenlandicum 1.- Habit of upper part of stem (wet). 2.- Stem leaves. 3.- Apex. 4.- Median leaf cells. 5.- Upper leaf cells. 6.- Lower leaf cells. 7.- Lower leaf cells in cross-section. 8.- Median leaf cells in cross section. 9.- Median-upper leaf cells in cross-section. 10.- Upper leaf cells in cross-section. 11.- Capsules (dry).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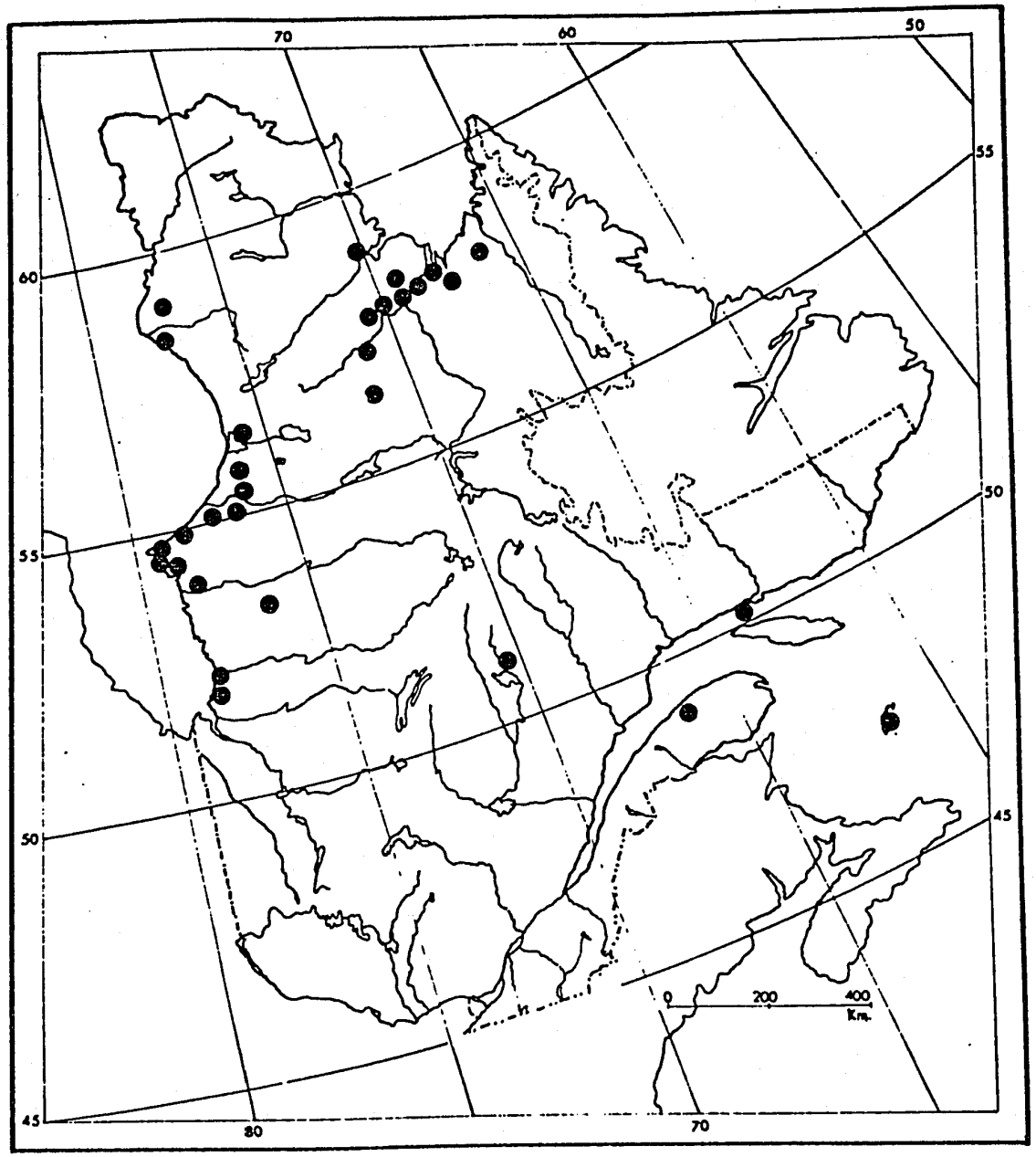


Map # 8: Distribution of Dicranum groenlandicum in Quebec.

9.- Dicranum spurium Hedw., Spec.Musc.141.1801.

Dicranum fragile Brid., Mant.Musc.55.1819.hom.illeg.
Dicranum brachycaulon Kindb.in Macoun, Cat.Canad.Pl.6:34.1892.

Plants in loose tufts, yellow-green to yellow-brown, dull. Stems 2-6 cm high, tomentose, interruptedly foliate, the leaves crowded in some parts forming globose regions. Leaves erect-spreading, arched and loosely imbricate with contorted apices when dry, ± undulate to rugose, (4.5) 5.0-6.5 (7.0) mm long, concave below, ± tubular above, acute, ovate at base; margins ± serrate above; laminae unistratose or with bistratose regions near costa and on margins; costae percurrent, 1/4 -1/8 the width of the leaves at base, rough and toothed above on dorsal surface; leaf cells strongly papillose above on dorsal surface, sometimes a few papillae on ventral surface; alar cells bistratose, distinctly differentiated, lower cells elongate, pitted, (5) 10-11 (15) µm wide and (30) 49-68 (101) µm long, abruptly shorter in the upper 1/2 of the leaf; upper cells short, not or indistinctly pitted, cell walls irregularly thickened, (5) 7-13 (20) µm wide and (7)11-12 (23) µm long. Leaves in cross-section with a row of guide cells, two stereid bands extending to apex, dorsal layer of cells differentiated, cell walls between cells weakly to strongly bulging.

Pseudomonoicous. Dwarf males on the rhizoids of female plants. Setae solitary, 1-2 cm long. Capsules yellow-brown, arcuate, erect, contracted below mouth and furrowed when dry, 1.5-2.0 mm long. n = 12,24.

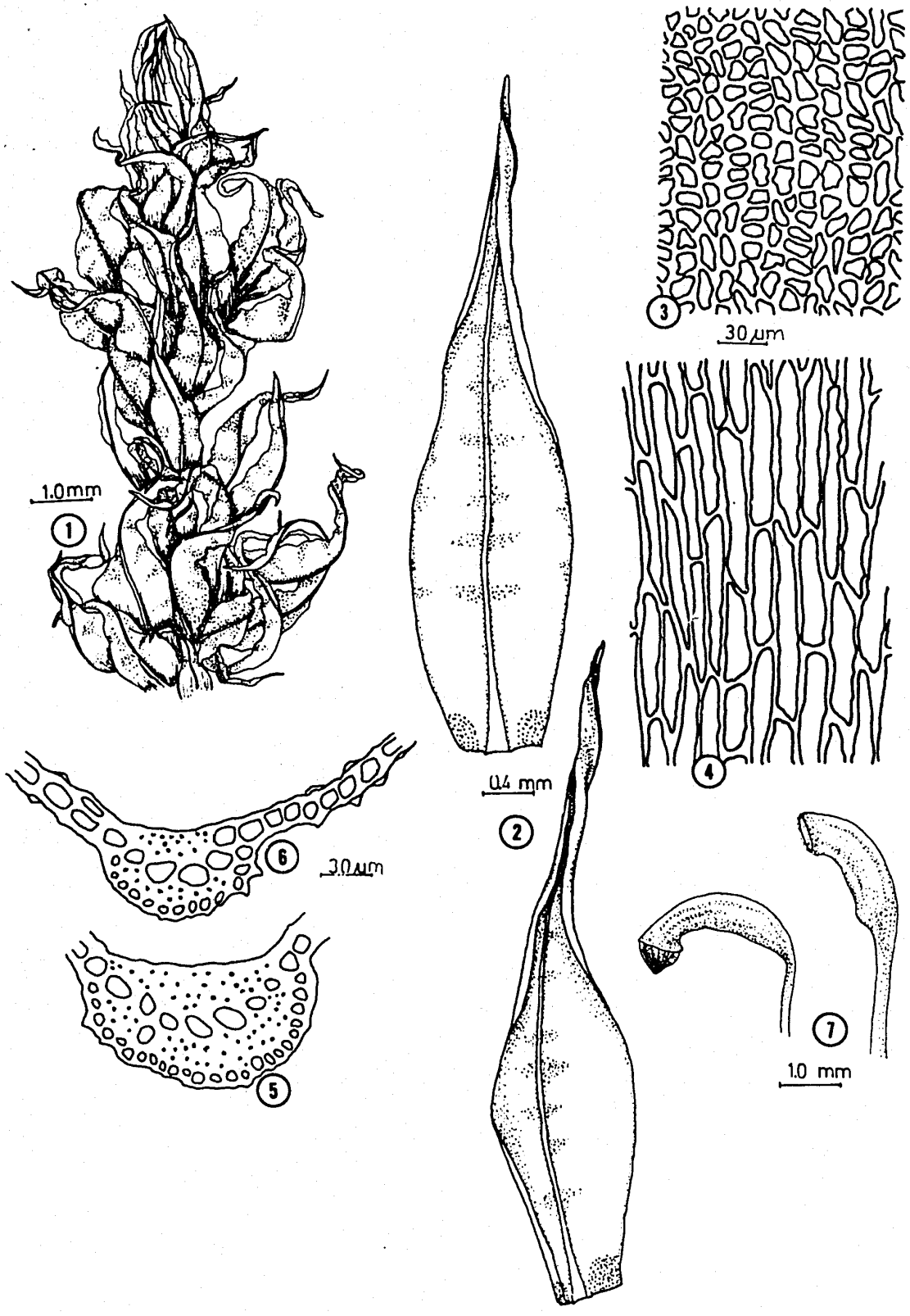
Growing on rock or sandy soil. Rare in the province. Collected in Gatineau, Hull, Témiscamingue and Charlevoix East. Circumpolar. Newfoundland to Ontario, south to Georgia, Tennessee and Arkansas. Europe.

Easily recognized by its turgid aspect, its arched and imbricate leaves and its interruptedly foliate stems.

SPECIMENS EXAMINED

CHARLEVOIX: Port-au-Saumon, Parrot 13-7-1975 (QUE). HULL: East Templeton, Macoun 22-5-1902 (MTMG 11987, CANM)*. GATINEAU: Chelsea, Macoun 22-5-1891 (CANM 121700). SAGUENAY: Barnston (MTMG 79450, CANM)*. TEMISCAMINGUE: Baie Guard, Marie-Victorin 47 (CANM). VAUDREUIL: Rigaud, 45°29'N-74°18'W, Dupret 27-7-1908 (QFA).

PLATE #9: Dicranum spurium 1.- Habit of upper part of stem (dry). 2.- Stem leaves (dry). 3.- Upper leaf cells. 4.- Lower leaf cells. 5.- Median leaf cells in cross-section. 6.- Upper leaf cells in cross-section. 6.- Capsules (dry).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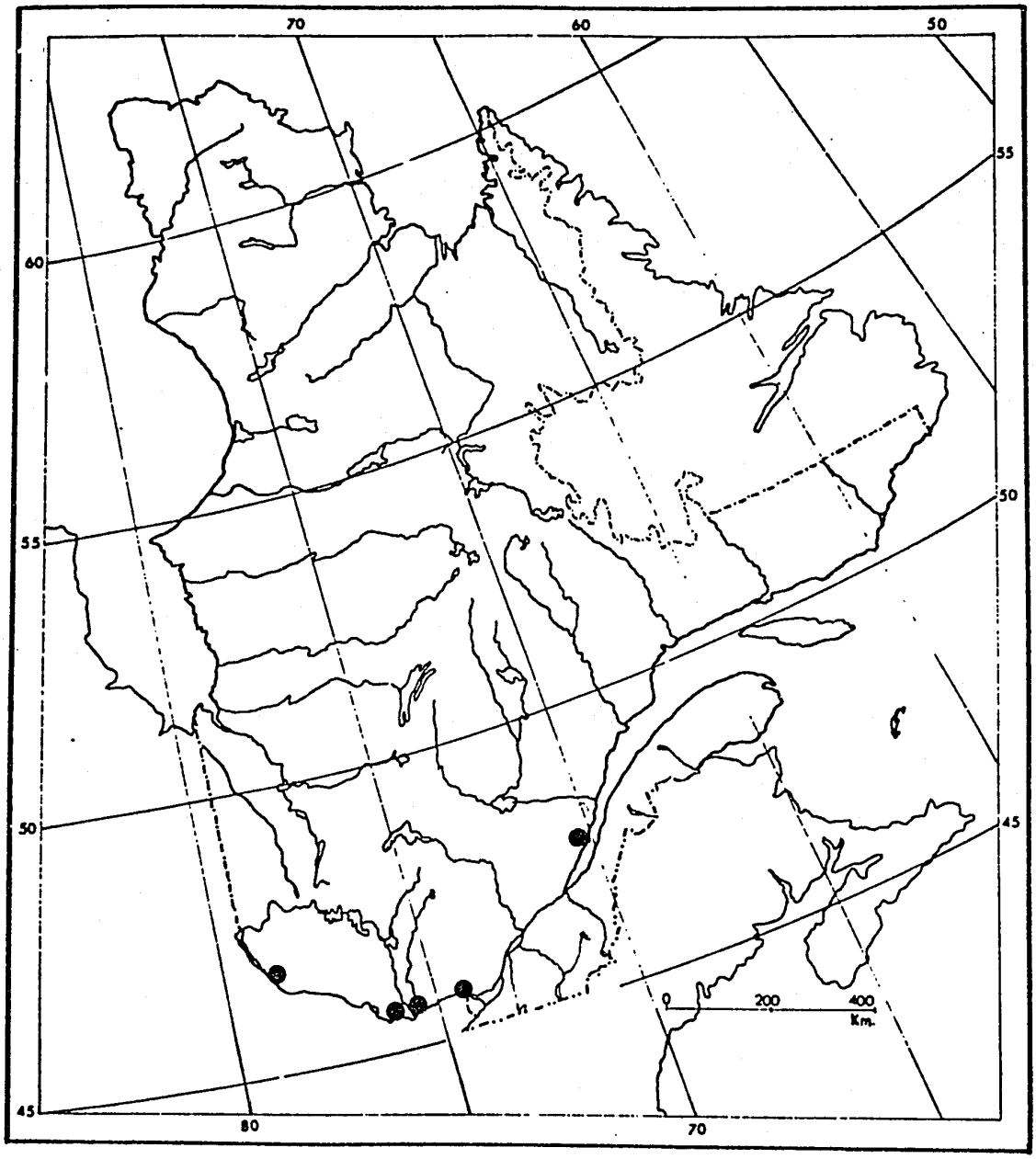


Map # 9: Distribution of Dicranum spurium in Quebec.

10.- Dicranum condensatum Hedw., Spec.Musc.139.1801.non plate 34.

Dicranum sabuletorum Ren.et Card., Rev.Bryol.15:701.1888.Sull.et Lesq.Musci Boreali Americani.
Dicranum arenarium Ren.et Card., Rev.Bryol.15:70.1888.nom.nud.

Plants in ± loose tufts, light green, dull. Stem 1-2 cm high, tomentose. Leaves erect-spreading, flexuose, ± curled at the tips when dry, slightly undulate or rugose, (2) 3.5-4.5 (5) mm long, concave below, strongly keeled above, fromaa broad lanceolate base gradually narrowing to a short-acuminate apex; margins serrulate in the upper half, involute in central part; laminae unistratose,with few bistratose regions; costa percurrent to slightly excurrent, 1/5-1/10 the width of the leaves at base, strong, slightly papillose above on dorsal surface; leaf cells papillose or smooth above in dorsal surface; alar cells bistratose, differentiated; lower cells elongate, pitted, (5) 6-7 (10) µm wide and (25) 41-56 (112) µm long; abruptly short towards the apex; median and upper cells irregularly angled, not or indistinctly pitted, cell walls unequally thickened, (5) 7-8 (12) µm wide and (5) 7-8 (20) µm long. Leaves in cross-section with a row of guide cells, two thick stereid bands extending well into the apex, dorsal layer of cells differentiated, cell walls between cells strongly bulging.

Pseudomonoicous. Dwarf males on stem rhizoids of female plants. Setae solitary, 2 cm long. Capsules yellow-brown, arcuate, erect, furrowed when dry, slightly contracted below the mouth, 1.5 mm long. n= 12.

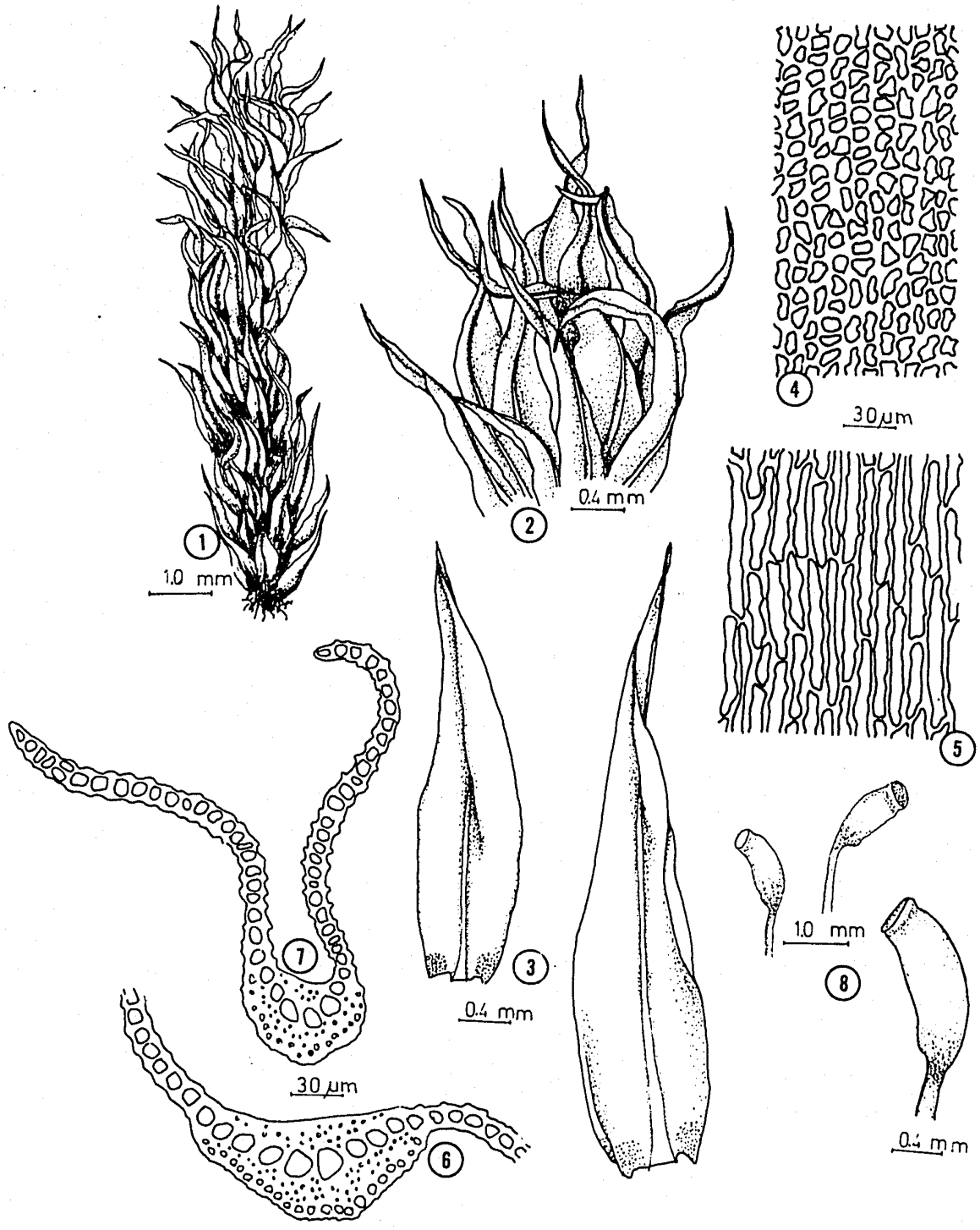
Grows on exposed sandy soil. Very rare in Quebec, where it has been collected on the Madeleine Islands. Endemic to eastern North America, occurring from Nova Scotia to Wisconsin, south to the Gulf States.

Recently, Peterson (1977) made the name Dicranum condensatum Hedw. valid. It replaces the name D. sabuletorum Ren.et Card. that was in use until now. The habit of D. condensatum resembles somewhat that of D. acutifolium, but the upper aerolation and specific habitat will readily distinguish them.

SPECIMENS EXAMINED

MADELEINE ISLANDS: East Island, Reilly 1398, 877A, 880 (CANM)*.
TERREBONNE: Mont Rolland, Marie-Anselme 4223 (QFA)*.

PLATE #10: Dicranum condensatum 1.- Habit of upper portion of stem (dry). 2.- Enlargement of upper part of stem (dry). 3.- Leaves (dry). 4.- Upper leaf cells. 5.- Lower leaf cells. 6.- Median leaf cells in cross-section. 7.- Upper leaf cells in cross-section. 8.- Capsules (dry).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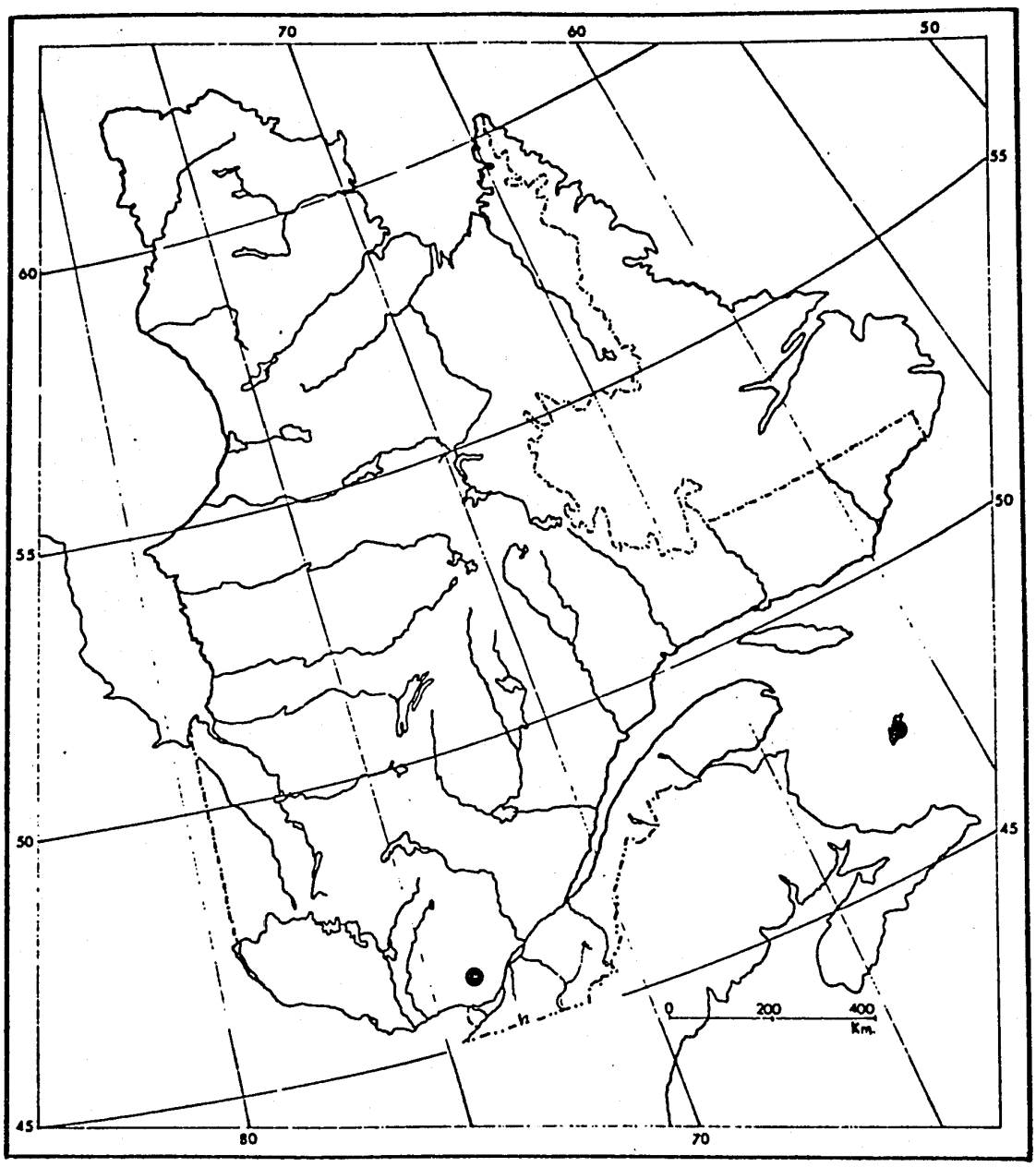


Map #10: Distribution of Dicranum condensatum in Quebec.

11.- Dicranum ontariense Peterson, Can.J.Bot.55:986.1977.

Dicranum undulatum (Ehrh.ex Web.et Mohr) var.folis angustioribus, subtortuosis Drummond, Musci Amer.L:86.1828.
Dicranum drummondii auct., non C.Muell.:Sull.in A.Gray,Man.Bot. North.Stat.ed.2:623.1856; Sull.et Lesq., Musci Bor.Amer.:69b.1857 ("1856").
Dicranum drummondii Sull.ex Lindb.,Bot.Not.1865:79.18:5 (hom. illeg.non D. drummondii C.Muell.1848).
Dicranum wilsonii Sull., ex Peterson, Can.J.Bot.55:988.1977. (pro.synon.).

Plants in loose mats, dark to light green, dull. Stems 4.5-8.0 cm high, densely tomentose, the whitish to reddish rhizoids extending to upper part of stems. Leaves falcate-secund, flexuose, undulate, contorted when dry, (5) 6.5-9.0 (10) mm long, concave below, keeled above, from a lanceolate base t a long-acuminate apex; margins strongly serrate above; laminae unistratose, rarely with bistratose regions on margins or near costa; costae percurrent to slightly excurrent, 1/5-1/6 the width of the leaves at base, apapillose and serrulate above on dorsal surface; leaf cells papillose and rough above on dorsal surface, sometimes papillose ventrally; alar cells bistratose rarely tristatose in parts, differentiated; lower cells elongate, pitted, (2) 7-8 (10) μm wide and (22) 40-64 (126) μm long; upper cells short quadrate to rectangular, not pitted, ± in longitudinal rows, marginal cells usually more elongate, some upper cells with long tooth-like projections, scattered on dorsal surface, (5) 8-12 (16) μm wide and (7) 12-18 (42) μm long. Leaves in cross-section with a row of guide cells, two thick, well-developed stereid bands, above and below, extending to apex, dorsal row of cells differentiated, cell walls between cells bulging.

Pseudomonoicous. Dwarf males on stem rhizoids of female plants. Setae aggregate, 2 to 5 per perichaetium, 2.5-3.5 cm long. Capsules brown, arcuate, erect to inclined, furrowed when dry, 2-3 mm long.

Growing on humus, soil or soil over rock, rarely on rotten wood. Distribution similar to D. undulatum but not occurring as far north. Common up to 51°N latitude. Endemic to North America, Newfoundland to Saskatchewan, south to New York, Ohio, Michigan, Wisconsin and Minnesota; also in Tennessee and North Carolina.

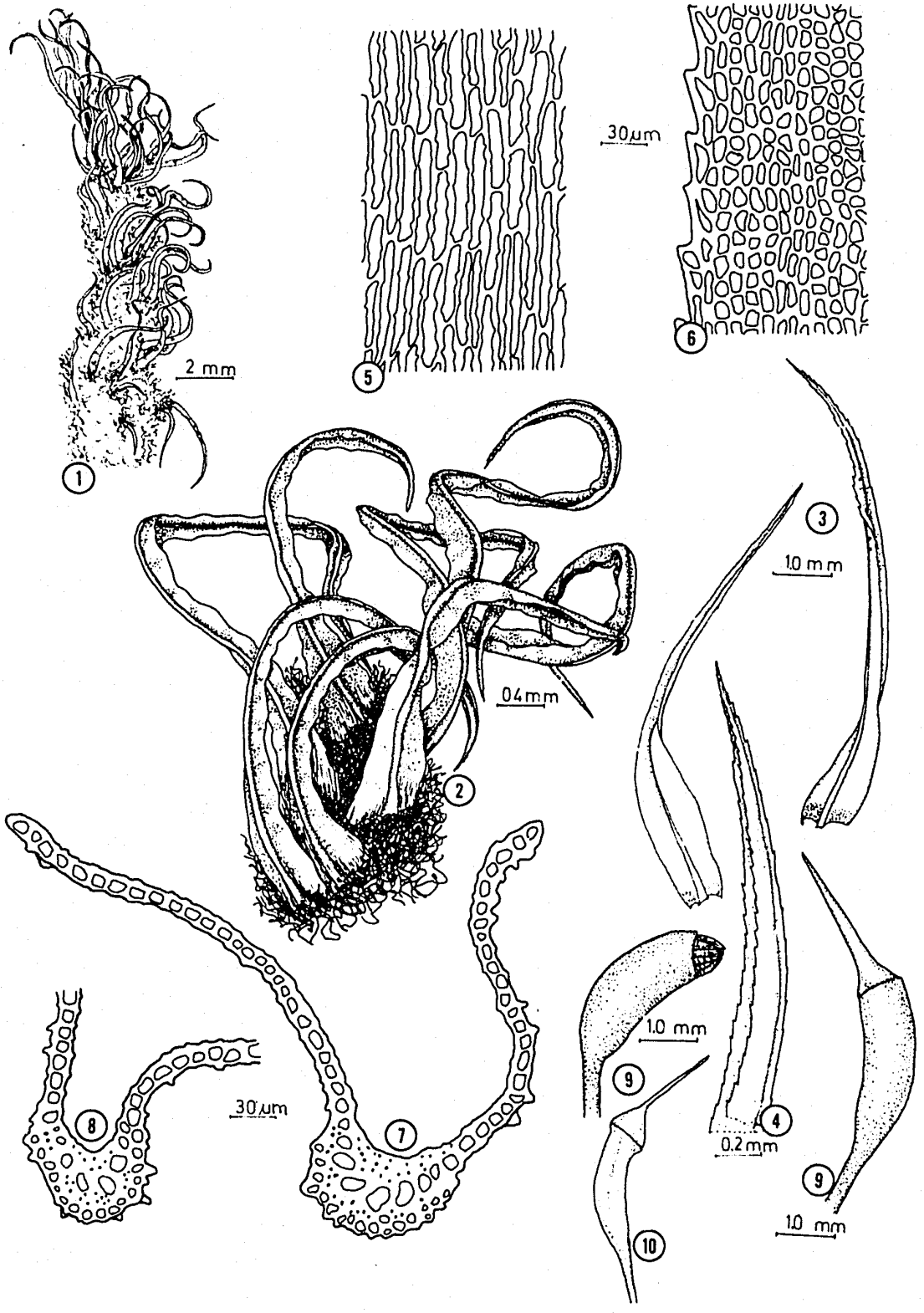
Without sporophytes this species can be confused with the form of Dicranum undulatum that has percurrent costae and ± acute apices. A cross-section of the upper part of the leaves shows D. ontariense has abundant papillae and teeth (see Plate 11, figures 7 & 8), while D. undulatum does not have them. Also, D. undulatum has a flat inner surface of the costa in the upper part of the leaves compared to the round upper ventral surface of the costa of D. ontariense. The leaves of D. ontariense when compared to D. undulatum are more contorted when dry, and the upper aerolation is more regularly quadrate. Finally D. ontariense has stems that are more tomentose than D. undulatum.

Peterson (1977) gave specific distinction to the North American plants that were previously referred to D. drummondii C. Muell., a Eurasian species. This distinction as also recognized by Isoviita (1977) is accepted in this treatise.

SELECTED SPECIMENS EXAMINED

GASPE EAST: near Cape Basic, Macoun 22 August 1907 (CANM 119627)*. GATINEAU: Luskville Falls, Trucco 46 (GT)*. MATANE: Mont Albert, LeBlanc 6530 (QFA), (atypical habit). MADELEINE ISLANDS: East Island, Reilly 657 (CANM)*. SAGUENAY: Barnston (MTMG 79426). Franquelin District, 49°18'N-67°54'W, Gardner & Mantion 112 (MICH). TEMISCAMINGUE: 46°44'N-78°58'W, Brown 103T-1 (CANM). TERREBONNE: Mont Tremblant Park, Crum 9990 (CANM)*.

PLATE #11: Dicranum ontariense 1.- Habit of upper part of stem (dry). 2.- Enlargement of part of stem (dry). 3.- Stem leaves. 4.- Upper portion of leaf. 5.- Lower leaf cells. 6.- Upper leaf cells. 7.- Median leaf cells in cross-section. 8.- Upper leaf cells in cross-section. 9.- Capsules (wet). 10.- Capsule (dry).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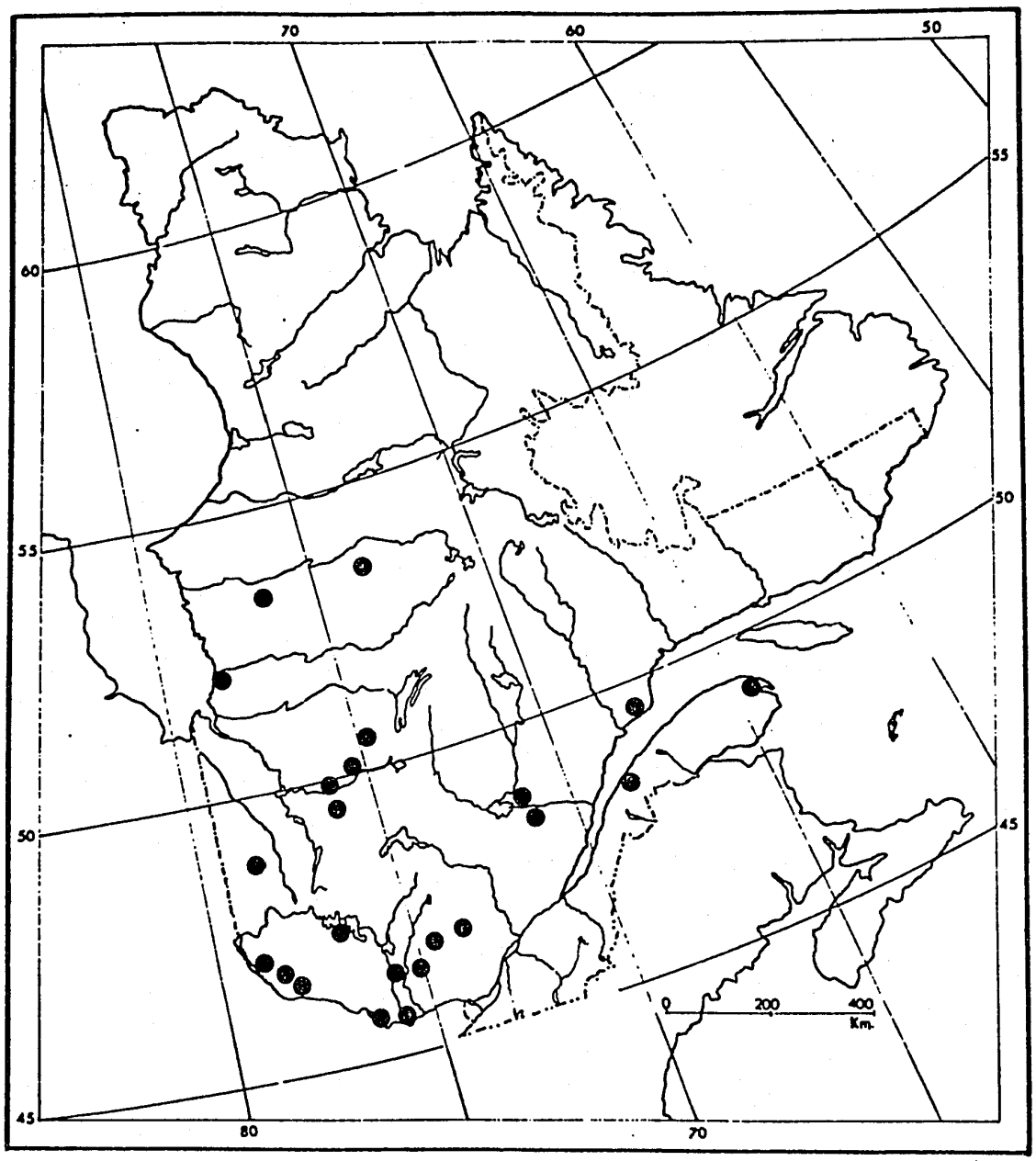


Map # 11: Distribution of Dicranum ontariense in Quebec.

12.- Dicranum acutifolium (Lindb.et Arn.)C.Jens. in Weim.,Foert.Skand. Vaext.Moss.2:18.1937.
Dicranum bergeri var. acutifolium Lindb.et Arn., L.Svensk.Vet.Ak. Handl.23(10):79.1890.
Dicranum bergeri var. rupincola Kindb., Eur.N.Amer.Bryin.2:193.1897.
Dicranum rupincola (Kindb.)Perss., Bryologist 57:196.1954.nom.illeg. incl.spec.

Plants in dense to loose tufts, light green to light brown, dull. Stems 1.5-7.0 cm high, generally branched above. Leaves erect-spreading, slightly curled to ± straight when dry, usually with few undulations in the upper part, (4) 5-8 (10) mm long, concave below, keeled above, lanceolate , acuminate; upper margins somewhat involute, serrulate to serrate; laminae with few bistratose regions on or near the upper margins; costae percurrent to excurrent, 1/4-1/6 the width of the leaves at base, smooth to slightly papillose and undulate above on dorsal surface; leaf cells smooth to slightly papillose above on dorsal surface; alar cells bistratose, differentiated; lower cells linear-rectangular, pitted (5) 6-8- (12) µm wide and (22) 41-60 (84) µm long; median and upper cells short, not pitted, irregularly quadrate, rounded or rectangular, (4) 8-9 (14) µm wide and (7) 12-20 (28) µm long. Leaves in cross-section shaped liked a "pair of tongs" with a row of guide cells, two stereid bands extending to the apex, dorsal row of cells differentiated, cell walls between cells strongly bulging.

Pseudomonoicous. Dwarf males on stem rhizoids of female plants. Setae solitary, 1.5-2.5 cm long. Capsules brown to reddish brown, arcuate, erect to inclined, furrowed when dry, rarely slightly strumose, 2.0-2.5 mm long.

On soil or soil over rocks and humus. Mainly in northern Quebec above 53°N latitude or at high elevations below 53°N. Circumpolar. Greenland to Alaska, south to Quebec, Ontario and Alberta. Europe and Asia.

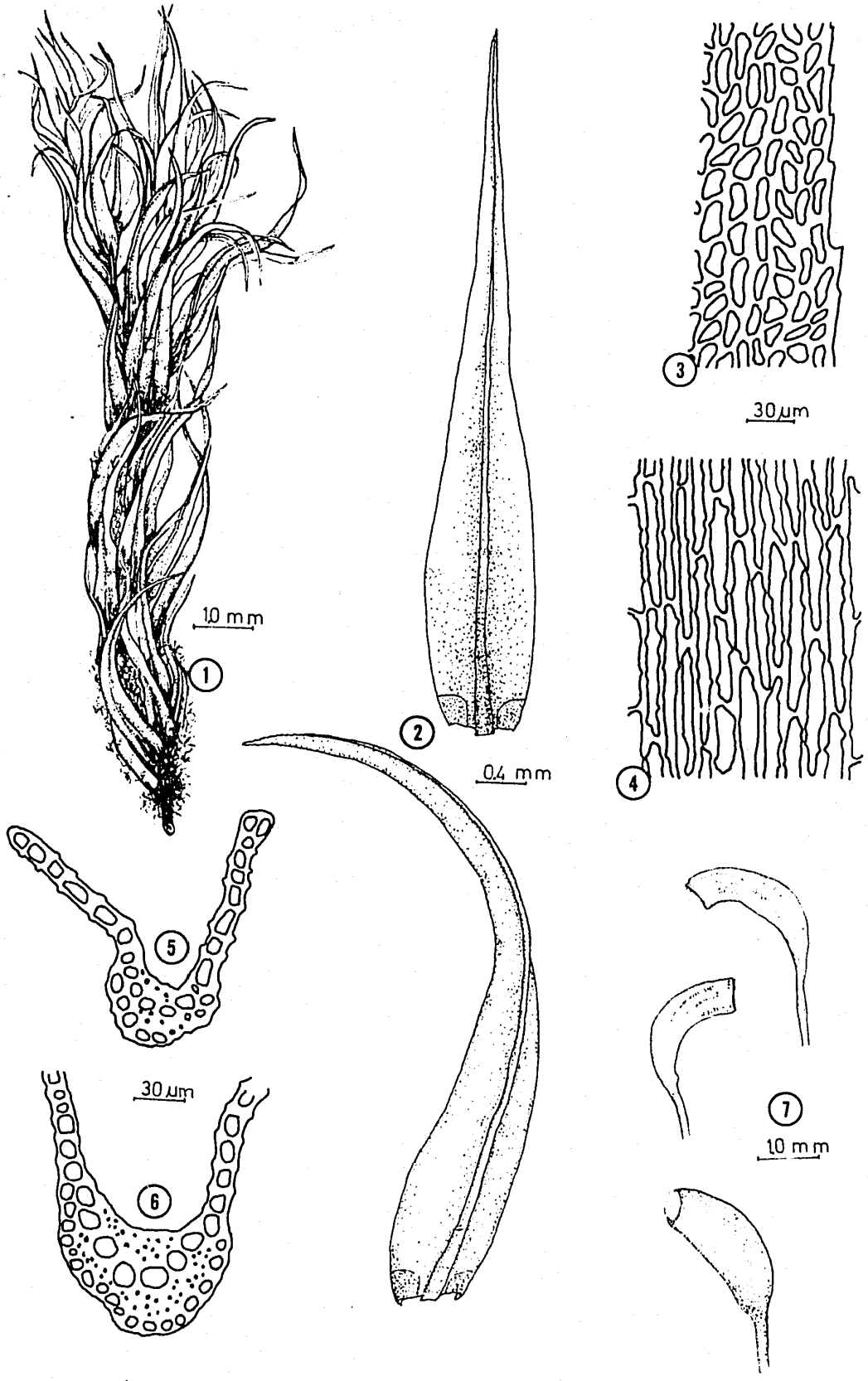
In its typical form D. acutifolium is easily recognized by its keeled leaves and short subula that is slightly undulate in the upper part. When it has indistinctly undulate leaves it can be confused with D. fuscescens. However, D. fuscescens has a longer, rougher subula, upper cells that are more regularly quadrate-rectangular, smaller bulging cell walls between the cells in cross-section, and more bistratose regions on the margins than D. acutifolium.

A syntype of D. acutifolium (as D. bergeri var. acutifolium Lindb. et. Arn.) collected in Sibirum, Irisée, Tolstoinos, 30-8-1876 by H. Arnell, has been examined.

SELECTED SPECIMENS EXAMINED

GASPE WEST: Mont Albert, Collins & Fernald J.F.C.4164 (MICH). NEW QUEBEC: 53°45'N-78°50'W, Blouin QFB-E4191 (CANM)*. Long Island Sound, 54°50'N-79°02'W, Kucyniak & Tuomikoski T 1005 (CANM). Tasiujacq, 58°59'N-69°38'W, Ducruc 36-7 (CANM). Golfe de Richmond, Payette 213 (CANM). Copper Point, 58°41'N-69°40'W, Ducruc 37-6 (CANM). Rivière Chukòtat, Lac Rusty, 77°56'N-60°50'W, Blouin 129 (QFA). TEMISCOUTA: Lac Lajoie, Masson 14355 (CANM).

PLATE #12: Dicranum acutifolium 1.- Habit of upper portion of stem (dry). 2.- Stem leaves. 3.- Upper leaf cells. 4.- Lower leaf cells. 5.- Upper leaf cells in cross-section. 6.- Lower leaf cells in cross-section. 7.- Capsules (dry above; wet below).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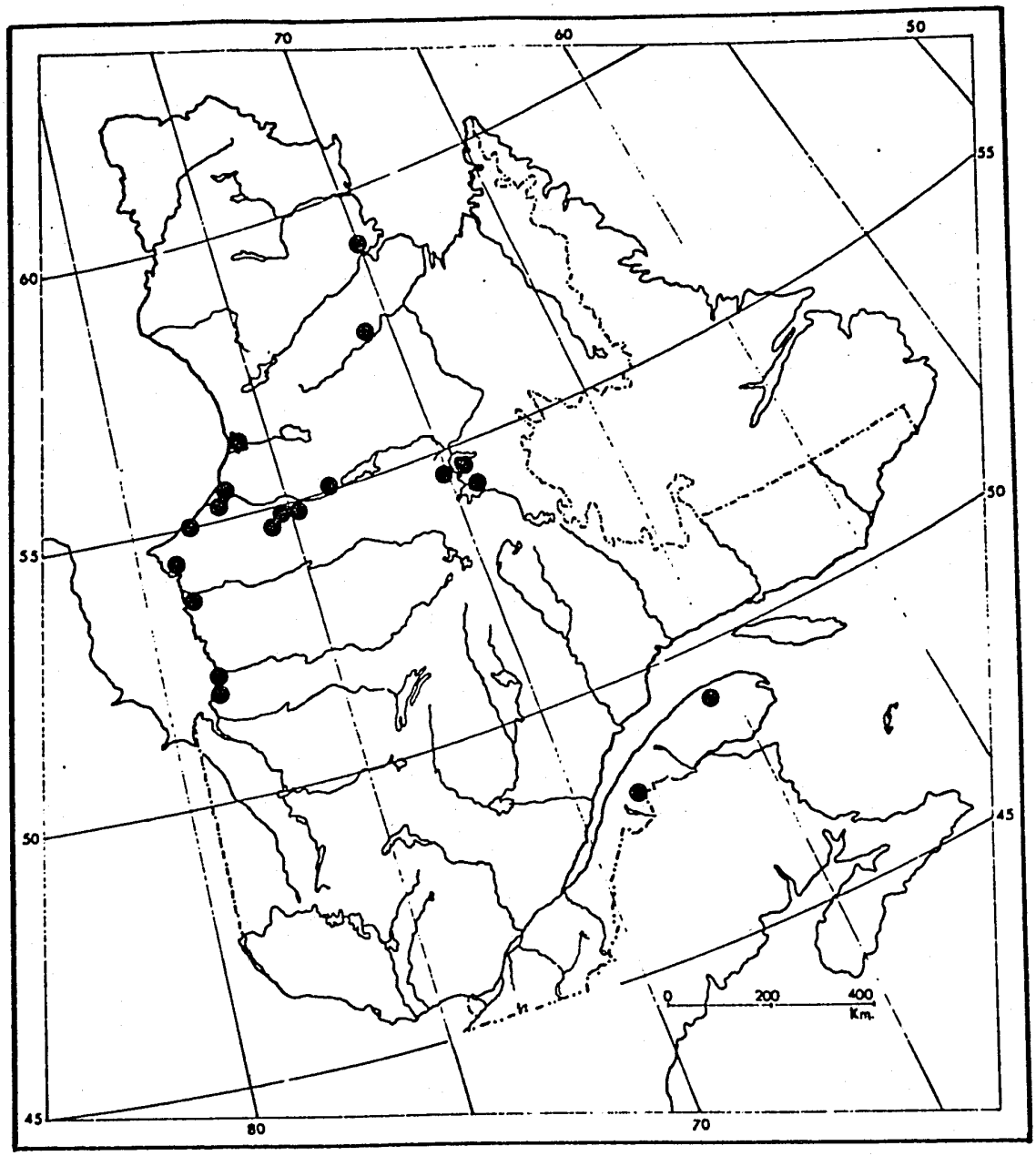


Map # 12: Distribution of Dicranum acutifolium in Quebec.

13.- Dicranum brevifolium (Lindb.)Lindb., Musci Scand.24.1879.

Dicranum muehlenbeckii var. brevifolium Lindb., Bot.Not.1865: 80.1865.
Dicranum congestum var. cirratum Schimp., Coroll.16.1856.
Dicranum cirratum (Schimp.)Lindb.,Medd.Soc.F.Fl.Fenn..6:206. 1881. hom.illeg.
Dicranum muehlenbeckii var. cirratum (Schimp.)Lindb., Laubm. Deutschl.1:355.1886.

Plants in dense tufts, light to dark green. Stems 3.5-8.0 cm high, densely tomentose nearly to stem apex. Leaves falcate-secund,spreading, strongly crisped when dry, (4.4) 5.5-6.5 (8.0) mm long, concave below, keeled above, acute; margins entire below, serrulate above, incurved in the middle of leaf; laminae with bistratose regions on margins or near costa; costae excurrent, 1/4-1/6 the width of the leaves at base, smooth or slightly rough above on dorsal surface; leaf cells smooth to ± papillose above on dorsal surface; alar cells bistratose, differentiated; lower cells elongate-rectangular, pitted, (6) 7-9 (12) µm wide and (19) 31-46 (70) µm long; upper cells short, irregularly quadrate-rectangular, not pitted, (4) 8-9 (13) µm wide and (5) 7-14 (37) µm long. Leaves in cross-section with one row of guide cells, two well-developed and thick stereid bands extending to the apex, dorsal row of cells differentiated, no ventral cells enlarged, cell walls between cells strongly bulging.

Pseudomonoicous. Dwarf males on stem rhizoids of female plants. Setae solitary, 1.3-3.5 cm long. Capsules yellowish brown, long-cylindric, arcuate, erect to ± inclined, slightly strumose, striate when dry,3-4 mm long.

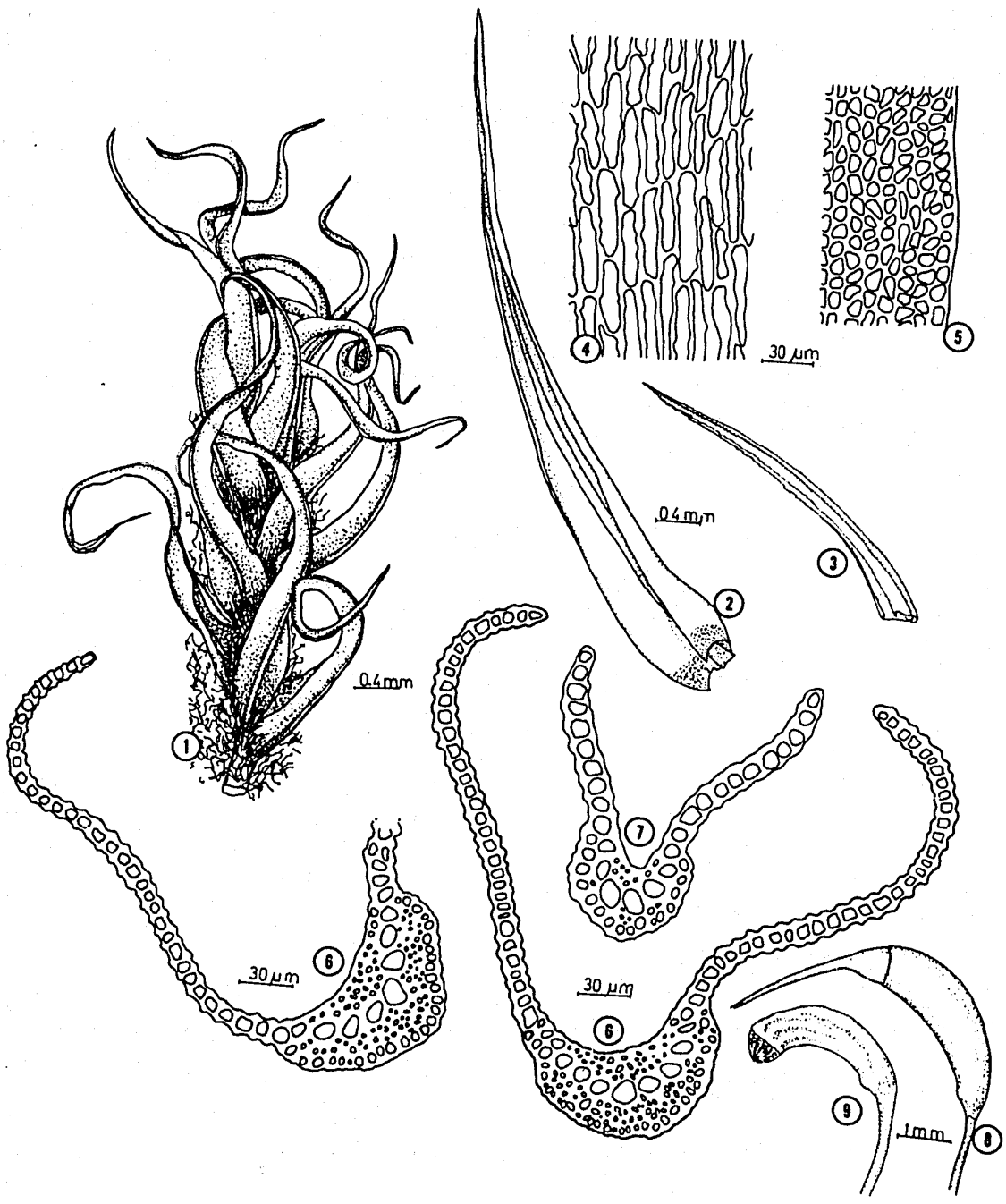
On humus and soil over rocks. Rare in Quebec, collected in Mistassini and New Quebec Territories. North American distribution poorly known. Seen from Quebec, Manitoba, Alberta, British Columbia and Montana.

This species is usually placed in the synonomy of D. muehlenbeckii var.cirratum on the basis of the crisped dry-leaf habit, the dense tomentum and the long-cylindric capsules. The macroscopic and microscopic features of D. brevifolium reveal that this species is close to D. acutifolium because of the undulate, keeled leaves, the bistratose regions on the margins and the similarity of the leaf cross-sections that are shaped like a "pair of tongs", lack of differentiated ventral cells, possess of strongly bulging cell walls, and capsules that are slightly strumose. It differs from D. acutifolium mainly by its crisped to cirrate leaves when dry, its densely tomentose stems, its leaves with median-margins incurved and its longer capsules.

SPECIMENS EXAMINED

MISTASSINI: Eastman River, 52°17'N-78°35'W, Kucyniak & Tuomikoski T378 (CANM)*. NEW QUEBEC: Fort George, 53°46'N-78°43'W, Kucyniak & Tuomikoski T444 (CANM)*. Lac Berthet, 58°27'N-68°28'W, Ducruc 33-7 (CANM)*.

PLATE # 13: Dicranum brevifolium 1.- Habit of upper portion of stem (dry). 2.- Stem leaf. 3.- Upper portion of leaf. 4.- Lower leaf cells. 5.- Median leaf cells. 6.- Median leaf cells in cross-sections. 7.- Upper leaf cells in cross-section. 8.- Capsule (wet). 9.- Capsule (dry).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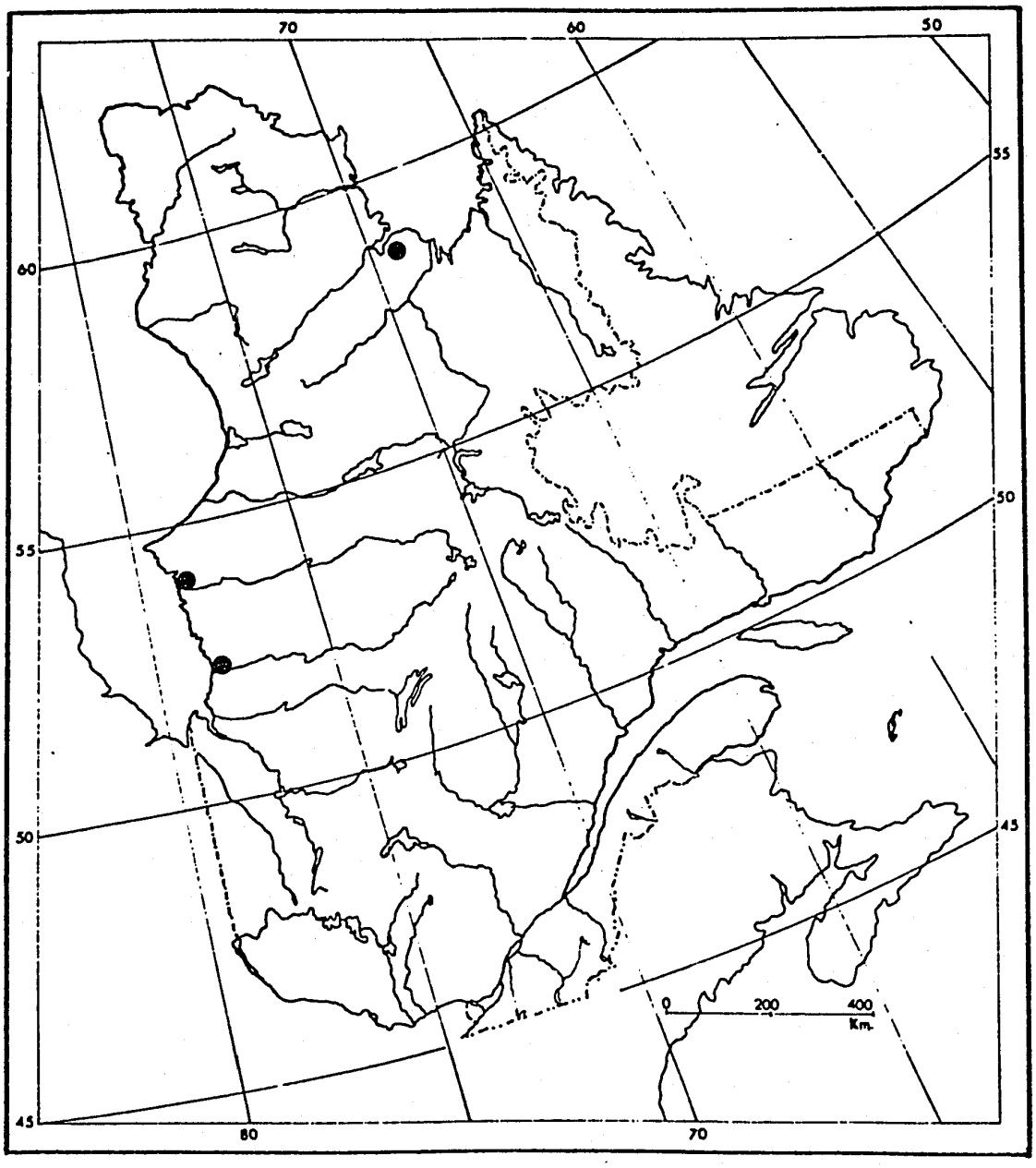


Map # 13: Distribution of Dicranum brevifolium in Quebec.

14.- Dicranum undulatum Schrad.ex Brid.,J.f.Bot.1800(2):294.1801.

Dicranum schraderi Wahlenb., K.Vet.Ac.Nya Handl.27:136.1806. nom.illeg.incl.spec.prior.
Dicranum bergeri Bland.in Sturm, Deutschl.Fl.2(b):ic.1809.
Dicranum stenodictyon Kindb., Bull.Torr.Bot.Cl.16:92.1889.
Dicranum rugosum Kindb., Ottawa Natural.4:61.1890.hom.illeg.

Plants in dense, compact tufts, yellowish brown, ±dull. Stems 3.5-8.0 (14) cm high, tomentose. Leaves erect-spreading, weakly to strongly undulate, erect-appressed or sometimes slightly flexuose, the upper leaves twisted when dry, (4.5) 5.0-7.5 (9.0) mm long, concave below, keeled above, from a lanceolate base to a gradually narrowed broad acumen, rarely narrowly acute; margins serrulate in upper half of the leaves, laminae unistratose, sometimes with few bistratose regions; costae strong, ending below the apex, sometimes nearly percurrent, 1/5-1/6 the width of the leaves at base, smooth to serrulate above on dorsal surface; leaf cells smooth; alarcells bistratose, differentiated; lower cells elongate, pitted, incrassate, (2) 4-6 (8) µm wide and (22) 38-61 (79) µm long; median cells rectangular, pitted, becoming shorter and not pitted towards apex (4) 11-12 (17) µm wide and (7) 11-14 (28) µm long. Leaves in cross-section with a row of guide cells, two stereid bands above and below, extending to apex, dorsal layer of cells differentiated, cell walls between cells weakly to strongly bulging.

Pseudomonoicous. Dwarf males on stem rhizoids of female plants. Setae solitary, 2-4 cm long. Capsules yellowish brown, arcuate, inclined, furrowed when dry, ± contracted below mouth 2.0-2.8 mm long.

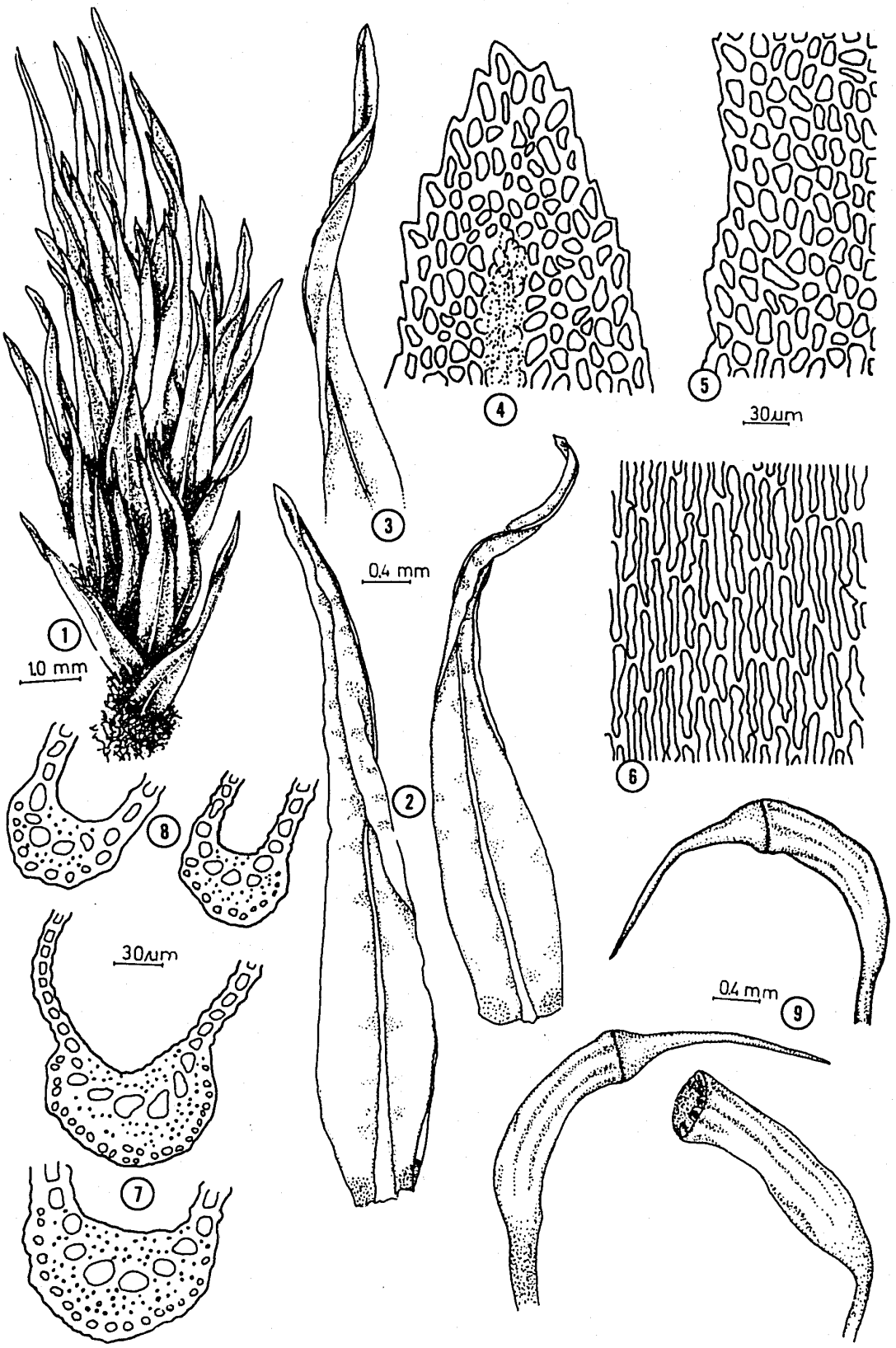
Usually in wet situations, such as bogs, swamps, margins of lakes, rarely in drier habitats on soil or humus. Not uncommon up to 51°N latitude, but rare farther north. Circumpolar. Greenland to Alaska, south to New Jersey, Michigan, Wisconsin, Colorado, Montana and Washington. Europe and Asia.

Easily recognized because of the broad leaf apex, the costa that ends below the apex, the undulate leaves and the characteristic twisting of the apex when dry (see Plate 14, fig.3). Sometimes, when the apex is narrower and the costa almost percurrent, sterile plants can be confused with D. ontariense (see discussion under D. ontariense).

SELECTED SPECIMENS EXAMINED

ABITIBI: Obaska-Perron road, Erskin 3-7-1970 (CANM). BONAVENTURE: 48°51'N-64°26'W, Grandtner 7853/M4 (CANM, QFA). CHICOUTIMI: 48°22'N-71°06'W, Gauthier 2738 (RG). GASPE WEST: Mont Albert, Crum & Williams 10726 (CANM)*. Mont Albert, LeBlanc 651 (QFA). GATINEAU: Ramsay Lake, Ireland 10102 (CANM)* SHEFFORD: Granby, LeBlanc 1956 (CANM)*. KAMOURASKA: 47°41'N- 69°33'W, Comeau 249 (CANM). MATANE: St.Ulrich, Comeau 248 (CANM). Matane, LeBlanc 4925 (QFA). MISTASSINI: Loon Point 52°05'N-78°45'W, Kucyniak & Tuomikoski T-160 (CANM). NEW QUEBEC: Great Whale River, 55°17'N-46°W, Brisson & Forest 22644 (CANM)*. Lac Diana, 58°20'N-68°58'W, Ducruc 13-11 (CANM). Fort George, 53°46'N-78°43'W, Kucyniak & Tuomikoski K-304 (CANM). Black Whale Harbour 55°09'N-78°08'W, Kucyniak & Tuomikoski T-1230 (CANM). Lac Jaucourt 52°45'N-74°07'W, Argus 9199 (CANM). 53°58'N-71°59'W, Lethiecq QFB-E4105 (CANM). 53°30'N-69°23'W, Lethiecq QFB-E4119 (CANM). RIMOUSKI: Point au Père, 48°30'N-68°28'W, Gauthier 5956-8 (RG). SAGUENAY: 48°35'N-69°07'W, Comeau 238 (CANM). Saint Maurice, 46°38'N-73°14'W, Gagnon 451-1 (CANM). Anticosti Island, Macoun 13 August 1883 (CANM 121986).

PLATE #14: Dicranum undulatum 1.- Habit of upper portion of stem (dry). 2.- Stem leaves (dry). 3.- Apex of leaf (dry). 4.- Apex. 5.- Upper leaf cells. 6.- Lower leaf cells. 7.- Median leaf cells in cross-section. 8.- Upper leaf cells in cross-section. 9.- Capsules (dry).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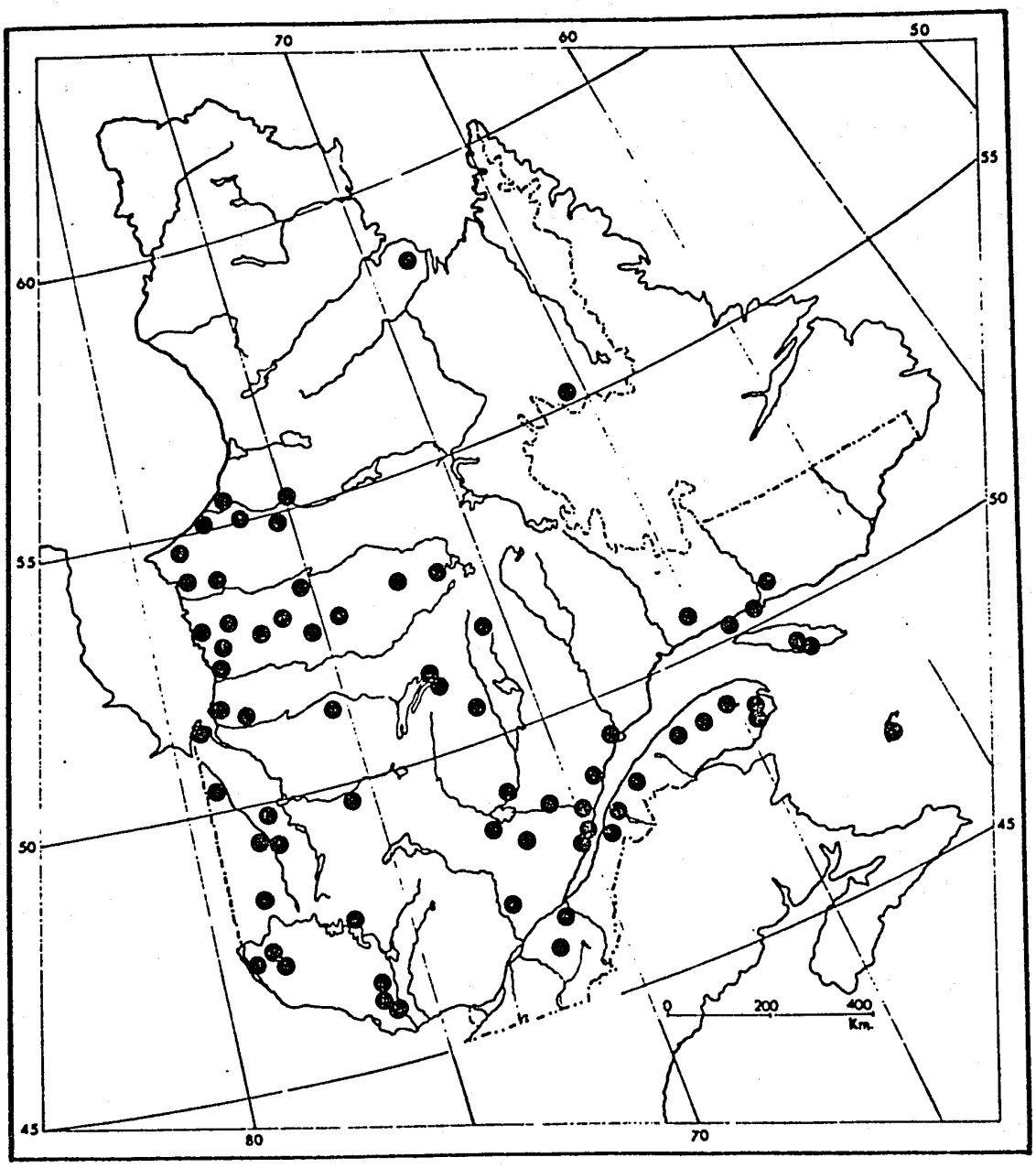


Map # 14: Distribution of Dicranum undulatum in Quebec.

15.- Dicranum fuscescens Turn., Musc.Hib.60.5f.1.1804.

Dicranum congestum Brid., Spec.Musc.1:76.1806.
Dicranum crispulum C.Muell.et Kindb. in Macoun,Cat.Canad.Pl.6:27.1892.
Dicranum sulcatum Kindb.in Macoun,Bull.Torr.Bot.Cl.17.87.1890.hom.illeg.
Dicranum leucobasis C.Muell.et Kindb.in Macoun, Cat.Canad.Pl.6:30.1892.
Dicranum trachyphyllum Ren.et Card., Bot.Gaz.22.48.3B.1896.
Dicranum camptophyllum Kindb., Eur.N.Amer.Bryin.2:193.1897.

Plants in loose tufts, light green to dark brownish green, dull. Stems 2-6 (18) cm high, tomentose. Leaves falcate-secund, upper leaves curled, lower leaves with flexuose apices, slightly to strongly curled and crisped when dry, (3) 3.5-5.0 (7) mm long, concave below, keeled above, from a lanceolate base to a gradually narrowed, fine, keeled subula; margins entire below, slightly to strongly serrate above; laminae unistratose and usually bistratose on one or both margins above, rarely some bistratose regions near costa; costae excurrent, 1/4-1/6 the width of the leaves at base, strong and terete, rough on dorsal surface; leaf cells smooth to slightly papillose below on dorsal surface, papillose above on dorsal surface; alar cells bistratose, strongly differentiated, brown; lower cells elongate, pitted, (2) 6-8 (12) µm wide and (25) 43-62 (93)µm long; median-upper cells short-rectangular, quadrate, irregular, not pitted, (4) 6-7 (10) µm wide and (7) 16-31 (56) µm long; upper cells short-rectangular to regularly quadrate-rectangular, not pitted, (5) 8-12 (14) µm wide and (8) 18-23 (31)µm long.Leaves in cross-section shaped like a "pair of tongs", with a row of guide cells, two well-developed stereid bands extending to upper part of leaf, only dorsal row of cells differentiated, cell walls between cells weakly bulging.

Dioicous. Male plants as large as the females, growing intermixed, or in separate patches. Setae solitary, 1.0-3.5 cm long. Capsules dark brown to reddish brown, arcuate, inclined or erect, strumose, strongly furrowed when dry, somewhat contracted below mouth, 1.0-2.8 mm long. n= 9,10,11,12,24.

On wood, living trees, rotten logs, soil, rock or humus. Common and widely distributed throughout Quebec. Circumpolar. Greenland to Alaska, south to Florida, Michigan, Wisconsin, Minnesota, Colorado, Idaho and California. Europe and Asia.

This Dicranum is not only the most common of all species in Quebec but also has the widest distribution. It is one of the most variable species, especially when growing above 55 °N latitude. In its typical form it is easily recognized by the curled, keeled upper leaves that are rough on the back, and the bistratose margins. Plants growing in the high latitudes tend to grow in more dense, compact tufts, the leaves are slightly or not at all falcate-secund and the upper subula is shorter and less keeled. One can see in these arctic specimens the presence of abnormal shoots with small, ovate, blunt leaf apices, like those that occur in many other species that grow in arctic Quebec (e.g.,D.elongatum, D. spadiceum and D. scoparium).

The arctic collections of this species can be confused with D. acutifolium when the latter is indistinctly undulate. However, the two may be distinguished since D. acutifolium has larger, more rounded bulging

cell walls between the cells, and fewer bistratose regions on the margin than D. fuscescens. Some plants of D. fuscescens from northern Quebec have leaves that are not strongly keeled. This is especially true for male plants but the cross-section will readily identify this species.

SELECTED SPECIMENS EXAMINED

ABITIBI: Lac Chicobi, 48°50'N-78°32'W, Gaudreau 8107-3 (CANM). BELLECHASSE: 46°30'N-70°08'W, Gauthier 35-1 (QFA). CHARLEVOIX: Mont du Lac-des-Cygnes, Hedley, Raymond & Kucyniak 45-59 (MICH). COMPTON: Mégantic Mountain, Marcottes 43-3 (CANM)*. DORCHESTER: Frampton, Gagnon & Masson 8633 (CANM). FRONTENAC: Mégantic Mountain, Marcotte 6-5 (CANM). GASPE WEST: Mont Albert, Crum & Williams 10679 (CANM)*. Rivière au Diable, Crum & Williams 10624 (CANM, MICH). Mont Albert, Collins 4095 (MICH). LABELLE: L'Annonciation, 42°20'N-74°52'W, Gagnon 263-4 (CANM). MADELEINE ISLANDS: East Island, Reilly 667 (CANM). MASKINONGUE: St.Didace, Gagnon 426-2 (CANM). MATANE: Cap Chat River, Collins 5700 (CANM). Mont Blanc, LeBlanc 6302 (QFA)*. MISTASSINI: Lake Mistamiquechamic, 52°59'N-73°39'W, Haber & Bergeron 2-8-1974 (CANM, MTMG). MONTMORENCY: Macoun, 23 June 1905 (CANM 120243). PORTNEUF: La Tuque, Marie-Anselme744 (CANM). NEW QUEBEC: Great Whale River, 55°13'N-77°57'W, TuomikoskiT1440, (CANM)*. Port Harrison, 58°13'N-78°07'W, Kucyniak & Tuomikoski T1763 (CANM)! Knob Lake, 54°47'N-66°48'W, Grayson 5066 (CANM). Territoire de la Baie de James, 53°20'N-71°00'W, Lethieco QFB-E4181 (CANM), 53°50'N-79°04'W, Andet QFB-4194 (CANM). 53°40'N-74°55'W, Blouin QFB-E4094 (CANM). Rivière Mucalic, 58°05'N-67°03'W, Ducruc 73-1831 (CANM). Wolstenholme, Polunin 2252a-6 (MICH). Koklak Mislake Bay, 59°14'N-78°03'W, Taylor 206 (MICH). RIVIERE DU LOUP: St. Modeste, Blouin 5804-2 (CANM). 47°59'N-69°51'W, Blouin 5851-2 (MICH). SAGUENAY: Forestville, 48°41'N-69°08'W, Comeau 215 (CANM). Franquelin, 49°18'N-54°W, Gardner & Mantion 124 (MICH). Anticosti Island, Becsie River, Macoun 3-9-1883 (CANM 120253). Mingan Islands, Ile Fright, Desroches 49b (PD). TEMISCOUATA: St. Rose-du-Dégelis, Ireland 10163 (CANM). TEMISCAMINGUE: Lake Kipawa, Brown 181T3 (CANM).

15a.- Dicranum fuscescens var. flexicaule (Brid.)Wils., Bryol.Brit.77.1855.

Dicranum flexicaule Brid., Bryol.Univ.1:421.1826.
Dicranum congestum var. flexicaule (Brid.)B.S.G., Bryol.Eur.1:140. 77a.1847.

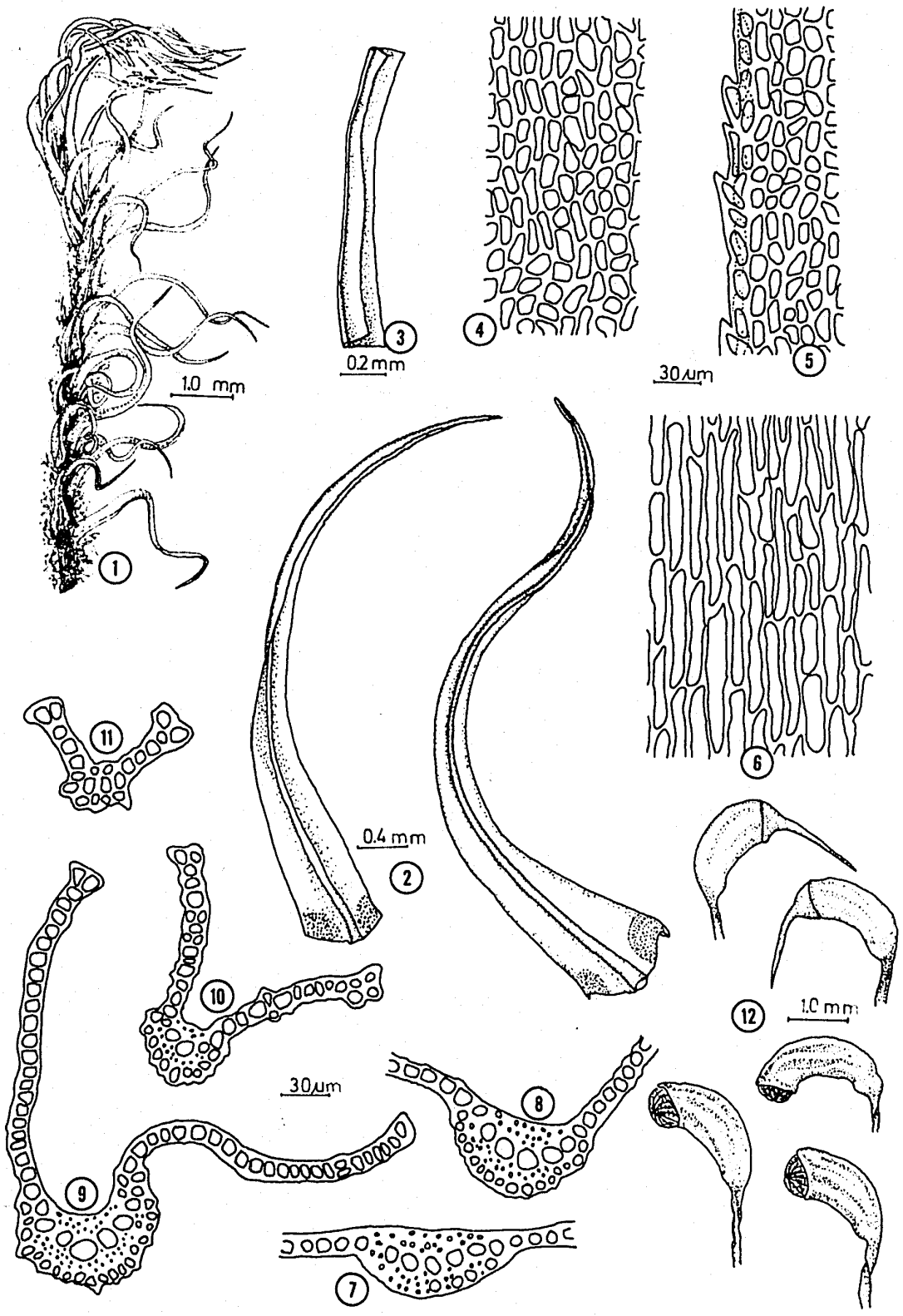
Plants in loose tufts. Stems 8-18 cm high, scarcely tomentose. Leaves strongly falcate-secund, somewhat sparse; lower leaf cells elongate, (5) 7-9 (12) µm wide and (19) 42-54 (84) µm long; upper leaf cells irregularly rounded, elliptic or short-rectangular, (4) 8-9 (13)µm wide and (7) 9-19 (36) µm long. Setae 2.5-3.5 cm long. At high latitudes above 53°N and at high elevations in the Gaspé Peninsula.

This variety is presently not recognized in North America. Kucyniak (in Löve et al., 1958) who has recognized it stating: "when one allows D. scoparium and D. bonjeani to stand apart as separate species, in spite of the fact that both grade freely into each other, there seems little reason why D. fuscescens var. flexicaule, which on the whole is a less variable and more distinct entity, should be melted in the species to which it belongs". The type of D. fuscescens var. flexicaule (as D.flexicaule Brid.) collected in Alpis Cavint.(?) 1819 by Norschuch has been examined.

SPECIMENS EXAMINED:

GASPE WEST: Mont Jacques-Cartier, 48°59'N-57°W, Boudreau 2, 27.1 (CANM)*. Castle Ridge, Collins 4520A (MICH)* Rivière au Diable, Crum & Williams10625 (CANM, MICH)*. Mont Albert, Collins 4098b, 4095a, 4079b, (MICH).
NEW QUEBEC: Fort George, 53°46'N-78°43'W, Kucyniak & Tuomikoski T-438 (CANM). Lac Duplix, 52°43'N-73°46'W, Haber & Bergeson 3-8-1974 (CANM). Great Whale River, 55°14'N-77°23'W, Tuomikoski T 1968 (CANM).

PLATE #15: Dicranum fuscescens 1.- Habit of upper portion of stem (dry). 2.- Stem leaves. 3.- Upper median portion of leaf. 4.- Median leaf cells. 5.- Upper leaf cells. 6.- Lower leaf cells. 7-8.- Lower leaf cells in cross-section. 9.- Median leaf cells in cross-section. 10-11.- Upper leaf cells in cross-section. 12.- Capsules (dry).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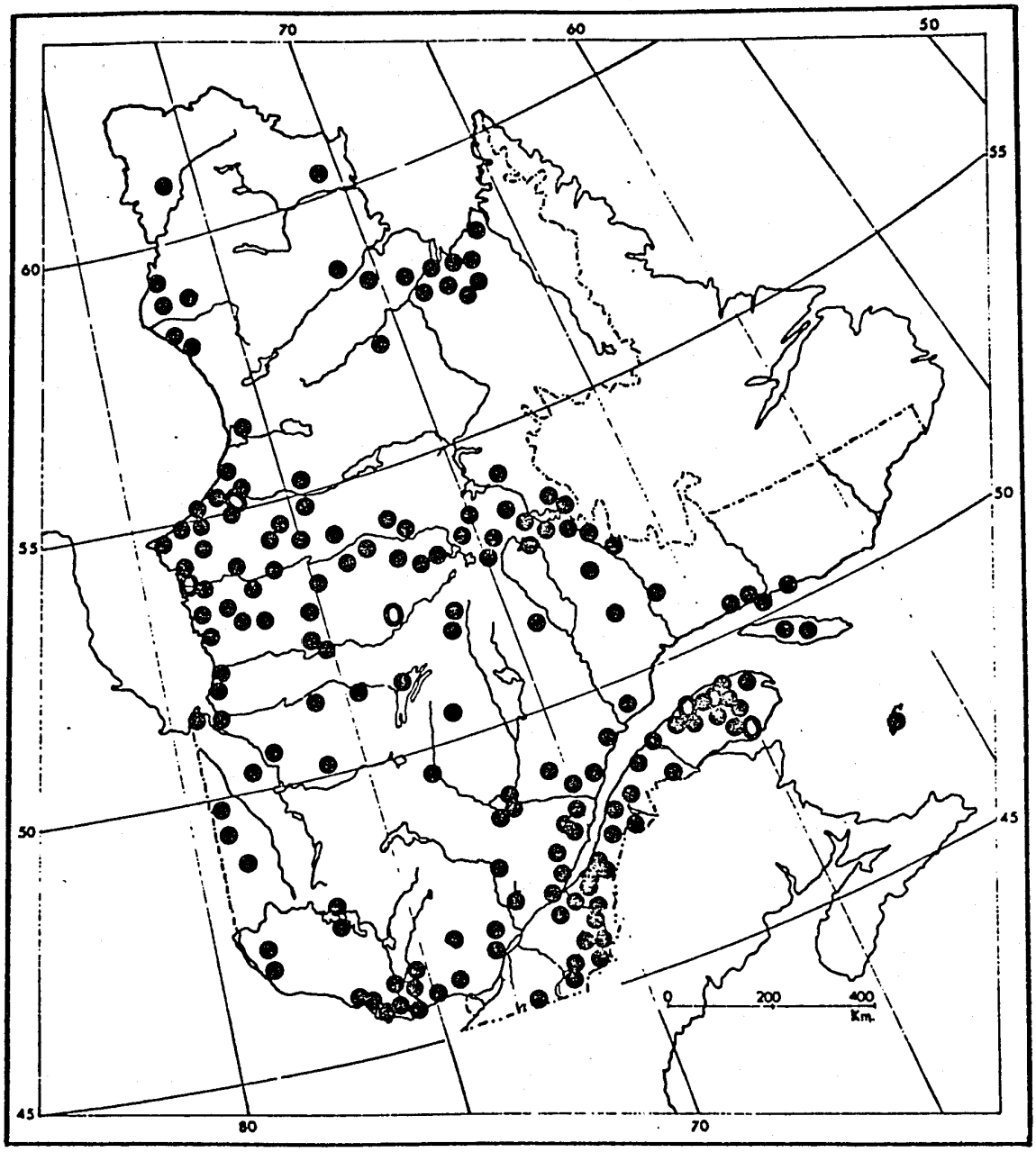


Map # 15: Distribution of Dicranum fuscescens (●) and Dicranum fuscescens var. flexicaule (O) in Quebec.

16.- Dicranum majus Turn., Musc.Hib.58.1804.

Dicranum scoparium var. majus (Turn.)Wahlenb., Fl.Carp.343.1815.

Plants in loose tufts, green to light green, glossy. Stems 5-16 cm high, little tomentose. Leaves somewhat sparse, falcate-secund or straight, (6) 8.0-11.5 (12) mm long, concave below, tubulose above, from a lanceolate to ovate-lanceolate base, gradually narrowed to a long, falcate-secund or straight, acute apex; margins serrate in the upper half; laminae unistratose or with few bistratose regions; costae percurrent to excurrent, 1/10-1/12 the width of the leaves at base, toothed above on dorsal surface; leaf cells smooth; alar cells bistratose, well-differentiated; lower cells elongate, pitted, (5) 9-10 (15) μm wide and (42) 71-112 (140) μm long; upper cells shorter, linear to oval, pitted, (7) 10-11 (17) μm wide and (42) 60-62 (99) μm long. Leaves in cross-section with a double row of guide cells, two stereid bands extending to apex, dorsal layer of cells differentiated, some ventral enlarged, cell walls between cells not bulging.

Pseudomonoicous. Dwarf males in rhizoids of females plants. Setae aggregate, 2-5 per perichaetium, rarely solitary, 2.5-5.0 cm long. Capsules dark brown or yellowish brown, arcuate, inclined, striate when dry, 2.0-3.5 mm long. n = 11,12,13,17.

On humus, soil, soil over rock and rotten wood. This species in its typical form has an oceanic tendency, usually growing near the coast along the Gulf of St. Lawrence, the St. Lawrence River and the coast of

Hudson Bay. Greenland to Alaska, south to New England, Ontario, Alberta and Washington. Europe and Asia.

Dicranum majus in its typical form is easily recognized by its glossy, smooth, long, falcate-secund leaves. The presence of a double row of guide cells and aggregate setae will distinguish it from its allied species.

SELECTED SPECIMENS EXAMINED

BELLECHASSE: Beaumont, Masson 8562 (CANM)*. GASPE EAST: Parc Nat. Forillon, Majcen 8377/M7 (113) (CANM). GASPE WEST: Mont Jacques-Cartier, LeBlanc 6775 (QFA). MATANE: Matane, LeBlanc 4024 (QFA)*. Tourbière de St. Ulrich 48°48'N-67°37'W, Gauthier 5977-2 (RG). MISTASSINI: Rupert House, 51°27'N-78°49'W, Kucyniak & Tuomikoski K 60 (CANM). NEW QUEBEC: Great Whale River 55°17'N-77°47'W, Savile 621 (CANM)* Golfe de Richmond, Payette 119-4 (CANM). Manitounuk Sound, 55°20'N-77°42'W, Kucyniak & Tuomikoski K-557 (CANM). Fort George, 53°46'N-78°43'Wm Kucyniak & Tuomikoski T-445. Port Harrison, 58°13'N-78°07'W, Kucyniak & Tuomikoski T-1753 (CANM). Bush Lake, 57°50'N-78°08'W, Taylor 69 (MICH). RIMOUSKI: Pointe au Père, 48°30'N-69°29'W, Gauthier 5968-1 (RG). SAGUENAY: Harrington Island, Johansen 14-9-1919 (CANM). Pointe-au-Boisvert, Comeau 208 (CANM). Anticosti Island, Jupiter River, Macoun 26-August-1883 (CANM 120599). Rivière Vauréal, Marie-Victorin & Rolland-Germain 49-613 (MICH).

16a.—Dicranum majus var. orthophyllum A.Braun ex Mild., Bryol.Siles. 71.1869.

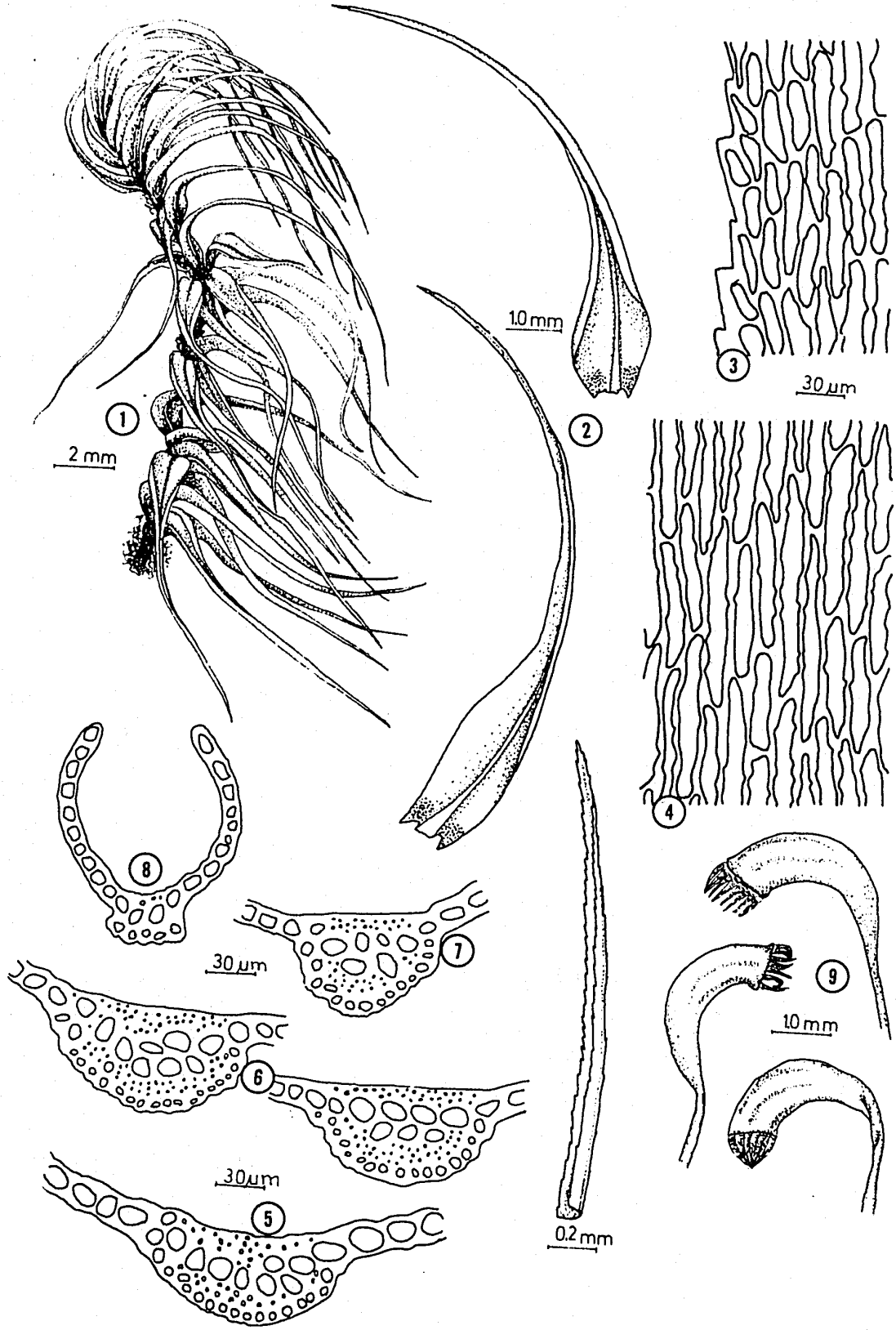
Leaves erect-patent, 6-8 mm long, tubulose above; margins slightly serrulate above, Leaves in cross-section with an interrupted double row of guide cells. Setae aggregate, rarely solitary. It is mainly an arctic species that sometimes grows inland.

Most of the specimens that belong to D. majus var. orthophyllum have been identified as Dicranum spadiceum. The variety is distinguish from it by the following characters: dentate apex, rough costa above on dorsal surface, an interrupted double row of guide cells, cell walls between cells not bulging and aggregate setae. Dicranum majus is a variable species and the var. orthophyllum has been overlooked in North America.

SPECIMENS EXAMINED

NEW QUEBEC: Sucker Creek, 54°58'N-78°35'W, Kucyniak & Tuomikoski T-1071 (CANM)*. Black whale, 53°21'N-78°58'W, Kucyniak & Tuomikoski T339 (CANM). Long Point, 52°45'N-78°55'W, Kucyniak & Tuomikoski T 209 (CANM). James Bay, Lethiecq QGB-E 12370 (QFB, CANM)*. Bush Lake, 57°50'N-75°28'W, Taylor 69 (MICH). Cape Jones, East Coast of Hudson Bay, Marr M464 (MICH). 55°30'N-77°03'W, Lethiecq QFB-E 9555 (CANM, QFB). Lac Fusil, 58°20'N-72°12'W, Morin 67-9 (CANM).

PLATE#16: Dicranum majus 1.- Habit of upper portion of stem (dry). 2.- Stem leaves (above), upper portion of leaf (below). 3.- Upper leaf cells. 4.- Lower leaf cells. 5.- Lower leaf cells in cross-section. 6-7.- Median leaf cells in cross-section. 8.- Upper leaf cells in cross-section. 9.- Capsules (dry).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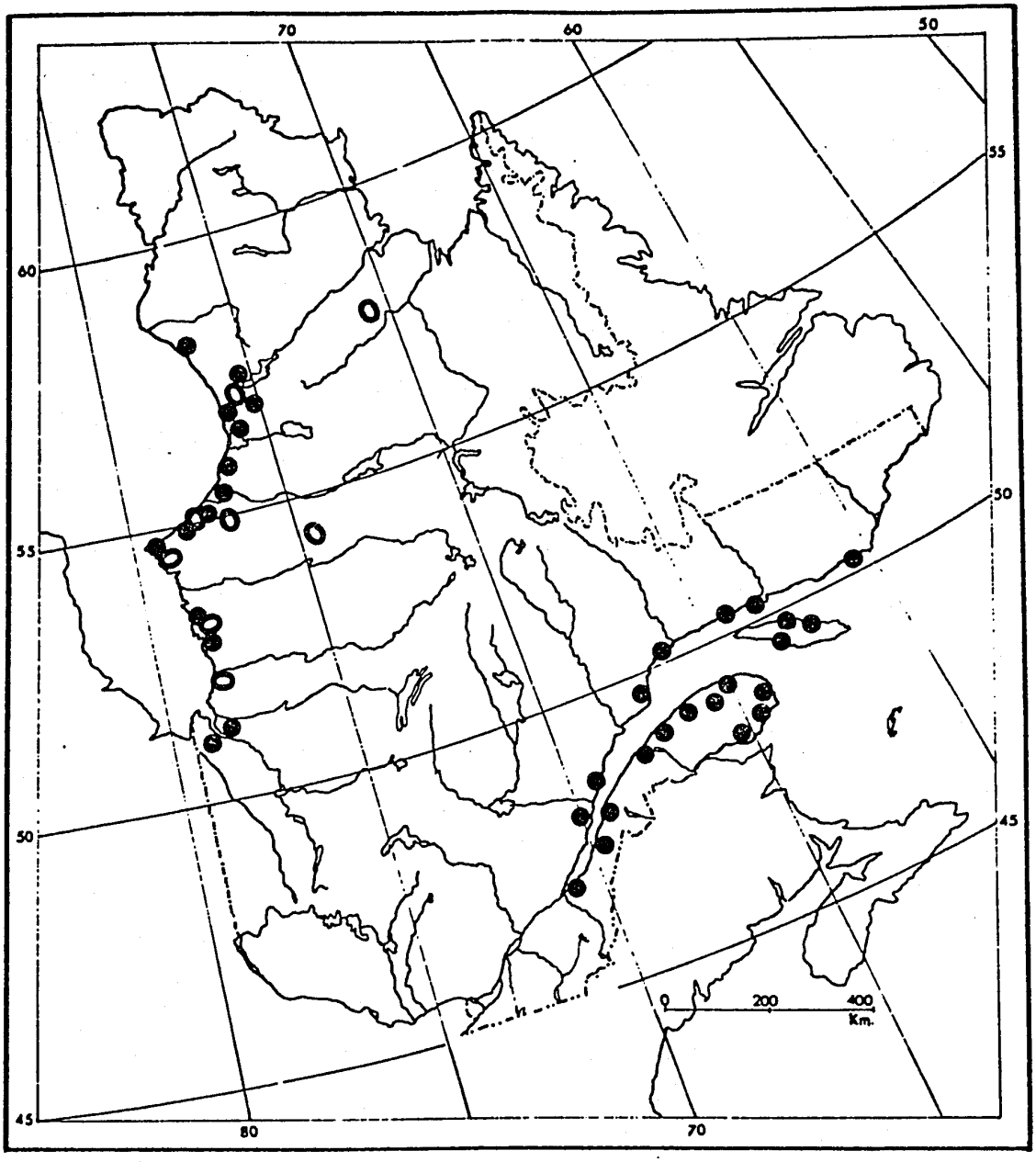


Map # 16: Distribution of Dicranum majus (●) and Dicranum majus var. orthophyllum (O) in Quebec.

17.- Dicranum scoparium Hedw., Spec. Musc.126.1801.

Dicranum condensatum Brid., Bryol.Univ.1:412.1826. (D. condensatum Spreng.1826.nom.inval.).
Dicranum pallidum Bruch et Schimp.ex C.Muell., Syn.1:359.1848. hom.illeg.
Dicranum mexicanum Schimp.in Besch., Mém.Soc.Sc.Nat.Cherbourg 16: 164.1872.
Dicranum scopariforme Kindb., Ottawa Nat.2:154.1889.
Dicranum consobrinum Ren.et Card., Bot.Gaz.15:39.5B.1890.
Dicranum angustifolium Kindb.in Macoun, Bull.Torr.Bot.Cl.17: 86.1890.hom.illeg.
Dicranum canadense Kindb.in Macoun, Bull.Torr.Cl.17:87.1890.
Dicranum kindbergii Par., Ind.Bryol.356.1895.
Dicranum alatum (Barnes)Card.et Thér., Bot.Gaz.37:364.17.f.1.1904.

Plants in loose to dense tufts, light to dark green, glossy or sometimes dull. Stems 2-10 cm high, tomentose. Leaves very variable, usually falcate-secund, rarely straight and erect, sometimes slightly rugose or undulate, slightly crisped when dry, (4) 5.0-8.5 (10) mm long, concave below, keeled above, lanceolate, apex acute to somewhat obtuse; margins strongly serrate in the upper 1/3 or rarely slightly serrulate; laminae unstratose; costae percurrent, excurrent or ending below apex, 1/5-1/10 the width of the leaves at base, usually with 2-4 toothed ridges above on dorsal surface; leaf cells smooth; alar cells bistratose, well-differentiated; lower cells linear-rectangular, pitted, (5)7-12 (13)µm wide and (25) 47-100 (126) µm long; upper cells shorter, broad, sinuose,pitted, (5) 8-12 (20) µm wide and (11) 27-43 (53) µm long. Leaves in cross-section with a row of guide cells, two thin stereid bands, the dorsal one interrupted by several enlarged dorsal cells that form part of the dorsal ridge, not extending to the apices, cell walls between cells not bulging.

Pseudomonoicous or dioicous. Dwarf males on rhizoids of female plants or male plants as large as females. Setae solitary, rarely two per perichaetium, 2.5-4.0 cm long. Capsules chestnut-brown, arcuate, inclined, smooth to striate when dry, 2.5-4.0 mm long. n= 10,13,14.

On soil, humus,, stones, decaying wood, tree bases, sometimes in bogs. Very common in southern Quebec below 50°N latitude, which corresponds to that of the Great-Lakes-St.Lawrence Forest Region. It has a distribution similar to that of Dicranum polysetum in the north where it has a tendency to grow on the coast, mainly along James and Hudson Bays. Circumpolar. Greenland to Alaska, south to Florida, Louisiana, Colorado, and California. Europe, Asia, Australia and New Zealand.

This is one of the most variable species of Dicranum in Quebec. The stance of the leaves varies from strongly falcate-secund to straight and erect (mainly in northern specimens). The leaves vary in shape from lanceolate and long-acuminate to ovate-lanceolate and short-acuminate. Typically the leaves are smooth but sometimes they are undulate-rugose. The costae vary in extent from subpercurrent to slightly excurrent. The margins have strong to weak dentations.. The toothed ridges on the dorsal surface of the costae are usually well-developed but in some forms they are almost nonexistent. The upper aerolation of the leaves is consistent throughout these forms, with little variation. The cells are usually short-sinuose and broad, generally containing oil drops.

The plants growing in the arctic region, as well as the ones that grow in bogs, generally have a different habit. They have straight and erect leaves, which are ovate-lanceolate and short-acuminate with the dentations on the margins and the dorsal ridges less developed. Sometimes these plants also have upper shoots with abnormal leaves which are shorter and wider than the lower leaves. Perhaps after further studies they may deserve taxonomic rank.

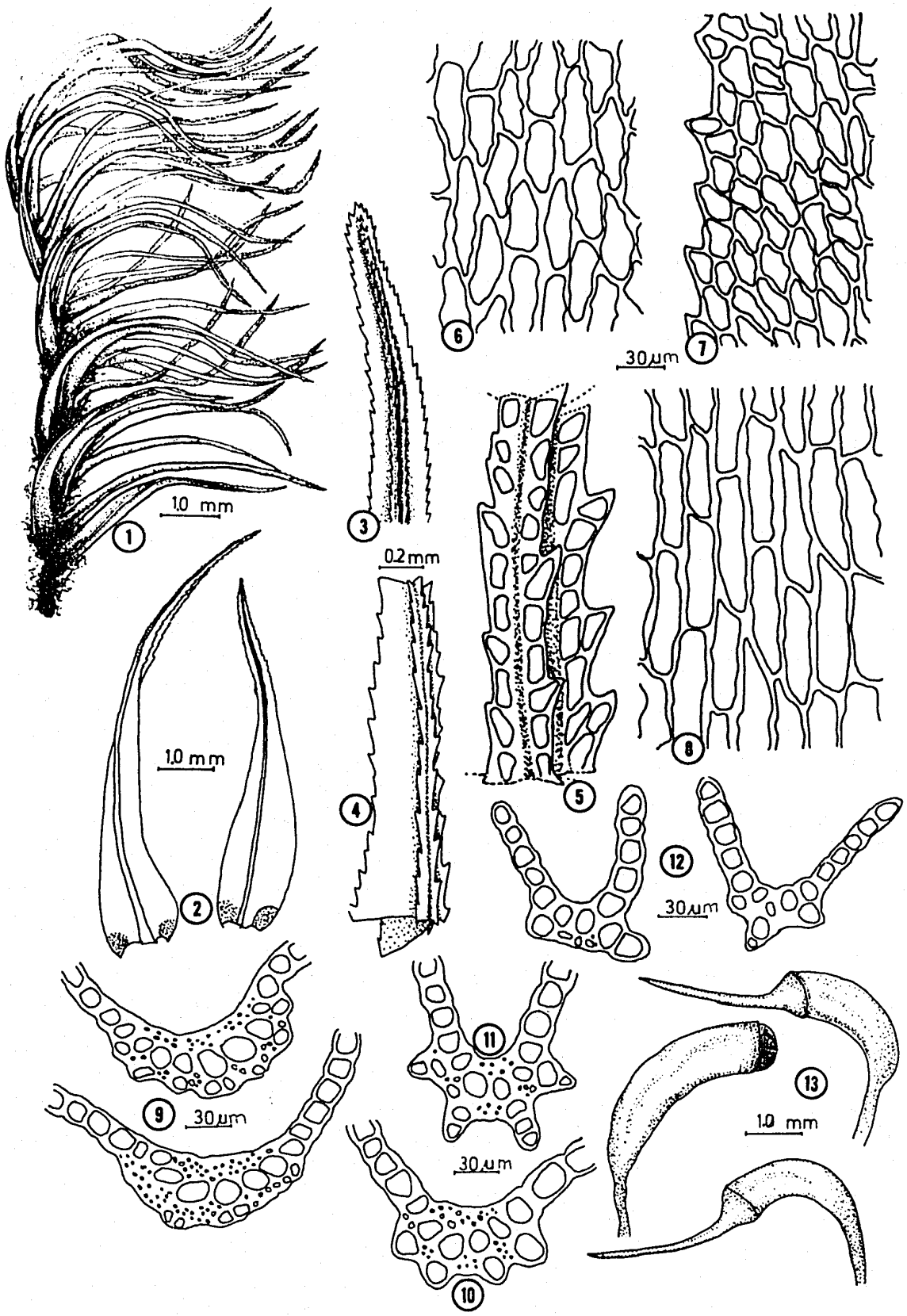
When sterile, a large-leaved form of Dicranum scoparium can be confused with D. majus. The latter is distinguished by the double row of guide cells, the thicker stereid bands and the upper cells that are narrower and more elongate than in D. scoparium. This large form of D. scoparium also has longer capsules with the urn being close to 4 mm long.

Dicranum scoparium is not a true peatland moss, prefering habitats such as stones, forest soil and wood. Its morphological features intergrade freely with the closely related D. bonjeanii which has weakly developed dorsal ridges and teeth on the upper margins compared to D. scoparium. Experimental studies may prove D. bonjeanii to be merely an ecological form of the variable D. scoparium, as suggested by Crum (1973). In the key these intermediate plants will key out to D. scoparium f.

SELECTED SPECIMENS EXAMINED

BEAUCE: Beauceville, Marie-Anselme 2860 (CANM)*. BAGOT: St.Pie, LeBlanc 2663 (QFA). BROME: Mont Oxford, LeBlanc 5905, 5837 (CANM). DEUX MONTAGNES: Oka, Mont de St. Joseph, Dupret & Louis-Marie 28-5-1927 (QFA 154312). FRONTENAC: Mégantic Mountain, Marcotte 23-2 (CANM). GASPE EAST: 46°39'N-71°10'W, Majcen 8332 M1(1/2) (CANM). GASPE WEST: Mont Jacques-Cartier, Boudreau 57-5.1 (CANM). GATINEAU: Luskville Falls, Trucco 103 (GT)*. Chelsea, Macoun, 23 Sept.1893 (CANM 121331 MICH). IBERVILLE: Ile St. Thérèse, Marie-Anselme MA19 (CANM). JOLIETTE: 46°30'N-73°42'W, Gagnon 478-1 (CANM). LA BELLE: 46°20'N-74°43'W, Gagnon 284-5 (CANM). LEVIS: 46°39'N-71°10'W, Caubone 29-12 (CANM). MATANE: Mont Blanc, LeBlanc 3128 (QFA). MONTCALM: 46°18'N-74°08'W, Gagnon 234-7 (CANM). NEW QUEBEC: Sucker Creek, 54°58'N-78°35'W, Tuomikoski T-1069 (CANM). Fort George, 53°50'N-79°01'W, Kucyniak & Tuomikoski T 513 (CANM). Asbestos Hill, 61°48'N-73°55'W, Gardner & Mantion 135 (MICH). RIVIERE DU LOUP: 47°58'N-69°26'W, Comeau 231 (CANM). 47°49'N-69°20'W, Blouin 5799-1 (MICH). SHEFFORD: Waterloo, Marie-Anselme 1234 (CANM, MTMG). TERREBONNE: Mont Tremblant, Crum 9726 (CANM). Mont Rolland, Marie-Anselme 3865 (QFA). TEMISCAMINGUE: 46°39'N-78°05'W, Brown 166T-5 (CANM,MICH). SAGUENAY: Anticosti Island, Jupiter River, Macoun 26 August 1883 (CANM 121335).

PLATE #17: Dicranum scoparium 1.- Habit of upper portion of stem (dry). 2.- Stem leaves. 3.- Apex in dorsal view. 4.- Upper portion of leaf in dorsal view. 5.- Dorsal toothed ridges. 6.- Median leaf cells. .- Upper leaf cells. .- Lower leaf cells. 9.- Lower leaf cells in cross-section. 10.- Median leaf cells in cross-section. 11.- Upper-median leaf cells in cross-section. 12.- Upper leaf cells in cross-section. 13.- Capsules (dry).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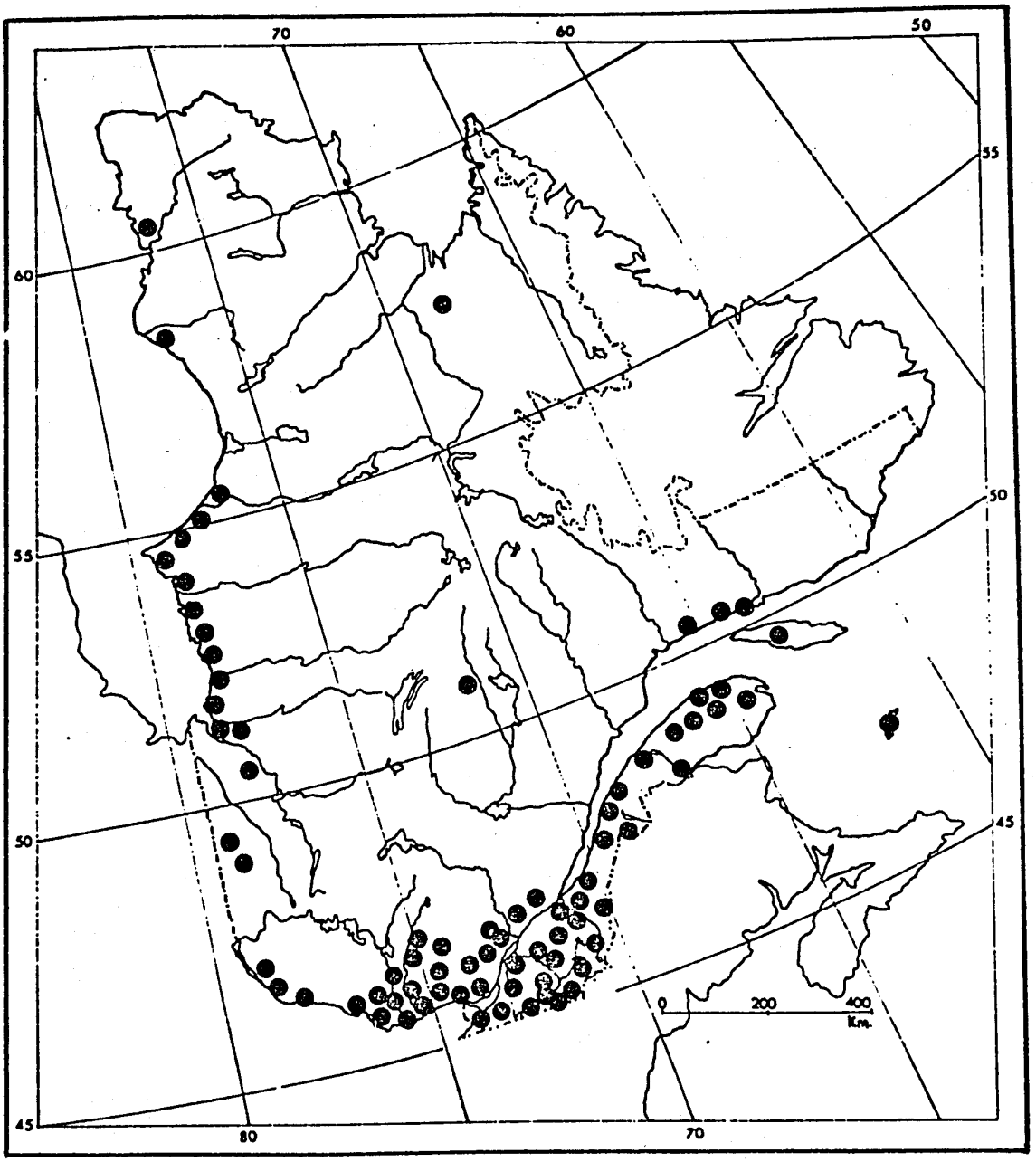


Map # 17: Distribution of Dicranum scoparium in Quebec.

18.- Dicranum polysetum Sw., Monthl.Rev.34:538.1801.

Dicranum undulatum Ehrh.ex Web.et Mohr, Ind.Mus.Pl.Crypt.1803. hom.illeg.

Dicranum rugosum (Funck)Hoffm.ex Brid., Spec.Musc.1:75.1806. nom.illeg.incl.spec.prior.

Plants in loose tufts, light green, glossy. Stems 5-18 cm high, densely tomentose with whitish or reddish rhizoids, loosely foliate. Leaves spreading, ± flexuose, strongly undulate, (5.5)7.0-9.5(10.5)mm long, concave below, keeled above, lanceolate, acute; margins strongly toothed in the upper half; laminae unistratose; costae ending below the apices, 1/8-1/12 the width of the leaves at base, strong, with two toothed ridges above on dorsal surface; leaf cells smooth; alar cells bistratose, well-differentiated; lower cells elongate, pitted, (5) 9-10 (14) μm wide and (45) 78-129 (156) μm long; upper cells shorter, sinuose, pitted, (4) 9-10 (13) μm wide and (42) 64-68 (115) μm long. Leaves in cross-section with one row of guide cells, two stereid bands, some dorsal cells enlarged, cell walls between cells not bulging.

Pseudomonoicous. Dwarf male plants on stem rhizoids of female plants. Setae aggregate, 3 to 5 per perichaetium, 2.5 - 4.0 cm long. Capsules yellowish brown or reddish brown, arcuate, inclined, furrowed when dry, 2.0-3.5 mm long. n = 12,13,14.

Growing in forest on humus, soil over rock, decaying wood, but

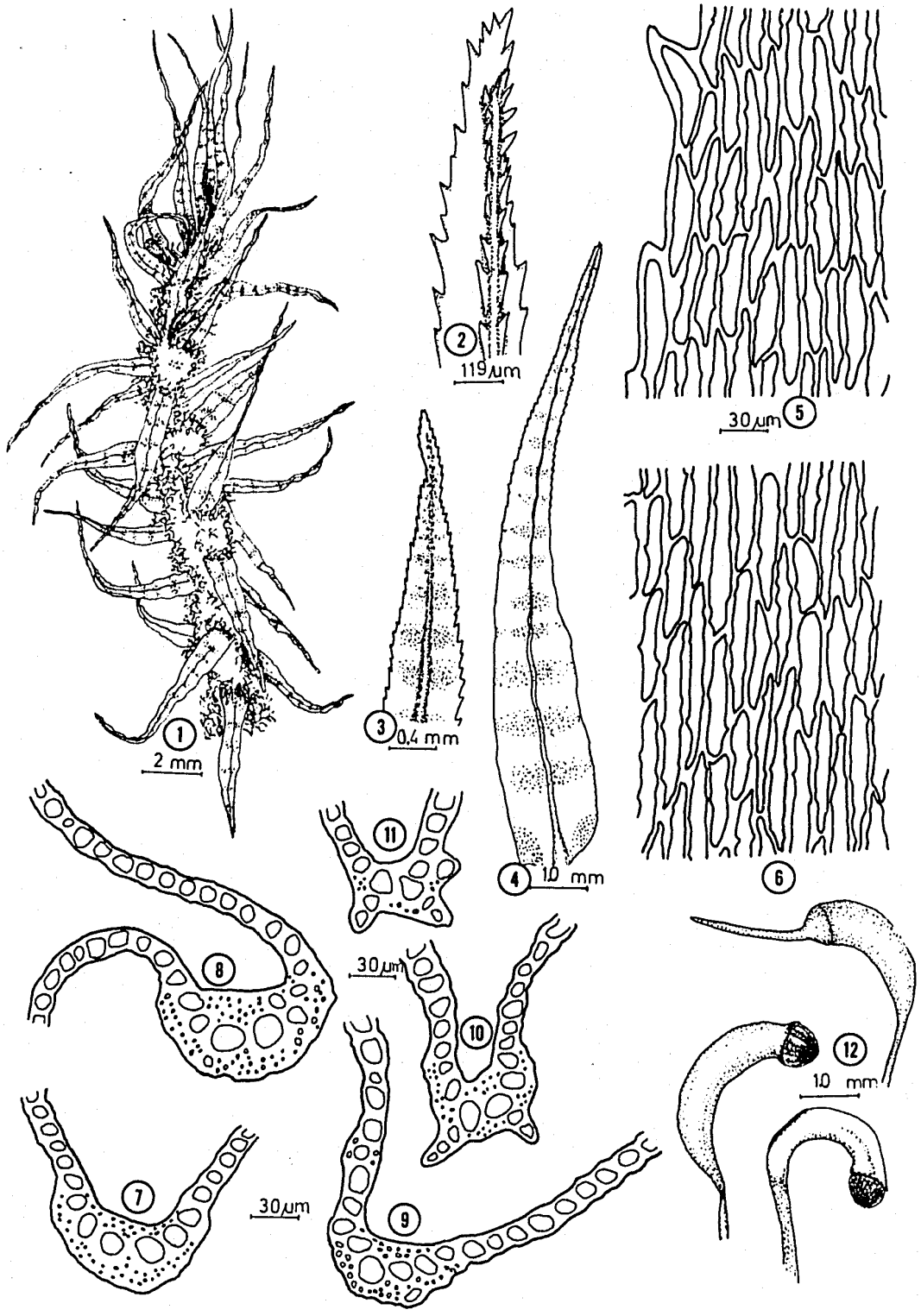
also occurring infrequently in bogs. Very common in the south of Quebec, up to 50°N latitude. In the north it tends to be a more coastal species, growing mainly along the Hudson Bay Coast. Circumpolar. Newfoundland to Alaska, south to North Carolina, Kentucky, Illinois, Missouri, South Dakota, Wyoming and Washington. Europe and Asia.

As Crum (1973) states, this is the largest and showiest Dicranum. The species is easily recognized by the shiny leaves that reflect the light from its numerous undulations, by the wide-spreading leaves and by the clustered sporophytes. This is one of the few species that has no apparent intergradations with any other species of Dicranum.

SELECTED SPECIMENS EXAMINED

BELLECHASSE: St. Damien, Masson & Gagnon 9148 (CANM). CHAMPLAIN: St. George, Domaine June 1974 (CANM, MTMG). CHARLEVOIX: Parc Prov. des Laurentides, 47°42'N-70°53'W, Gauthier 3248 (RG). COMPTON: Mégantic Mountain, Marcotte 73-9 (CANM)*. DORCHESTER: St. Louis de Gonzague, Gagnon & Masson 10056 (CANM). GASPE EAST: Penouille, Grandtner 7866/M2 (QFA). GATINEAU: Gatineau Park, Ireland 9674 (CANM)*. JOLIETTE: St. Zénon, Gagnon 478-8 (CANM). KAMOURASKA: Southwest of St. André, Ireland 11106 (CANM). LABELLE: La Macaza, Gagnon 276-1 (CANM). LAC ST. JEAN WEST: St. Félicien, Marie-Anselme 29-8-1939 (MICH). LEVIS: Fôret de Beauséjour, Grandtner 29 (QFA). MATANE: Matane, LeBlanc 4026 (QFA). MISTASSINI: Rupert House, 51°27'N-78°49'W, Kucyniak & Tuomikoski T-105 (CANM). MONTCALM: Lac Chat, Parc du Mont Tremblant, Hermann 16701 (CANM). NEW QUEBEC: Great Whale River, 55°17'N-77°46'W, Brisson & Forest 21340 (CANM)*. Lac Long, 53°35'N-77°19'W, Ducruc 73-5022 (CANM). Fort George 53°46'N-78°43'W, Kucyniak & Tuomikoski T 431 (CANM). RICHMOND: Johnville Bog, Palmer 19 a (MICH). RIMOUSKI: St. Fabien, Comeau 239 (CANM). RIVIERE DU LOUP: St.Arsene, Blouin 5619-2 (CANM). SAGUENAY: Franquelin, 49°18'N-67°54'W, Gardner & Mantion 112a (MICH). SAINT-MAURICE: Lac Edouard, Lamoureux & Durand 7-127-11 (CANM).

PLATE # 18: Dicranum polysetum 1.- Habit of upper portion of stem (dry). 2.- Apex in dorsal view. 3.- Upper portion of leaf in dorsal view. 4.- Stem leaf. 5.- Upper leaf cells. 6.- Lower leaf cells. 7-9.- Median leaf cells in cross-section. 10-11.- Upper leaf cells in cross-section. 12.- Capsules (dry).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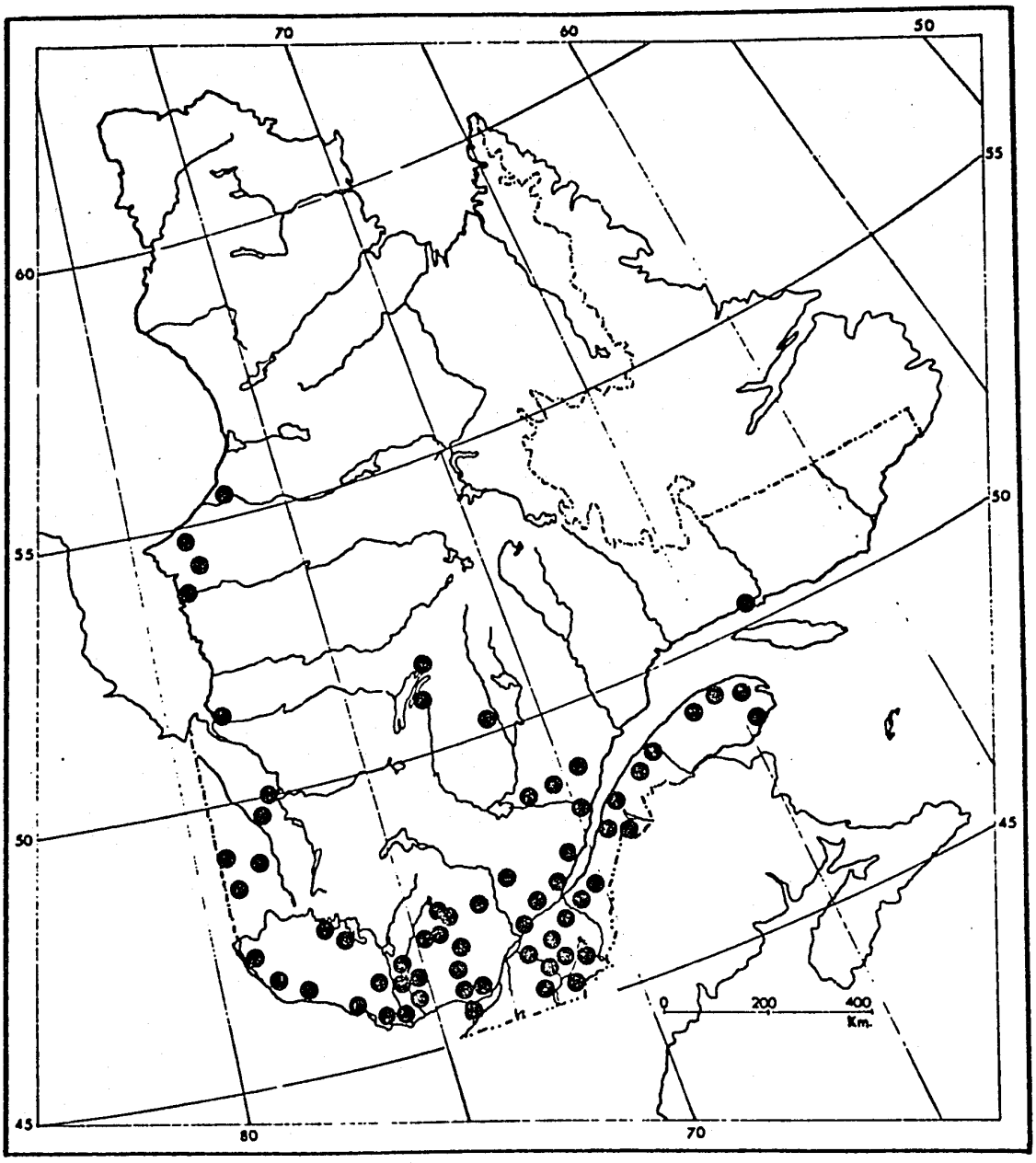


Map # 18: Distribution of Dicranum polysetum in Quebec.

19.- Dicranum spadiceum Zett., K.Svensk.Ak.Handl.5(10):2.1865.

Dicranum neglectum Jur.ex De Not., Atti Univ.Genova 1:612, 613.1869.
Dicranum muehlenbeckii var. neglectum (De Not.)Pfeff., Neue Denkschr.Schwarz.Ges.Naturw.4(5):23.1869.
Dicranum algidum Kindb., Rev.Bryol.23:17.1896.
Dicranum angustum Lindb., Medd.Soc.F.Fl.Fenn.6:252.1881.
Dicranum laevidens Williams, N.Amer.Flora 15:126.1913.
Dicranum muehlenbeckii var.spadiceum (Zett.)Podp,Consp.143.1954.

Plants in dense to loose tufts, green to yellowish green or brown, glossy. Stems 3-7 cm high, tomentose. Leaves straight,erect-spreading, (4) 5.5-8.0 (9) mm long, concave below, tubulose above, from a lanceolate base to a long-acuminate subula, apices acute or sometimes ± blunt; margins entire or slightly serrate in the upper part; laminae unistratose; costae percurrent to slightly excurrent, 1/8-1/10 the width of the leaves at base, smooth to slightly rough above on dorsal surface; leaf cells smooth; alar cells bistratose, well-differentiated; lower cells elongate, pitted, (3) 7-8 (10) µm wide and (16)36-62 (112) µm long; upper cells short-elongate, pitted, (3) 7-8 (10) µm wide and (9) 10-17 (31) µm long. Leaves in cross-section with a row of guide cells, two well-developed stereid bands extending almost to the apex, dorsal layer of cells differentiated, rarely some ventral cells enlarged, cell walls between cells not or slightly bulging.

Pseudomonoicous. Dwarf males on rhizoids of female plants. Setae solitary, rarely 2 per perichaetium, 2.5-3.5 cm long. Capsules light to dark brown, arcuate, erect or inclined, furrowed when dry,

2.6-3.0 mm long. n = 12.

This is a northern species, growing above 52°N latitude. It appears to have oceanic tendencies, although this does not agree with its distribution in the rest of Canada, where it is found inland in arctic regions. Circumpolar. Greenland to Alaska, south to Quebec, Ontario and Alberta. Europe and Asia.

A lectotype of D. spadiceum Zett. collected in Pyrénées Centrales, Port de Vénasque, 9 September 1856 by Zetterstedt (S-PA), an isotype of D. laevidens Williams collected in Klondyke River, 23 July 1899, by R.S.Williams (NY), and a type of D. angustum Lindb. collected in Luppovaara, 27 June 1877, by Hjelt & Hult (H), were examined.

The holotype and syntypes of Dicranum angustum and the lectotype and syntype of D. spadiceum have many characters in common; namely, leaves that are erect-patent when dry, narrowed from a lanceolate base to a long tubulose subula, lamina cells smooth on dorsal surface, long, sinuose, pitted lower cells becoming shorter towards the apex, margins entire or slightly serrate near apex, costae percurrent to slightly excurrent, smooth on dorsal surface, and apices varying from acute to ± blunt (this variation of the apex is seen even in leaves on the same stem). Also, the leaves of both taxa are similar in cross-section, each possessing one row of guide cells, the dorsal row of cells differentiated, occasionally some ventral cells enlarged and thick cell walls, somewhat bulging between cells, especially in the upper part of the leaf.

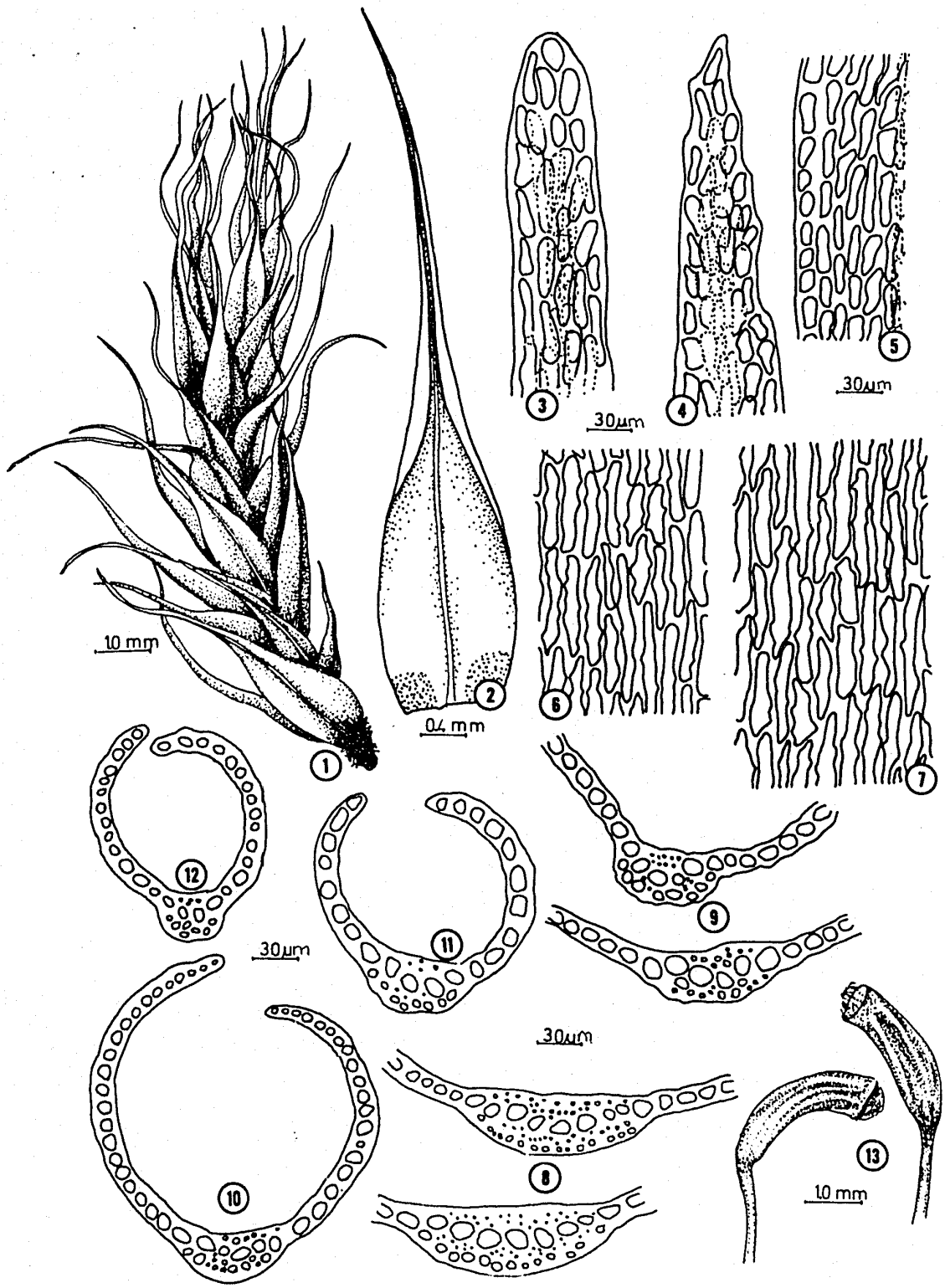
Therefore, D. angustum is included within the specific limits of D. spadiceum. North American-wide studies are required to determine if any valid specific differences exist between these two described taxa.

The description of Dicranum angustum Lindb. can easily fit a number of species and there is no mention of blunt leaf apices which one usually associates with the concept of this species. The type of D. laevidens consistently blunt leaf apices, thick cell walls and costae with thin stereid bands. It is possible that D. laevidens is different from D. spadiceum and D. angustum, therefore, deserving specific rank.

SELECTED SPECIMENS EXAMINED

NEW QUEBEC: Vicinity of Gerin Mountain, 55°04'N-67°14'W, Viereck 706 (CANM)*. Baie de James 53°28'N-70°42'W, Majcen QFB-E 4296 (CANM). Manitounuk Sound, 55°21'N-77°46'W, Kucyniak & Tuomikoski K-550 (CANM)*. Lac de Freneuse 58°26'N-69°18'W, Ducruc 73-2822 (CANM). Goose Bay, 53°55'N-79°08'W, Kucyniak & Tuomikoski T 589 (CANM). Long Island Sound 54°45'N-79°32'W, Tuomikoski T 890 (CANM).

PLATE# 19: Dicranum spadiceum 1.- Habit of upper portion of stem (dry). 2.- Stem leaf. 3-4.- Apices. 5.- Upper leaf cells. 6.- Median leaf cells. 7.- Lower leaf cells. 8.- Lower leaf cells in cross-section. 9.- Median leaf cells in cross-section. 10-12.- Upper leaf cells in cross-section. 13.- Capsules (dry).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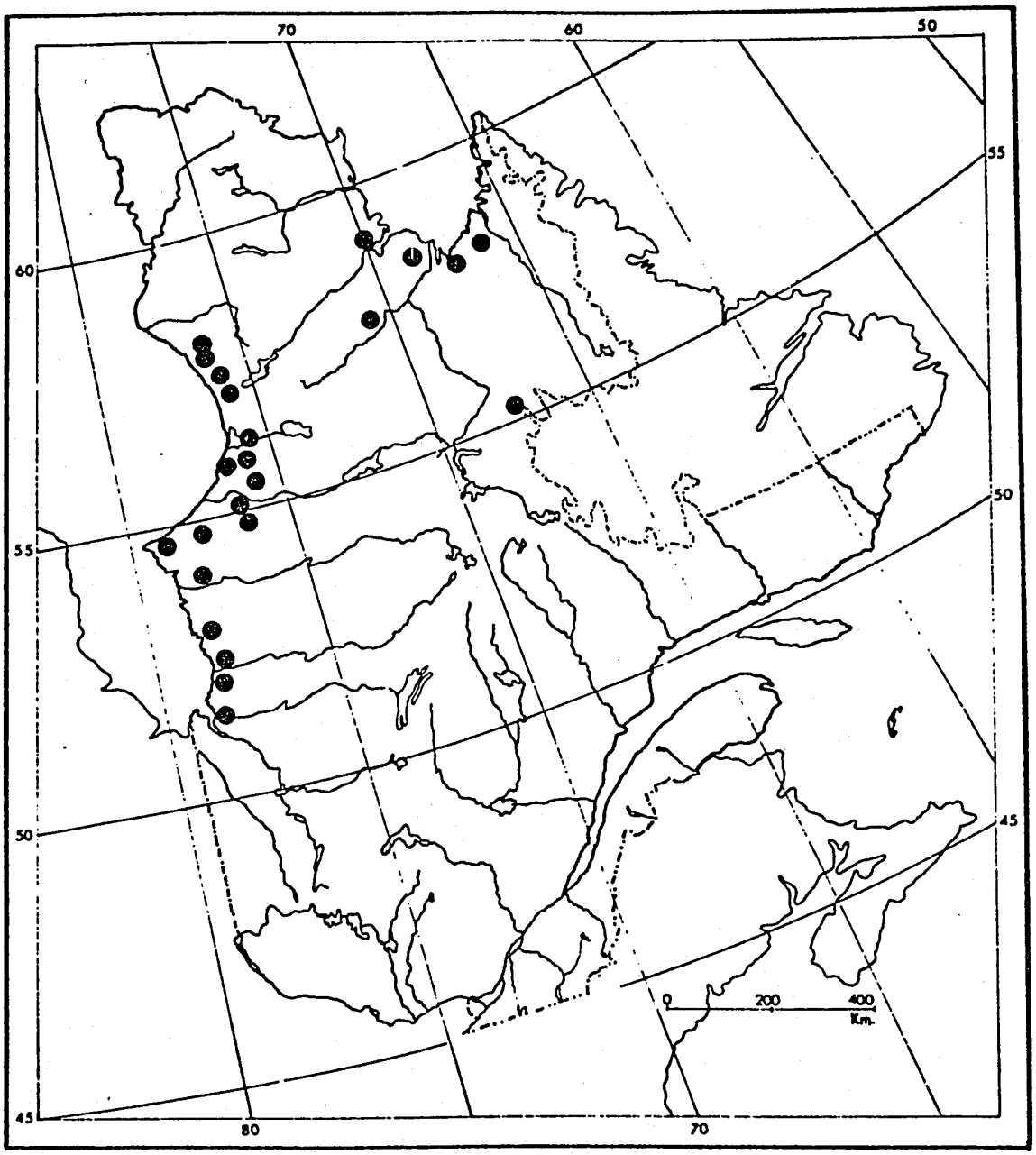


Map #19: Distribution of Dicranum spadiceum in Quebec.

20.-Dicranum leioneuron Kindb.in Macoun, Bull.Torr.Bot.Cl.16:92.1889.

Dicranum bonjeanii var. anomalum C.Jens.in Warnst.,Krypt.Fl. Brandenbourg 2:151.1904
Dicranum bonjeanii var. integrifolium Lindb.in Bauer, Lotos Prag 53:227.1905.
Dicranum bonjeanii var. tenuinerve Mik., Bryoth.Balt.78.1909.
Dicranum bonjeanii var. integrum Broth., Sched.Bryoth.Fenn.4: 3.1916.nom.nud.

Plants in loose tufts, yellowish green, glossy. Stems 5-8 cm high, scarcely tomentose. Leaves erect or spreading, slightly rugose, upper leaves with twisted apices when dry, (3.5)5-7 (8.0) mm long, concave below, tubulose above, from an ovate-lanceolate base to a long or short subula, broadly acute, some leaves short, ovate, blunt, in the middle or lower part of stems; margins not or slightly serrate in the upper part; somewhat involute in the middle part; laminae unistratose; costae ending below the apex, 1/8-1/13 the width of the leaves at base, smooth or slightly rough above on dorsal surface; leaf cells smooth; alar cells bistratose, differentiated; lower cells elongate-sinuose, pitted, (7) 8-10 (16) µm wide and (42) 75-77 (107) µm long; upper cells short, sinuose, pitted, (7) 9-13 (16) µm wide and (16) 30-65 (79) µm long. Leaves in cross-section with a row of guide cells, two stereid bands, no differentiated dorsal or ventral rows of cells or sometimes a few dorsal enlarged, cell walls between cells not bulging.

Pseudomonoicous. Dwarf males on rhizoids of female plants. Sporophytes unknown in Quebec plants. Setae solitary, 2-5 cm high. Capsules yellow, arcuate, erect to inclined, ±furrowed when dry,

2.5-3.0 mm long.

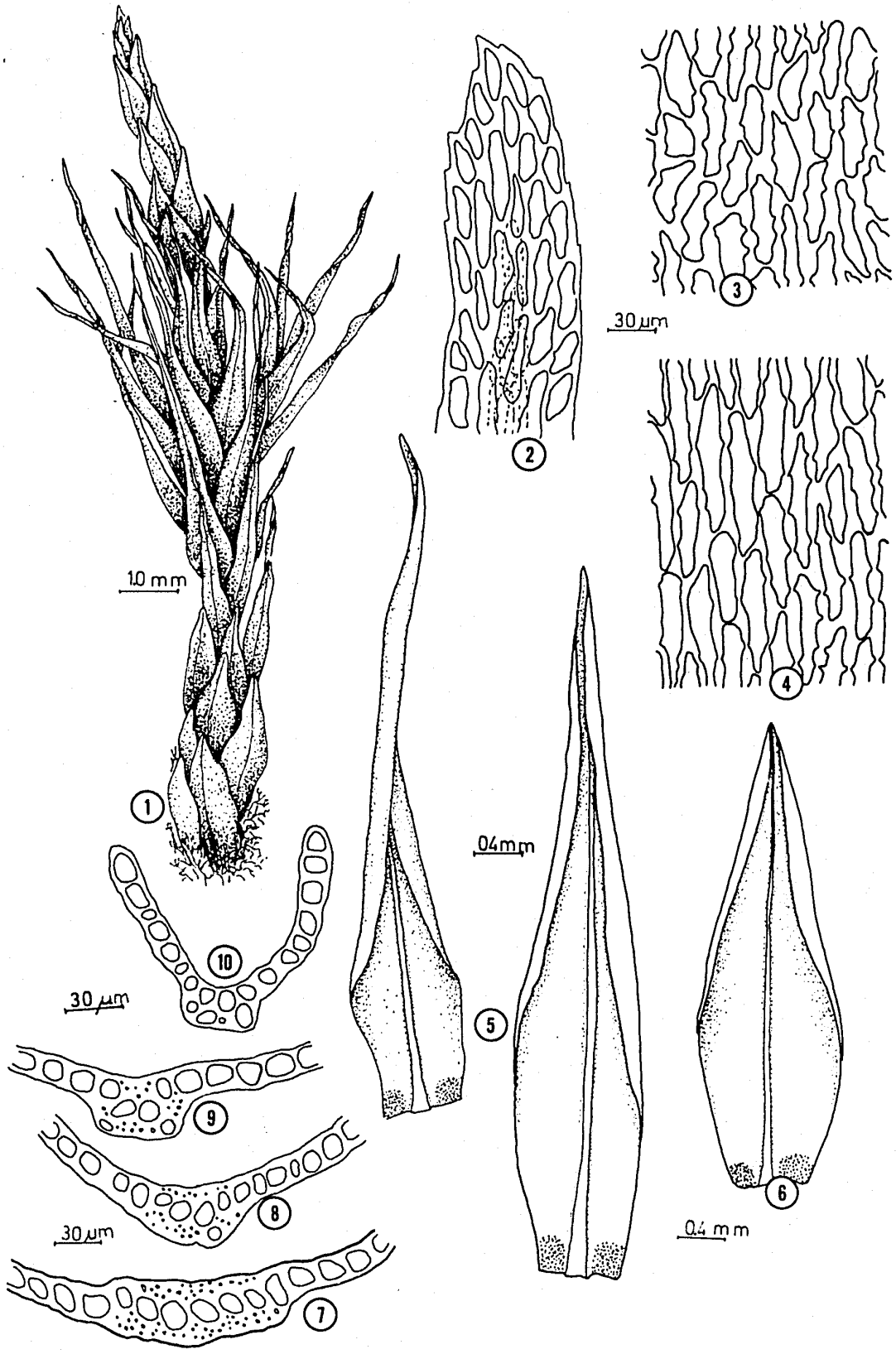
Primarily in ombrotrophic and oligotrophic peatlands. Not common in Quebec and found mainly below 52°N latitude. According to Ahti & Isoviita (1962) its distribution is very poorly known at present, having oceanic and suboceanic tendencies on both sides of the Atlantic. Known from Newfoundland, Prince Edward Island, Nova Scotia, Quebec, and Ontario. Northwestern Europe.

This species appears to be closely related to D. bonjeanii, although it does not intergrade freely with it like D. bonjeanii does with D. scoparium. The twisted apices of the upper leaves when dry, the abnormal leaves that are broad, short and blunt in the middle or lower part of the stem, make this species easy to recognize. Dicranum leioneuron has not been found with sporophytes in Quebec. The description of the sporophyte was based on Ontario plants.

SELECTED SPECIMENS EXAMINED

GASPE WEST: Mont Jacques-Cartier, Boudreau 29.2 (CANM)*. KAMOURASKA: Rivière Ouelle, 47°27'N-69°56'W, Gauthier 5986-9 (QFA). MADELEINE ISLANDS: Amherst Island, Reilly 1095 (CANM)*. Alright Island, Reilly 1104 (MICH). SAGUENAY: Grenier, 49°55'N-67°02'W, Comeau 297 (CANM). Manicouagan, 49°09'N-68°16'W, Comeau 228 (CANM)*. Betsiamites, 48°53'N-68°48'W, Comeau 204 (CANM).

PLATE #20: Dicranum leioneuron 1.- Habit of upper portion of stem (dry). 2.- Apex of normal leaf. 3.- Upper leaf cells. 4.- Lower leaf cells. 5.- Stem leaves (dry). 6.- Abnormal leaf. 7.- Lower leaf cells in cross-section. 8-9.- Median leaf cells in cross-section. 10.- Upper leaf cells in cross-section.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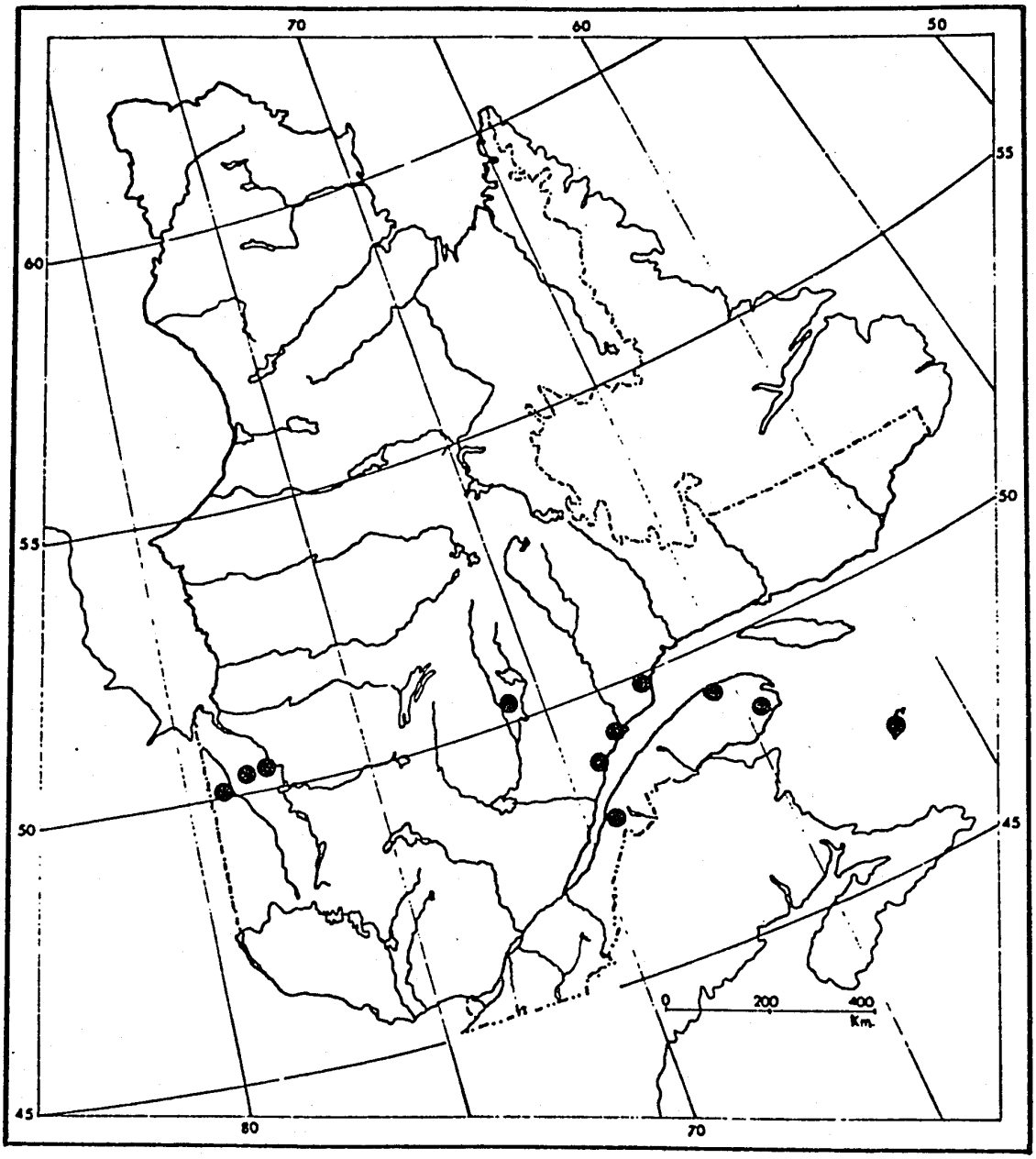


Map #20: Distribution of Dicranum leioneuron in Quebec.

21.- Dicranum bonjeanii De Not.in Lisa, Elenco Muschi Torino 29.1837.

Dicranum palustre B.S.G., Bryol.Eur.1:143.79.1847(fasc.37-40. Mon.39.31)hom.illeg.
Dicranum diptoneuron C.Muell., Flora 70:221. 1887.
Dicranum plano-alare C.Muell.et Kindb.in Macoun,Cat.Canad.Pl. 6.:31.1892.
Dicranum undulifolium C.Muell.et Kindb. in Macoun, Cat.Canad.Pl. 6:32.1892.
Dicranum subpalustre C.Muell.et Kindb. in Macoun, Cat.Canad.Pl. 6:33.1892.
Dicranum roelli (Barnes)Kindb., in Roell, Hedwigia 35:60.1896.
Dicranum hyalinum Kindb. in Roell, Hedwigia 35:61.1896.
Dicranum perichaetiale Kindb. in Roell, Hedwigia 35:61.1896.hom.illeg.

Plants in loose tufts, yellow to yellowish green, glossy. Stems 5-8 cm high, scarcely tomentose. Leaves erect, undulate or rugose, (3.5) 4.0-5.5 (6.0) mm long, flat to ± concave below, subtubulose above, from a lanceolate base to a short, broadly acute apex upper part of stem often with ovate, short-subulate, blunt leaves; margins serrate in the upper half; laminae unistratose; costae ending slightly below the apex, sometimes with two poorly developed toothed ridges above on dorsal surface, 1/8-1/13 the width of the leaves at base; leaf cells smooth; alar cells bistratose, well-differentiated; lower cells long, sinuose, pitted, (5) 9-11 (14) µm wide and (28) 47-71 (113) µm long; upper cells short-linear, sinuose, pitted, (5) 8-14 (20) µm wide and (25) 36-51 (73) µm long. Leaves in cross-section with a row of guide cells, two thin stereid bands, few (usually two) dorsal cells differentiated in upper part of the leaves, cell walls between cells not bulging.

Pseudomonoicous. Dwarf males on rhizoids of female plants. Setae solitary, 2.5-3.5 cm long. Capsules yellow-brown, arcuate, inclined,

striate when dry, 2.5-3.0 mm long. n = 12,11.

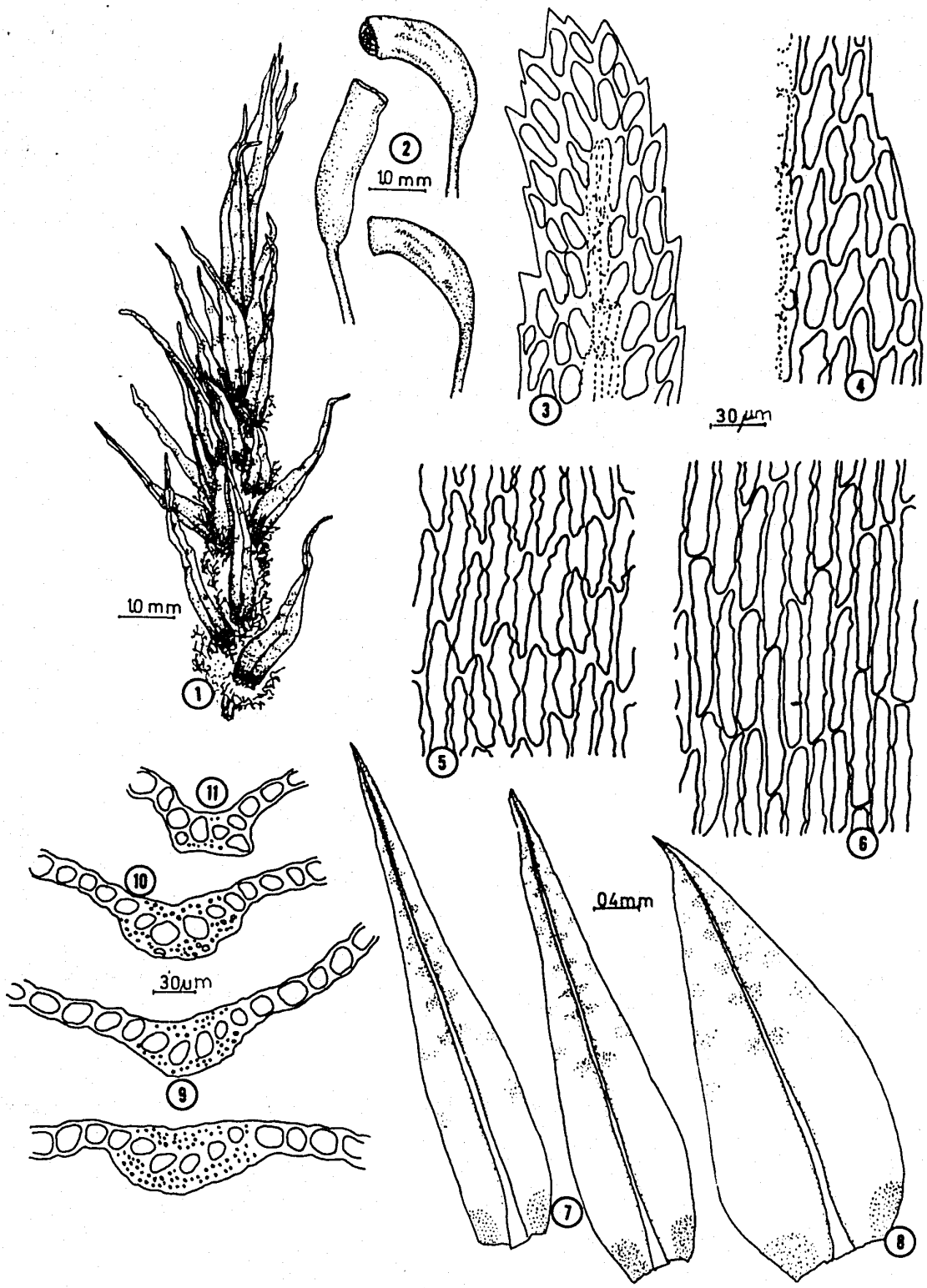
Growing mainly in fens, sometimes on wet soil. Not common in Quebec, mainly above latitude 50°N, and a few scattered regions in the south of the province. Labrador to Alaska, south to Virginia, Ohio and Colorado. Europe and Asia.

This species has many morphological features that intergrade freely with D. scoparium (see discussion under it).

SELECTED SPECIMENS EXAMINED

DEUX MONTAGNES: Oka, Dupret 18-9-1906 (CANM)*. KAMOURASKA: Rivière Ouelle, 47°27'N-69°56'W, Gauthier 5879-3 (QFA)*. NEW QUEBEC: Richmond Golf, Payette 239-2b (CANM). Goose Bay, 53°55'N-79°08'W, Kucyniak & Tuomikoski K 254 (CANM). Great Whale River 55°14'N-77°23'W, Tuomikoski T 2014 (CANM). SAGUENAY: Mingan Islands, Ile a la Proie, Marie-Victorin & Rolland-Germain 49-569 (MICH)*.

PLATE #21: Dicranum bonjeanii 1.- Habit of upper portion of stem (dry). 2.- Capsules (dry). 3.- Apex. 4.- Upper leaf cells. 5.- Median leaf cells. 6.- Lower leaf cells. 7-8.- Stem leaves. 9.- Lower leaf cells in cross-section. 10.- Median leaf cells in cross-section. 11.- Upper leaf cells in cross-section.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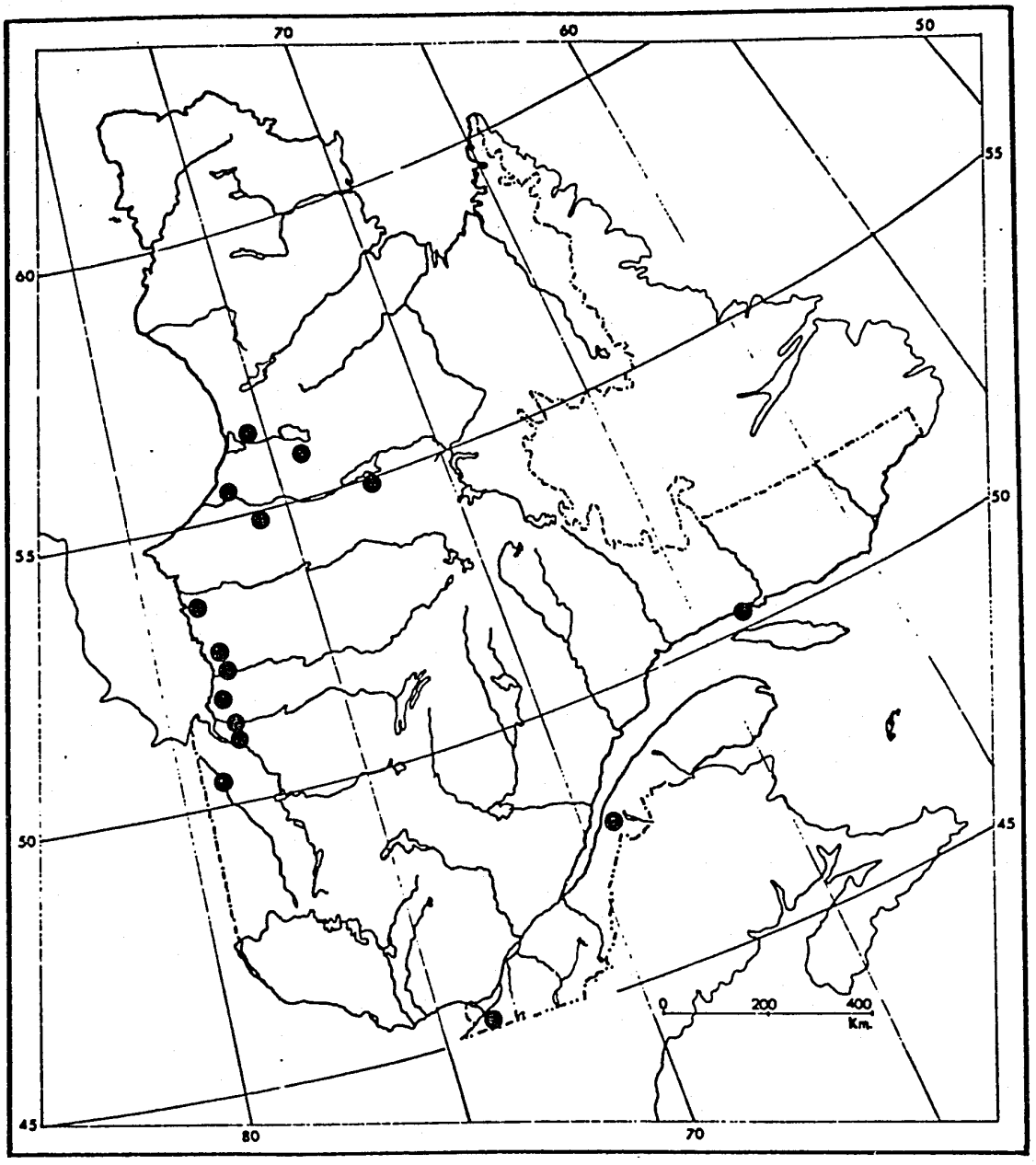

Map # 21: Distribution of Dicranum bonjeanii in Quebec.

D.- Excluded Taxa

1.- Dicranum tauricum Sap., Bot.Jahrb.46.Beible.105.10.2f.19.1911.
Dicranum strictum Schleich.ex Mohr, Ann.Bot.2:546.1806.hom.illeg.

Dicranum tauricum was reported from Quebec by E. Lepage in 1945 (as D. strictum Schleich.ex Mohr). Although this specimen was not seen its occurrence in Quebec is doubtful since D. tauricum is known to be a species of western North America.

2.- Kiaeria glacialis (Zett.)Hag., K.Norsk.Vid.Selsk.Skrift.1914(1): 118.1915.
Dicranum arcticum Schimp., Musci Eur.Nov.Bryol.Eur.Suppl.fasc. 3-4 Mon.Dicranum 3.3.1866.

Dicranum arcticum Schimp., which was reported from Quebec by E.Lepage (1945), is presently considered a synonym of Kiaeria glacialis (Zett.)Hag. An examination of the type of D. arcticum Schimp. collected in Dovre, Nistuhoe, 6-8-1858 by J.E. Zetterstedt (BM), revealed that this species should not be included in the genus Dicranum. The main reasons for including it in Kiaeria are its monoicous condition and its costa which sometimes has a few stereid cells, but they do not form a definite band above and below the guide cells as in Dicranum.

IV.- DISCUSSION

A.- Diagnostic Characters of Dicranum

Some specific diagnostic characters used in other genera, such as rhizoids, stem cross-sections, alar cells, perichaetial leaves, annuli, colour of setae, spores, etc., did not prove to be useful in separating Dicranum species. The characters that seem to be most useful for identifying the species are:

LEAVES:

- Form: Tubulose, subtubulose, keeled; straight, falcate; nature when dry.
- Surface: smooth, undulate, rugose.
- Shape: lanceolate, ovate, ovate-lanceolate.
- Apex:acute, obtuse; broken or not broken.
- Costa: percurrent, subpercurrent, excurrent; with or without dorsal lamellae.
- Margin: entire, dentate, serrate, serrulate; bistratose, unistratose.
- Cells: pitted or not pitted; length, width.
- Cross-section: cell walls between cells bulging or not; number of rows of guide cells; differentiation of dorsal and ventral cells.

CAPSULES:

- Urn form: straight, arcuate; erect, inclined.
- Neck: strumose or nonstrumose.
- Dry state: smooth, striate, furrowed.
- Number of sporophytes per perichaetium: solitary, aggregate.

Of all the above mentioned morphological characters, the leaf cross-section seems to be an extremely valuable one. Five basic types of cross-sections can be distinguished:

a.- Costa with few dorsal and ventral cells enlarged, one row of guide cells, stereid bands with cells not strongly differentiated, and walls between cells slightly or not bulging. This type of cross-section is present in Dicranum flagellare, D. montanum, D. elongatum, D. groenlandicum, D. fragilifolium, D. viride and D. fulvum (the latter with bistratose regions in the leaf blade).

b.- Costa with a dorsal row of cells differentiated, a few cells or a row of ventral cells enlarged, stereid bands well-differentiated, walls between cells slightly bulging. Two species have this cross-section: Dicranum spadiceum sensu lato, and D. muehlenbeckii (with differentiated ventral row of cells).

c.- Costa with a well-differentiated dorsal row of cells, no ventral cells differentiated, one row of guide cells, two strong, thick and well-developed stereid bands and walls between cells strongly or slightly bulging. This type of cross-section is found in: Dicranum fuscescens, D. acutifolium, D. brevifolium, D. condensatum, D. ontariense, D. undulatum and D. spurium (the first three with bistratose margins).

d.- Costa with well-differentiated dorsal row of cells, double row of guide cells, no ventral cells differentiated, two strong and well-developed stereid bands, and walls between cells not bulging. Dicranum majus belongs here.

e.- Costa with few dorsal cells enlarged (corresponding to the dorsal ridges), no differentiated ventral cells, one row of guide cells, two thin stereid bands, and walls between cells not bulging. This type is

present in Dicranum bonjeanii, D. leioneuron, D. scoparium and D. polysetum.

This grouping of species according to the type of leaf cross-section is very useful when identifying problematic specimens (intergrading forms) that present few typical characters used in the keys and descriptions. The leaf cross-section characters are more stable than other vegetative ones, and it seems that they are not influenced by enviromental factors as much as the other leaf characters (i.e. undulations, curvature of leaves, nature of leaves when dry, etc.). The use of the leaf cross-section can be especially useful in the identification of plants present in fossil samples. It is possible that after further investigation of these features, a key can be made on the basis of only leaf cross-section characters.

B.- Dicrana Distribution in Quebec

The distribution of the Dicrana in Quebec can be usefully categorized as follows: Southern (below 52° N), Northern (above 52° N), Widespread and Oceanic. However, species growing in the northern regions of Quebec may be also found at high elevations in the southern part of the province, Dicranum elongatum, D. groenlandicum and D. acutifolium, for example, are found in the Gaspé Peninsula at high elevations on Mont Albert and Mont Jacques-Cartier.

C.- Table of Species Comparison

The following table summarizes some outstanding and easily observed characters of the Dicranum taxa. These taxa are assembled in five groups based on capsule shape, leaf cells and upper leaf form. These groups are merely a convenient and simple way to categorize the taxa and they do not represent an infrageneric system of classification for Dicranum.

The groups are the following:

GROUP A: Capsules straight; lower and upper leaf cells not pitted, leaves tubulose to subtubulose.

GROUP B: Capsules arcuate; lower leaf cells pitted, upper leaf cells not pitted; leaves tubulose.

GROUP C: Capsules arcuate; lower leaf cells pitted, upper leaf cells not pitted, leaves keeled.

GROUP D: Capsules arcuate; lower and upper leaf cells pitted, leaves tubulose to subtubulose.

GROUP E: Capsules arcuate; lower and upper leaf cells pitted, leaves keeled.

TABLE OF SPECIES COMPARISON

Taxon	Relative Abundance	General Distribution	Dry Leaf Habit	Leaf Form	Special Features
GROUP A: Capsules straight; lower and upper leaf cells not pitted, leaves tubulose to subtubulose.					
montanum	common	south	crisped	secund	leaves strongly papillose above on dorsal surface
flagellare	common	south	crisped	secund	with clusters of flagelliform branchlets in leaf axils
fulvum	abundant	south	crisped	secund	wide costae (1/3-1/4 the width of the leaves at base)
viride	abundant	south	erect	straight	broken leaf tips
GROUP B: Capsules arcuate; lower leaf cells pitted, upper leaf cells not pitted, leaves tubulose.					
fragilifolium	rare	north	erect	secund	broken leaf tips
elongatum	common	north or high elev.	erect-flexuose	straight	leaves with thick upper cell walls, cells pitted below the middle
groenlandicum	abundant	north or high elev.	erect	straight	blunt leaf apices, leaf cells pitted above the middle
muehlenbeckii	rare	north	crisped	falcate	long capsules (4mm long), costa in cross-section with differentiated ventral cells

GROUP C: Capsules arcuate; lower leaf cells pitted, upper leaf cells not pitted, leaves keeled.

Taxon	Relative Abundance	General Distribution	Dry Leaf Habit	Leaf Form	Special Features
brevifolium	rare	north	crisped	falcate, undulate	incurved median leaf margins, strong bulging of leaf cell walls
fuscescens	common	widespread	crisped	secund	strumose capsules; bistratose margins
fuscescens var. flexicaule	rare	north or high elev.	flexuose	falcate-secund	stems 8-18 cm long, sparcely foliate, long setae, 2.5-3.5 cm long
acutifolium	abundant	north or high elev.	flexuose	falcate, undulate	forked stems; strong bulging of leaf cell walls
ontariense	common	south	crisped	falcate, undulate	polysetous; stems densely tomentose
spurium	rare	south	crisped-incurved	rugose-undulate	leaves ovate-lanceolate; stems interruptedly foliate
condensatum	rare	south	flexuose	straight	on sandy soil
undulatum	common	widespread	erect-flexuose	falcate, undulate	blunt leaf apices, costae subpercurrent; mainly in bogs

GROUP D: Capsules arcuate; lower and upper leaf cells pitted, leaves tubulose to subtubulose.

Taxon	Relative Abundance	General Distribution	Dry Leaf Habit	Leaf Form	Special Features
majus	abundant	oceanic	flexuose	falcate-secund	polysetous; leaves up to 12 mm long, costae with double row of guide cells
majus var. orthophyllum	rare	north	erect	straight	polysetous; costae with double row of guide cells
spadiceum	abundant	north	erect-flexuose	straight	long acute to blunt leaf apices
leioneuron	rare	south	erect	straight	twisted apex of upper leaves when dry; stems with short-leaved flagellary shoots
bonjeanii	rare-abundant	widespread	erect	undulate	in fens; leaves flat
GROUP E: Capsules arcuate; lower and upper leaf cells pitted, leaves keeled.					
scoparium	common	south or north-coast	crisped	falcate-secund	costae with 2-4 dorsal toothed lamellae
polysetum	common	south	spreading	undulate	polysetous; strongly undulate leaves; stems densely tomentose

D.- Some Considerations of the Genus Dicranum

Most specimens of Dicranum collected in southern Quebec's boreal forest do not present problems in identification since they are usually close to the "typical" concept of the species. Nevertheless, the differences between the forms of some species are few and often insignificant, sometimes resulting in apparent intergrades that make their identification difficult and suggest a slight genetic separation. These intergrading forms are usually found in habitats other than their usual ones. Some forms of Dicranum fuscescens, D. scoparium and D. majus all present intergrading characters that make them difficult to place. Slightly undulate forms of D. fuscescens with crisped, strongly papillose leaves intergrade with D. ontariense on the one hand, while on the other hand extremely small forms can be confused with D. montanum. A more problematic species is D. scoparium which has some forms very close to normally developed plants of D. majus and other forms that intergrade freely with D. bonjeanii. If one looks at the extremes of the two forms they are very different in leaf habit; the form close to D. majus has long, falcate-secund, acuminate leaves with strongly dentate margins and the form close to D. bonjeanii has short, straight, blunt leaves with weakly dentate margins. Dicranum undulatum typically grows on open peat bogs, but plants growing in more xeric conditions have a percurrent costa and a long narrow, acute subula (compared with the typical subpercurrent costa and the broad, short,blunt, subula) making them difficult to separate from D. ontariense when not producing sporophytes. Dicranum viride sometimes has the leaf tips

attached, making it difficult to distinguish from D. fulvum. Similar problems of intergradation exist between D. elongatum and D.groenlandicum. These intergrading forms may be young species in changing and adapting processes or, more likely, they could be forms modified by the environment.

When growing D. scoparium in an environmental chamber at 10°C, 250-280 fc light intensity and a 12/12 hours light regime, the growth pattern of the new shoot on the stems is different from the old growth on the plant. The new leaves are scattered on the stems, and they are undulate and crisped, although the dentations remain strong. Because this experimental growth study of D. scoparium was not planned for this taxonomic study, no quantitative results are available. It seems possible, therefore, that many forms and possibly some varieties simply represent habitat induced morphotypes rather than discrete genotypic taxa. This may account for the variability of some species such as D. scoparium and D. fuscescens.

A high percentage of the arctic Dicrana are taxonomically difficult. They exhibit a broad range of variability and lines of intergradation among them can be established. This suggests a possible genetic plasticity in these species, or that they are recent taxa which have evolved during postglacial times (Crum, 1966). This, together with the slow speciation of mosses (Crum, 1972; Anderson, 1963), may explain the difficulty in placing them in one taxon or another. It is interesting to note that most species collected in the northern regions of

Quebec tend to have similar growth habits. The plants are small, usually with straight leaves that are not crisped when dry, and they produce abnormal shoots with short, blunt leaves (e.g., D. elongatum, D. spadiceum and D. scoparium). They often grow in dense tufts intermixed with leafy liverworts.

The form of D. spadiceum with leaves that have a blunt, entire apex requires further study. It is possible that D. laevidens Williams, which is placed in synonomy under D. spadiceum sensu lato in the present study, should be reestablished as a valid species. However, in general, the arctic and subarctic Dicrana occurring in North America need much more study so that complexes, such as D. spadiceum-D. angustum-D. majus var. orthophyllum - D. laevidens, can be understood more clearly.

E.- Additional Studies Required in Dicranum

Cytotaxonomic work in Dicranum may prove to be helpful in clarifying the status of certain taxa such as Dicranum bonjeanii, D. fuscescens var. flexicaule, D. majus var. orthophyllum and the northern complex D. spadiceum- D. angustum - D. laevidens. There is not enough chromosome data of the species of Dicranum to be used as a taxonomic tool. It would be beneficial to have chromosome counts of different populations including the typical and intergrading forms of the different species.

The principal taxonomic difficulties in Dicranum remain in the northern taxa. Several moss collections were made in recent years in northern Quebec, but, unfortunately, a great number of them were not for taxonomic purposes so that numerous collections are represented by poor specimens with insufficient information. It is necessary for bryologists to make collecting trips to northern Quebec to observe the species in the field in order to learn more about their habitat preferences, associations, patterns of growth, etc., to help clarify these problems.

The nomenclature of Dicranum needs to be revised. This would require the examination of all types, the majority of which are in European herbaria.

The variability of some species, such as Dicranum scoparium, D. fuscescens, D. elongatum, D. groenlandicum and others, indicates the importance of starting experimental growth studies and observing these species under controlled enviromental conditions to establish their limits of variability. Briggs (1965) showed that the British populations of four species of Dicranum (D. bonjeanii, D. fuscescens, D. majus and D. scoparium) exhibit a wide phenotypic plasticity, and he reported distinct genotypes in D. fuscescens and D. scoparium. Further work is essential to understand the variation of Dicranum populations.

Finally, there is a need to revise the genera in the family Dicranaceae, especially the arctic Kiaeria, which contains some species (e.g., Kiaeria glacialis (Berggr.)Hag.) that are close to Dicranum species.

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