

Key to European *Dicranum* species

Lars HEDENÄS & Irene BISANG

Abstract: HEDENÄS, L. & BISANG, I. 2004. Key to European *Dicranum* species. – Herzogia 17: 179–197.

A key to the twenty-nine European *Dicranum* species is presented. The features that are important for their identification are discussed. For each species, diagnostic character states and information about habitat and geographical distribution are provided. Most critical characters are illustrated.

Zusammenfassung: HEDENÄS, L. & BISANG, I. 2004. Bestimmungsschlüssel für die *Dicranum*-Arten Europas. – Herzogia 17: 179–197.

Ein Schlüssel für die neunundzwanzig *Dicranum*-Arten Europas wird vorgestellt. Die zur Bestimmung der Arten wichtigen Merkmale werden diskutiert. Für jede Art werden die diagnostischen Merkmale beschrieben sowie Standortansprüche und geographische Verbreitung dargestellt. Die meisten der kritischen Merkmale sind abgebildet.

Key words: Dicranaceae, identification guide, mosses.

Introduction

Members of the genus *Dicranum* are widespread all over Europe. At the same time some species have become rare, and in some cases even endangered in those parts of the continent that are most heavily influenced by human activities. Most of the almost thirty European species are relatively large in size and several of them frequently cover large patches of their substrates. Many species are therefore quantitatively important, especially in forest and mountain habitats. A number of species seem to have special and relatively narrow habitat requirements and can therefore function as indicators for specific conditions, at least in certain regions.

In view of this, the role of *Dicranum* species in nature appears to be an evident target for in-depth studies in the fields of ecology and nature conservation. However, the frequently contradicting information that is provided in the literature regarding which species to recognise, how to separate several species, and the frequently quantitative distinguishing characters often hamper the identification of members of *Dicranum*.

In the present overview, a total of twenty-nine species are recognised in Europe. Problematic taxa are discussed in the notes after the key.

Important characters

Species of *Dicranum* are usually recognised as such by their typically large size and their narrow, lanceolate leaves that are more or less gradually narrowed towards the leaf apex, a long, single costa, and in most species well differentiated alar groups. The leaves may be straight, but are frequently homomallous to falcate, and the colour is mostly a rather deep and clear green. Members of a few other genera of the family Dicranaceae are also relatively large, and are superficially similar to *Dicranum* species in habit. Most species of *Dicranodontium*, *Campylopus* and *Paraleucobryum* have got broader costae than most *Dicranum* species, and in addition the

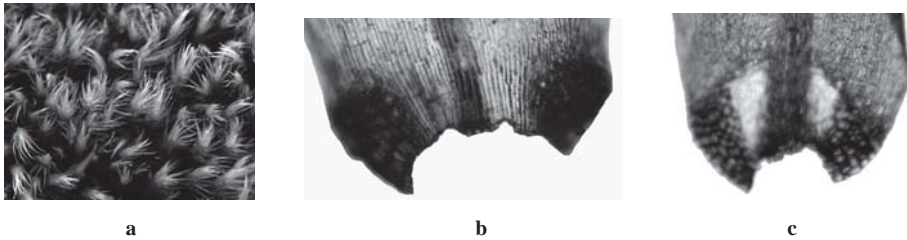


Fig. 1: a – *Kiaeria glacialis*, habit (moist), b – alar groups, c – *Dicranum angustum*, alar groups.

anatomy of the costa is different (NYHOLM 1987). A northern European species that is now and then misidentified as a *Dicranum* is *Kiaeria glacialis* (Berggr.) I. Hag. (fig. 1a), but this species is autoicous and has differently organised alar cells (fig. 1b) compared to those *Dicranum* species with which it could be confused. Especially, the alar cells are unistratose (in *Dicranum* found only in *D. montanum*, *D. flagellare*, and *D. tauricum*), and the inner alar cells never get thin and translucent (fig. 1c) like in the *Dicranum* species with which it can be confused.

Capsule orientation

Within the genus *Dicranum*, few sporophytic characters are useful for species identification. Since *Dicranum* species are dioicous and many species therefore relatively rarely produce sporophytes, one cannot rely only on sporophytic features for their identification. Thus, a key that separates $1/5$ of the species from the rest only by the orientation of the spore capsule (fig. 2), such as the one in NYHOLM (1987), is useless for most specimens.

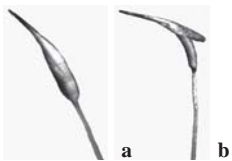


Fig. 2: a – Straight and erect spore capsule in *Dicranum scottianum*; b – curved, asymmetric capsule in *D. scoparium*.

Dwarf male plants

Many *Dicranum* species have dwarf male plants (fig. 3) that grow on or among the leaves, or in the frequently present dense rhizoids on the stems of the female plants. Male plants of about the same size as the female plants are found in *D. elongatum*, *D. flagellare*, *D. flexicaule*, *D. fragilifolium*, *D. fulvum*, *D. fuscescens*, *D. groenlandicum*, *D. montanum*, *D. scottianum*, *D. tauricum*, and *D. viride*, and probably in *D. canariense* and *D. laevidens* as well. In *D. scoparium*, both dwarf and normal-sized males occur, while the remaining species have only dwarf male plants.

Plant size

A feature that aids in the identification of some species is the overall plant size. While among most species the plants are of approximately the same size, those of *D. majus* (fig. 43), *D. drummondii* and *D. polysetum* are generally markedly larger than in the other species, whereas *D. montanum* (fig. 44) and *D. flagellare* have considerably smaller plants than the remaining ones.

Flagellae

Flagellae are shoots or shoot portions with small and more or less closely imbricate leaves. Such shoots may arise in the leaf axils or may consist of the upper, transformed parts of shoots that look normal below. Flagellae occur with different frequencies in all *Dicranum* species. In species such as *D. leioneuron* and *D. flagellare* they are almost invariably present, in other ones, like *D. bonjeanii* and *D. scoparium*, they are seen now and then, while in most species they are rare.



Fig. 3: Dwarf male plant in *Dicranum spurium*.

Vegetative leaf characters

Most of the characters that are useful for the identification of *Dicranum* taxa are found in the vegetative leaves. Besides leaf shape and whether the lamina is transversely undulate or not, a number of features related to the lamina cells are important. We would like to stress that it is important to study numerous leaves in order to correctly judge their characters. This especially concerns the lamina cell appearance.

Leaf orientation. Leaf orientation is one of the most useful characters for the recognition of many species, especially in the field. When moist, species like *D. undulatum* have mostly got all leaves erect, whereas in *D. polysetum* only the upper leaves are erect, and most leaves are spreading. Both these species have got straight or slightly curved leaves whereas, for example, *D. majus* and *D. fuscescens* have mostly got strongly falcate leaves. In some species, such as *D. scoparium*, straight- and falcate-leaved types are both frequent. Leaf orientation frequently differs between moist and dry plants, for example, in *D. brevifolium*, which has more or less secund leaves when moist and strongly curled ones when dry.

Transverse section of leaf and costa. The shape of transverse sections made in the upper portion of the leaves is sometimes diagnostic. In some cases, such as when tubular and flat leaves are compared, the shape of the section can be guessed from observations of the entire leaves. In other cases, it is necessary to really make sections, for example, to see the tongue-shaped sections of *D. brevifolium* and a few other species. Also the costal anatomy (fig. 4) can be crucial for the recognition of certain species. Especially, the presence or absence of stereid cells and how well the epidermal cells are differentiated is of interest. In a few species two or more lamellae are present on the back of the costa. Such structures are well developed in *D. scoparium* and closely related taxa.

Leaf lamina cells. Starting from the leaf base, the alar cells are usually at least partly bistratose, but as mentioned above, *D. montanum*, *D. flagellare*, and *D. tauricum* have unistratose, and *D. dispersum* has partly 3(–4)-stratose alar groups. Also the lamina cells further up may be bistratose, and are regularly so in several species, at least along the upper margins. Cell size is usually either too variable or too similar among species that are problematic to separate to be useful for their identification. On the other hand, both cell shape and cell wall thickness are frequently diagnostic. Both these features are sometimes difficult to estimate without some experience, and have therefore been illustrated in the key when relevant. Other lamina cell features that are sometimes important for the recognition of species are the frequency and development of pores in the cell walls, whether mammillae or spines are present on the dorsal side of the lamina, and whether the cell walls are projecting (seen in transverse sections of the lamina).

Leaf margin. In the present key denticulate means that cell portions form the ‘teeth’ of the leaf margin, whereas dentate implies that entire cells form the ‘teeth’.



Fig. 4: Transverse section of costa in **a** – *Dicranum tauricum*, **b** – *D. viride*; **c** – *D. scottianum*.

Key to the European *Dicranum* species



Fig. 5a
(dry)



Fig. 5b
(dry)



Fig. 6

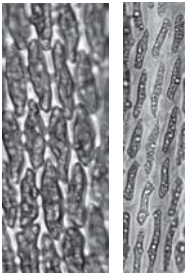


Fig. 7

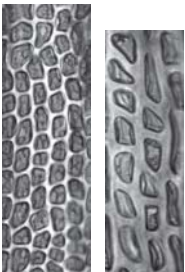


Fig. 8

- 1 Leaves stiff and fragile, in at least upper part of shoot straight and erect (fig. 5a), upper leaf portions very narrow and tips frequently broken (fig. 5b) 2
- 1* Leaves in upper part not at the same time fragile, straight and erect, upper leaf portions not markedly narrow 4
- 2 Costa in basal portion lacking stereid bands (fig. 4a), with up to 1–2 cell layers above and below guide cells; basal lamina cells narrowly rectangular to linear, eporose; alar cells unistratose (fig. 6). Capsule straight and erect, or almost so *D. tauricum*
- 2* Costa in basal portion with stereid bands, sometimes weak, with up to 2–3(–4) layers of cells above and below guide cells; basal lamina cells elongate and porose or rectangular and eporose; alar cells mostly bistratose at least in parts, rarely entirely unistratose. Capsule straight and erect or asymmetrical and curved 3
- 3 Epidermal cells of costa not differentiated from stereids; basal lamina cells narrowly rectangular to linear, more or less porose; lamina mostly unistratose. Capsule asymmetrical and more or less curved *D. fragilifolium*
- 3* Epidermal cells of costa wider than stereids, at least on dorsal side; basal lamina cells rectangular, not or hardly porose; lamina above in parts bistratose. Capsule straight and erect, or almost so *D. viride*
- 4 Cells in upper leaf mainly prosenchymatous, elongate and porose (fig. 7) 5
- 4* Cells in upper leaf mainly parenchymatous, quadrate or rectangular, rarely elongate-rectangular, with or without pores (fig. 8). (Note that in *D. spadiceum* the parenchymatous cells are sometimes restricted to the uppermost part of the acumen, at least in some leaves) 13
- 5 Leaves straight, in upper part more or less tubular (fig. 9a; transverse section); apex rounded (fig. 9b) or obtuse, sometimes acute (fig. 9c); margin entire throughout or sometimes with a few obtuse denticles near apex 6
- 5* Leaves falcate or straight, in upper part flat or channeled (e.g. fig. 12), apex acuminate; margin above finely to coarsely denticulate 8
- 6 Plants in dense, compact tufts (usually so dense that it is difficult to press your finger into the tuft). Peristome papillose *D. groenlandicum*
- 6* Plants in loose tufts. Peristome papillose or smooth 7
- 7 Almost invariably with flagellae having small, crowded, imbricate leaves. Leaf acumen relatively short and broad; costa with or without two weak and, when seen in transverse section, obtuse ridges. Peristome papillose *D. leioneuron*
- 7* Flagellae extremely rare. Leaf acumen long and narrow; costa without ridges. Peristome smooth *D. laevidens*

- 8 Costa above with two lamellae or ridges on back 9
- 8* Costa above with at least four lamellae or numerous ridges or furrows on back (at least in some leaves) 10
- 9 Costal lamellae tall; leaf lamina strongly transversely undulate; margin in upper part spinosely denticulate or dentate. Apical leaves erect, leaves below spreading (fig. 10) *D. polysetum*
- 9* Costal lamellae low or weakly developed; leaf lamina more or less strongly transversely undulate (at least in some leaves); margin obtusely to sharply denticulate. Orientation of apical leaves and leaves further down not clearly different *D. bonjeanii*
- 10 Costa above with numerous furrows or low ridges; leaf lamina cells in transverse section mostly rectangular (longest in direction from costa to leaf margin) *D. majus*
- 10* Costa above with distinct lamellae (fig. 11; right: upper costa seen from dorsal side); leaf lamina cells in transverse section mostly approximately quadrate 11
- 11 Leaf lamina unistratose *D. scoparium*
- 11* Leaf lamina above partly bistratose, or in spots tristratose 12
- 12 Leaf lamina spinose on back (fig. 12); upper leaf margin spinose-dentate *D. transylvanicum*
- 12* Leaf lamina smooth (fig. 13); upper leaf margin denticulate to dentate *D. crassifolium*
- 13 Upper leaf lamina in at least some leaves rugose, or more or less transversely undulate (dry and wet) 14
- 13* Upper leaf lamina neither rugose nor undulate 16
- 14 Leaf lamina rugose, in upper leaf on back with spine-like (fig. 14) or conically projecting cells; basal leaf portion ovate, leaf apex acuminate (figs 15b, c) 15
- 14* Leaf lamina transversely undulate, in upper part with smooth or lowly mammillose cells; basal leaf portion lanceolate, leaf apex more or less obtuse (fig. 15a) *D. undulatum*
- 15 Upper leaf lamina cells irregularly quadrate, walls esinuose; leaves gradually narrowed to long, falcate acumen (figs 15b, 16) *D. drummondii*
- 15* Upper leaf lamina cells very irregular, triangular, quadrate, with sinuose walls; leaves suddenly narrowed to short acumen (fig. 15c) (shoot apices when dry and viewed from above reminding about lettuce heads; fig. 17) *D. spurium*

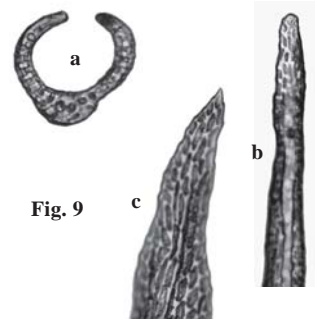


Fig. 9

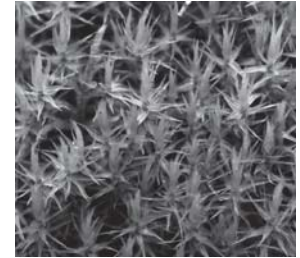


Fig. 10 (moist)

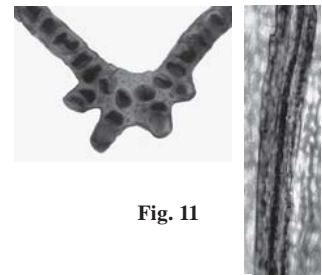


Fig. 11



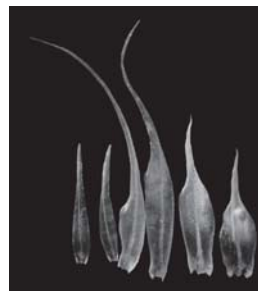
Fig. 12 (after LÜTH 2002)



Fig. 13 (after SÉRGIO et al. 1995)



Fig. 14 (left)



a b c

Fig. 15:
Stem leaves of
a – *Dicranum undulatum*,
b – *D. drummondii*,
c – *D. spurium*.

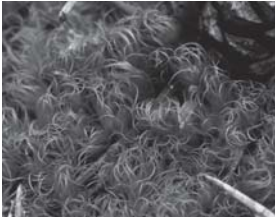


Fig. 16 (dry)



Fig. 17 (dry)



Fig. 18 (moist)



Fig. 19 (moist)



Fig. 20

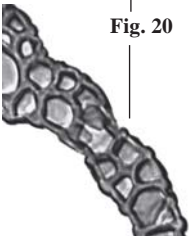


Fig. 21

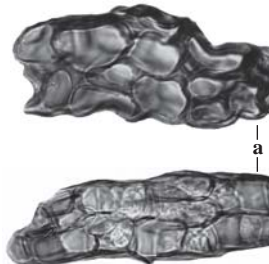


Fig. 22

- 16 Small plants (rarely above 3 cm high; leaves up to 4 mm long). Dry leaves strongly crisped; upper lamina cells mammillose, normally unistratose (fig. 18; transverse section of upper lamina) *D. montanum*
- 16* Plant size variable. Leaf orientation variable; upper lamina cells variable, if mammillose or papillose, then lamina partly bistratose, leaves fragile, or plants larger 17
- 17 Small plants that almost invariably have numerous easily detached flagellae from upper leaf axils (fig. 19). Alar cells unistratose *D. flagellare*
- 17* Plant size variable; if flagellae present, then never several on each plant. Alar cells at least partly bistratose 18
- 18 Upper leaf lamina bistratose (fig. 20), sometimes only along margins (rarely restricted to uppermost margins); leaves frequently falcate, when dry more or less strongly crisped 19
- 18* Leaf lamina unistratose (occasional plants may have bistratose spots); leaf orientation variable 26
- 19 Upper leaf lamina bistratose in large portions (also besides leaf margins; fig. 20). Costa very broad (c. $\frac{1}{3}$ of basal leaf width) *D. fulvum*
- 19* Leaf lamina bistratose only along margins. Costa narrower, or in *D. scottianum* and *D. canariense* very broad 20
- 20 Transverse section of upper leaf looking like a pair of tongs (fig. 21) 21
- 20* Transverse section of upper leaf varying, not looking like a pair of tongs 23
- 21 Plants relatively large (stem leaves 6.0–8.5 mm long). Alar cells 2–3(–4)-stratose (fig. 22a); epidermal cells on ventral side of costa differentiated (fig. 22b); leaf lamina cell walls not projecting in transverse section *D. dispersum*
- 21* Plants smaller (stem leaves 3.5–7.0 mm long). Alar cells 2-stratose; epidermal cells on ventral side of costa undifferentiated or at most slightly differentiated; leaf lamina cell walls projecting in transverse section (fig. 37) 22
- 22 Upper leaf lamina cells quadrate. Upper leaves when dry curled, leaves when moist usually secund (fig. 23) *D. brevifolium*

- 22* Upper leaf lamina cells irregular, quadrate, triangular, or shortly rectangular. Upper leaves when dry slightly curled to slightly bent, leaves when moist not or slightly secund *D. acutifolium*
- 23 Lamina cells thin-walled or slightly incrassate (fig. 24a). Capsule asymmetrical and more or less curved 24
- 23* Lamina cells above incrassate (fig. 24b). Capsule straight and erect, or almost so 25
- 24 Upper leaf margin more or less densely denticulate in upper $\frac{1}{3}$ – $\frac{1}{2}$ (fig. 25a), from apex and some distance below frequently coarsely denticulate; upper lamina cells relatively regularly quadrate (fig. 25b), frequently mammillose; costa dorsally densely denticulate or rough in upper $\frac{2}{5}$ – $\frac{4}{5}$ (fig. 25c; $\frac{1}{3}$ way down from leaf apex) *D. fuscescens*
- 24* Upper leaf margin irregularly denticulate, with long entire portions, in upper $\frac{1}{5}$ – $\frac{1}{3}$ (fig. 26a), near apex sometimes coarsely denticulate; upper lamina cells irregular in shape (figs 26b, c), only scattered ones sometimes mammillose; costa dorsally relatively distantly denticulate or rough in upper $\frac{1}{3}$ (fig. 26d; $\frac{1}{3}$ way down from leaf apex) *D. flexicaule*
- 25 Leaf margin entire or with few and obtuse denticulations (fig. 27a) except close to apex, where a few denticles may be present (fig. 27b), costa smooth (fig. 27c; $\frac{1}{4}$ way down from leaf apex), occasionally with a few denticles near apex; costa near base (above alar groups) weakly convex on back, with 1–2 ventral and 2–4 dorsal layers of stereids. Aristate acumen of perichaetial leaves entire, occasionally weakly denticulate in uppermost part. Plants when dry slightly glossy *D. scottianum*
- 25* Leaf margin denticulate or dentate in upper ($\frac{1}{7}$ –) $\frac{1}{6}$ – $\frac{1}{4}$ (figs 28a, b), costa rough in upper $\frac{1}{4}$ – $\frac{1}{2}$ (fig. 28c; $\frac{1}{4}$ way down from leaf apex); costa near base convex on back, with 2–4 ventral and 3–5 dorsal layers of stereids. Aristate acumen of perichaetial leaves obtusely denticulate or denticulate in upper $\frac{2}{5}$ – $\frac{4}{5}$, near apex partly spinosely denticulate. Plants when dry dull *D. canariense*



Fig. 23 (dry)

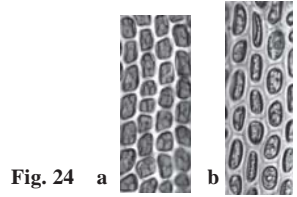


Fig. 24 a b

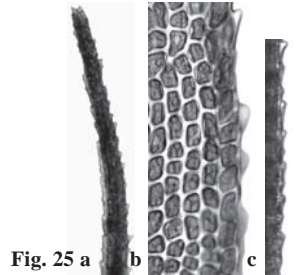


Fig. 25 a b c

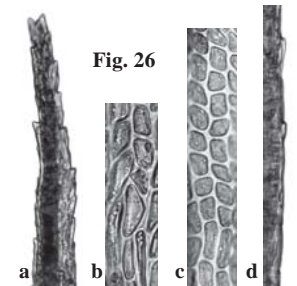


Fig. 26

a b c d

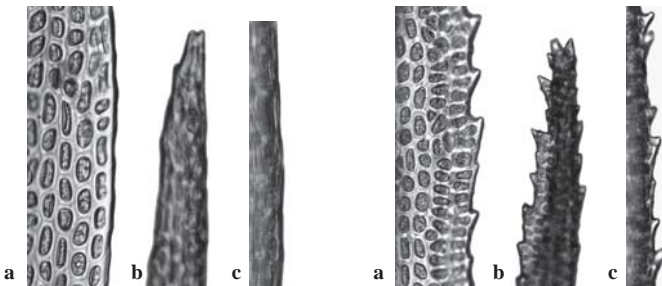


Fig. 27

Fig. 28



Fig. 29

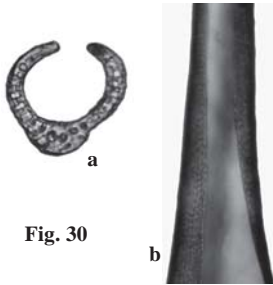


Fig. 30

- 26 Transverse section of upper leaf looking like a pair of tongs (fig. 29) 27
- 26* Transverse section forms a more or less circular outline (costa plus lamina; fig. 30a); upper leaf tubular (fig. 30b) 29
- 27 Plants relatively large (stem leaves 6.0–8.5 mm long). Alar cells 2–3(–4)-stratose (see fig. 22a); epidermal cells on ventral side of costa differentiated (see fig. 22b); leaf lamina cell walls not projecting in transverse section *D. dispersum*
- 27* Plants smaller (stem leaves 3.5–7.0 mm long). Alar cells 2-stratose; epidermal cells on ventral side of costa undifferentiated or at most slightly differentiated; leaf lamina cell walls projecting in transverse section (fig. 37) 28



a (moist)

Fig. 31



b

- 28 Upper leaf lamina cells quadrate. Upper leaves when dry curled, leaves when moist usually secund (fig. 23) *D. brevifolium*
- 28* Upper leaf lamina cells irregular, quadrate, triangular, or shortly rectangular. Upper leaves when dry slightly curled to slightly bent, leaves when moist not or slightly secund *D. acutifolium*
- 29 Leaves when dry strongly curled. Leaf margin near apex irregularly and coarsely denticulate to dentate *D. muehlenbeckii*
- 29* Leaves when dry straight or weakly curled in their upper portions. Leaf margin weakly denticulate to almost entire 30



Fig. 32

- 30 Plants in dense, compact tufts (fig. 31a). Upper leaf lamina cells strongly incrassate (fig. 31b); leaf base lanceolate *D. elongatum*
- 30* Plants more loosely tufted. Upper leaf lamina cells thin-walled to moderately incrassate (fig. 32); leaf base ovate or ovate-lanceolate 31

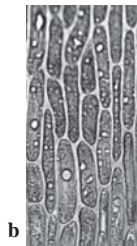
- 31 Leaves erect-spreading to spreading (fig. 33a). Leaf lamina cells not or hardly porose (fig. 33b, from basal leaf); costa weak. Shoots loosely tufted or scattered among other mosses in rich fens *D. angustum*

- 31* Leaves erect-spreading to loosely appressed (fig. 34a). Leaf lamina cells densely porose, at least in lower leaf (fig. 34b, from basal leaf); costa strong. Shoots rather closely tufted on moist soil, rocks, decaying logs, etc. *D. spadiceum*



Fig. 33

a (moist)



b

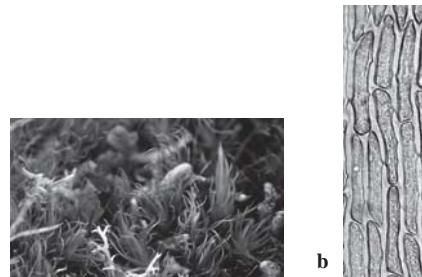


Fig. 34

a (moist)



b

European *Dicranum* species

Dicranum acutifolium (Lindb. & Arnell) C. E. O. Jensen [*D. bergeri* var. *acutifolium* Lindb. & Arnell; *D. muehlenbeckii* var. *acutifolium* (Lindb. & Arnell) Nyholm]

D. acutifolium is closely related and very similar to *D. brevifolium*. Both these species, as well as *D. dispersum*, are easily recognised by having a tong-shaped transverse section in the upper leaf portion. The leaves of *D. acutifolium* are somewhat straighter than those in *D. brevifolium*, both when moist and dry, and the upper leaf lamina cells are more irregular than in the latter. The features distinguishing *D. dispersum* are mentioned under the latter.

This species is widespread in N and probably also C Europe (numerous finds of *D. acutifolium* from Austria in S). – Grows on more or less calcareous soil or rocks, mainly in mountainous areas.

Dicranum angustum Lindb.

This species forms loose tufts in wetlands, or sometimes grows scattered among other bryophytes. It can be differentiated from other wetland *Dicranum* species by its long, narrow, tubular, acuminate or occasionally blunt leaves that are erect-spreading or spreading. The lamina cells are thin-walled or only slightly incrassate, and are eporose or only slightly porose, and the leaf margins are entire or only near apex slightly denticulate (fig. 35).

D. angustum is widespread in the boreal to arctic areas of N Europe. It is unlikely that it occurs in C Europe. – Grows in more or less mineral-rich fens.



Fig. 35: *Dicranum angustum*, leaf acumen.

Dicranum bonjeanii De Not. (*D. amannii* Peterson, nom. inval.; *D. latifolium* J. J. Amann; *D. palustre* Bruch & Schimp.; *D. undulatum* Turner)

Among the species having prosenchymatous upper leaf lamina cells, *D. bonjeanii* can usually be recognised by its weakly to strongly transversely undulate upper leaf portions (at least in some leaves), its two weak dorsal leaf lamellae, which may be serrate or entire, and by its leaf acumen above typically narrowing shortly to a broad, often blunt or obtuse leaf apex. Note, however, that the length of the acumen may vary from relatively short, common in open or sparsely tree-covered habitats, to long, usually in swampy forests. Like many other *Dicranum* species, this species can have both straight and falcate leaves. In some floras (e.g. NYHOLM 1987) it is stated that the relatively similar species *D. bonjeanii* and *D. leioneuron* can be separated by the presence of flagellae in *D. leioneuron* and the absence of such shoots in *D. bonjeanii*. However, even if flagellae are almost invariably present in *D. leioneuron*, they occur also in *D. bonjeanii* (fig. 36) where they seem to be especially common in habitats that dry out occasionally, such as depressions on calcareous ground. *D. leioneuron* is a species of poor fens or bogs and has entire or almost entire leaf margins, whereas *D. bonjeanii* occurs in richer habitats and has denticulate or at least obtusely denticulate leaf margins. Also in the habitually similar *D. scoparium*, flagellae are occasionally found.

This species is widespread in Europe. – Found in more or less mineral-rich habitats, such as rich fens or relatively rich mire portions in mixed mires, moist soil, or in temporarily wet depressions on flat, horizontal rocks, more rarely in humid non-wetland habitats (SAUER 1999).



Fig. 36: *Dicranum bonjeanii*, habit, with flagellae (moist).

Dicranum brevifolium (Lindb.) Lindb. (*D. muehlenbeckii* var. *brevifolium* Lindb.; *D. muehlenbeckii* auct., p.p.)

D. brevifolium is usually easily recognised when it is dry, due to its curled or twisted, relatively stiff leaves. Like in *D. acutifolium* and *D. dispersum*, transverse sections made in the upper leaf are tong-shaped in outline. Differences between these three species are discussed under *D. acutifolium* and *D. dispersum*, respectively. AMANN (1918) considered *D. brevifolium* a high altitude variant of *D. muehlenbeckii*, and believed there were transitions between typical *D. muehlenbeckii* and *D. brevifolium*. However, the two are easily distinguished by the very different appearances of transverse sections made in the upper portions of the leaves, tong-like in *D. brevifolium*, circular in *D. muehlenbeckii*, and the longitudinal leaf lamina cell walls are strongly projecting in *D. brevifolium* (fig. 37), not so in *D. muehlenbeckii*.



Fig. 37: *Dicranum brevifolium*, transverse section of leaf lamina (NYHOLM 1987).

D. brevifolium is widespread in large areas of N, C, and E Europe. – Grows on usually dry soil or rocks, and is most frequent in open and calcareous environments.

Dicranum canariense Hampe ex Müll. Hal.

D. canariense belongs to the *Dicranum* species with erect sporophytes, which in addition are relatively frequent in this species. It is most closely related to *D. scottianum*, from which it differs by much more strongly denticulate leaf margins and costa, and by a thicker costa.

This species occurs on the Canary Islands and Madeira, and is also known from Spain and possibly France (REIMERS 1930) on the European mainland. – Grows both as an epiphyte, on Madeira often on *Erica scoparia* L. and on vertical rocks.

Dicranum crassifolium Sérgio, Ochyra & Séneca

With its partly bistratose or in spots tristratose leaf lamina and distinct lamellae on the upper back of its costa, this species could only be confused with *D. transsylvanicum*. The latter has, however, spinosely dentate rather than denticulate to dentate leaf margins, and spines on the back of its upper lamina (smooth in *D. crassifolium*). *D. scoparium* differs from both these species in having an unistratose leaf lamina.

SÉRGIO et al. (1995) reported *D. crassifolium* from Portugal, Spain (up to 1750 m a.s.l.), and Italy (Toscana, Apuan Alps). – Grows on soil or humus in open or shaded places, as well as on rocks and at tree bases, preferably in relatively acid places (SÉRGIO et al. 1995).

Dicranum dispersum Engelmark

D. dispersum is a relatively large species, forming tufts that can reach 10 cm height, with straight or slightly flexuose leaves that are loosely crisped when dry. Like in *D. acutifolium* and *D. brevifolium*, the transverse section is tong-shaped in the upper portion of the leaves. Both the latter species can be separated from *D. dispersum* by their not or poorly differentiated ventral epidermal costa cells, by thickened longitudinal cell walls (fig. 37), and by never having 3(–4) layers of alar cells.

In Europe so far reported only from Baden-Württemberg in Germany (ENGELMARK 1999, SAUER 2000), and recently discovered in Switzerland based on a collection from 1984 [Ct. Bern, Simmental, Erlenbach, Stockenfluh, 1940 m a.s.l., I. Bisang 84246 (S; B78569)]. We therefore believe that the species most likely occurs also in other localities in Central Europe. – Grows in calcareous, semi-shady, dry habitats, on humus-covered rocks as well as on humus-rich stony ground (SAUER 2000).

Dicranum drummondii Müll. Hal. (*D. elatum* Lindb.; *D. robustum* Blytt ex B., S. & G.)

D. drummondii belongs to the large-sized *Dicranum* species, comparative in size to *D. majus* or *D. polysetum*. Its leaves have an ovate base and narrow gradually towards a long, falcate acumen (fig. 38). The upper leaf lamina is rugose, and has got distinct dorsal, spine-like or highly conical projections, often sitting in transverse or oblique rows.

This species occurs in the northern parts of Europe. – It is a characteristic species in dry pine forest, either on dry sandy soils or on rocky ground.



Fig. 38: *Dicranum drummondii*, dry shoots.

Dicranum elongatum Schleich. ex Schwägr. [*D. sendtneri* Limpr., p.p.; *D. elongatum* subsp. *sendtneri* (Limpr.) Podp., p.p.]

D. elongatum characteristically grows in very dense cushions (fig. 39a), usually so dense that it is difficult to push your fingers into a cushion. The leaves are relatively narrow throughout, when moist erect or almost so and straight or somewhat falcate, when dry slightly crisped, the costa is strong, and both the upper and lower (fig. 39c) leaf lamina cells are strongly incrassate. *D. groenlandicum* also forms very dense cushions, but can be differentiated from *D. elongatum* by having long, porose cells throughout the leaves, whereas *D. elongatum* has short, eporose cells in the upper portion of the leaf. While the leaf point is sharp to blunt in *D. elongatum* (fig. 39b), it is blunt to rounded in *D. groenlandicum*.

LIMPRICHT (1886) described *D. sendtneri* from the Sudetes. According to the original description, *D. sendtneri* should differ from *D. elongatum* in having longer and more curved leaves, denticulate leaf margins and costae (supposedly entire in *D. elongatum*), a narrower costa ($\frac{1}{7}$ – $\frac{1}{6}$ vs. $\frac{1}{4}$ – $\frac{1}{3}$ of maximal basal leaf width), and elongate upper leaf lamina cells (quadrate in *D. elongatum*). We studied S material of *D. elongatum* and such that should belong to *D. sendtneri* according to the labels, but were not able to recognise two different taxa. Moreover, the isotype material of *D. sendtneri* Limpr. that is present in S consists partly of *D. elongatum* and partly of *D. fuscescens* (annotated by T.-B. Engelmark).

D. elongatum is widespread in northern and mountainous parts of Europe. – It grows on more or less acid soil, on heaths, in bogs or in bog portions of poor mires, and on rocks.

Dicranum flagellare Hedw. [*Orthodicranum flagellare* (Hedw.) Loeske]

D. flagellare is usually easily recognised by its small size in combination with the almost universal occurrence of numerous flagellae that arise in the upper leaf axils.

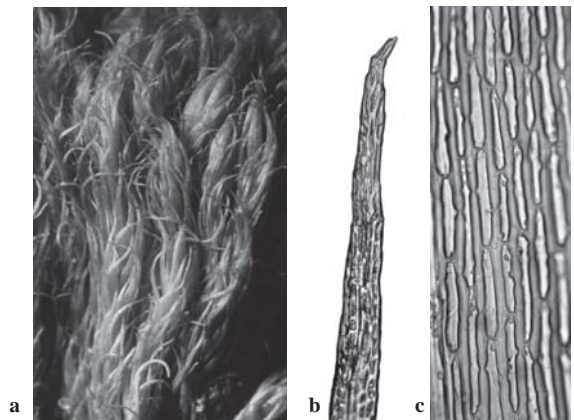


Fig. 39: *Dicranum elongatum*. a – dry shoots, b – leaf apex, c – basal lamina cells.

Widespread in Europe, rare or absent in the far north. – Mostly found on decomposing wood, humus-rich soil, or peat, in more or less humid habitats.

Dicranum flexicaule Brid. [*D. congestum* var. *flexicaule* (Brid.) Bruch & Schimp.; *D. congestum* auct.; *D. fuscescens* subsp. *congestum* auct. (GEISSLER et al. 1998)]

D. flexicaule is very similar to *D. fuscescens*, but has more irregular upper leaf lamina cells than the latter, and less regularly serrate leaf margins and back of costa, the latter being serrate in at most the upper third of the leaf. The differences between these two species are discussed under *D. fuscescens*.

Widespread in Europe, but apparently rarer in the south than in the north. – Grows on soil, rocks, stumps, and logs, from the lowlands to high altitudes in the mountains.

Dicranum fragilifolium Lindb. [*Orthodicranum fragilifolium* (Lindb.) Podp.]

D. fragilifolium is one of the three European *Dicranum* species with straight and erect, stiff, and fragile leaves. It differs from *D. tauricum* in having stereid bands in the basal part of the costa, in having porose basal leaf lamina cells, and at least partly bistratose alar cells. It can be separated from *D. viride* by its undifferentiated costal epidermal cells, its longer and porose basal lamina cells, and its unistratose leaf lamina. It differs from both the other species in having an asymmetrical and more or less curved spore capsule.

This species is widespread in the northern parts of Europe. NYHOLM (1987) reported *D. fragilifolium* from the mountains of C Europe, but this could not be confirmed by additional literature reports. – It grows on logs, stumps, and humus-rich soil, mostly in humid habitats.

Dicranum fulvum Hook. [*Paraleucobryum fulvum* (Hook.) Loeske]

D. fulvum forms dark green or sometimes brownish tufts. The leaves are falcate when moist and curled when dry, and give a somewhat rigid impression. The leaf acumen may be slightly fragile. This species is sometimes confused with *D. scottianum* or *D. viride*, but the leaf margin is denticulate far down in *D. fulvum* (fig. 40a), almost entire or with a few denticles close to the apex in the other two. The basal lamina cells are mainly rectangular in *D. fulvum* and *D. viride* (fig. 40b), but predominantly or in large portions linear in *D. scottianum*. Finally, the leaves are straighter and stiffer in *D. scottianum* and *D. viride* than in *D. fulvum*. *D. fulvum* could also be confused with *D. fuscescens*, but can be separated from the latter by its broader and more longly excurrent costa, larger portions of leaf lamina bistratose, its stiffer and sometimes fragile leaves, and its more strongly incrassate lamina cells.

This species is widespread in Europe, except in the far north. – Found on usually shaded (except in strongly humid environments) siliceous rocks, rarely also on stem bases, mostly in deciduous, but sometimes also in coniferous forest.

Dicranum fuscescens Turner [*D. congestum* Brid.; *D. fuscescens* subsp. *congestum* (Brid.) Kindb.; *D. sendtneri* Limpr., p.p.; *D. elongatum* subsp. *sendtneri* (Limpr.) Podp., p.p.]

D. fuscescens is a medium-sized *Dicranum* species (see fig. 43, under *D. majus*) with narrow upper portions of the leaves, which are more or less secund when moist and crisped when dry. The back of the costa is densely serrate or mammillose in the upper $\frac{2}{5}$ – $\frac{4}{5}$ and the leaf margin is denticulate in the upper $\frac{1}{3}$ – $\frac{1}{2}$.



Fig. 40: *Dicranum fulvum*.
a – upper leaf acumen,
b – basal leaf lamina cells.

D. fuscescens is often confused with *D. flexicaule*, which has more irregularly shaped upper lamina cells, and which leaf margins and costa back are less regularly serrate, the latter at most in upper c. $\frac{1}{3}$ of the leaf. However, even if extreme phenotypes are readily distinguished from each other, other phenotypes appear almost intermediate and it is not clear to us whether these two taxa are really good species. Some characters that supposedly separate them, such as, whether the spore capsule is furrowed when dry and empty (= *D. fuscescens*) or not, and the differences in leaf curvature and plant size, seem unreliable. According to observations of L.H., the states of the capsule are not correlated with the gametophytic characteristics that supposedly define these two taxa. *D. fuscescens* could also be confused with *D. fulvum*; characters separating these two are discussed under the latter. Regarding the identity of *D. sendtneri* Limpr., see the note under *D. elongatum*.

Widespread in Europe, but seemingly rarer than *D. flexicaule* in the north. – Found on soil, rocks, stumps, and logs, from the lowlands to the alpine zone.

***Dicranum groenlandicum* Brid. [*D. elongatum* subsp. *groenlandicum* (Brid.) Mönk.]**

D. groenlandicum grows in very dense cushions (fig. 41a). The upper portions of the leaves are tubular, the leaf point is blunt to rounded, the upper lamina cells are prosenchymatous, and both the lower and upper lamina cells are strongly incrassate and porose (figs 41b–d). In these features, *D. groenlandicum* is similar to *D. laevidens*, but the latter species grows in loose tufts (fig. 42a). The differences between *D. groenlandicum* and *D. elongatum*, which also grows in very dense cushions, are discussed under the latter species.

The distribution of this species is confined to northernmost Europe. – Grows on moist or periodically wet soil in tundra vegetation, or in bogs.

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

D. laevidens has tubular upper leaf portions, the leaf point is blunt to rounded (fig. 42b), the upper lamina cells are prosenchymatous, and both the lower and upper lamina cells are strongly incrassate and porose. In these features, *D. groenlandicum* is similar to *D. laevidens*, but the present species grows in loose tufts (fig. 42a).

Only known from northernmost Europe. – Found in intermediate to rich fens, in relatively dry places in the fens.

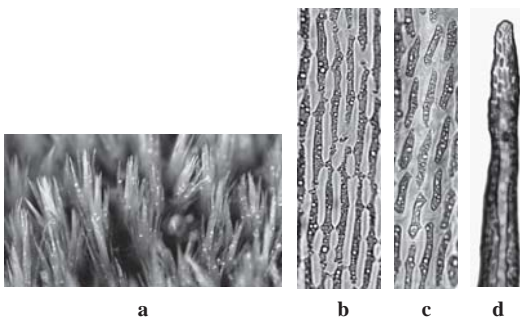


Fig. 41: *Dicranum groenlandicum*. a – habit (moist), b – basal leaf lamina cells, c – upper leaf lamina cells, d – upper part of leaf acumen.

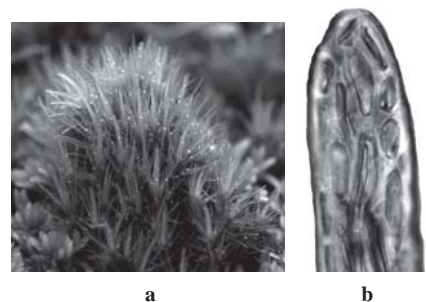


Fig. 42: *Dicranum laevidens*. a – habit (moist), b – upper part of leaf acumen.



Fig. 43: *Dicranum fuscescens* (left) and *D. majus*, habit (almost dry).

Dicranum leioneuron Kindb. (*D. bonjeanii* var. *anomalum* C. E. O. Jensen; *D. bonjeanii* var. *integrifolium* H. Lindb.)

D. leioneuron belongs to the species having prosenchymatous upper leaf lamina cells. It is almost invariably found with flagellae arising from the apex of the shoots, and has entire or almost entire leaf margins. It is sometimes confused with *D. bonjeanii*, and the characters separating these species are given under the latter.

D. leioneuron has been reported both from N and C Europe, although its exact geographical distribution is unclear. – Found both in bogs, among *Sphagnum*, in poor fens and in areas with high rainfall occasionally in more xeric habitats in rock crevices or on boulders (CORLEY 1991).

Dicranum majus Turner

When well developed, *D. majus* is one of the largest members of the genus (fig. 43), with regularly falcate-secund leaves. Its leaves are gradually narrowed to a long, fine point, and the upper lamina cells are prosenchymatous and often partly bistratose shortly inside the leaf margin. In the alpine region of the mountains and in the Arctic the plants are frequently smaller and the leaves less distinctly falcate. Such plants may be confused with *D. scoparium* that, however, has got distinct ridges on the upper back of the costa rather than the furrows and serrations found in *D. majus*. In transverse section most of the upper leaf lamina cells are rectangular in *D. majus*, quadrate in *D. scoparium*, and when sporophytes are present there are 1–5 per perichaetium in *D. majus*, but only one in *D. scoparium*. *D. majus*, as presently understood, is a variable taxon that still needs to be investigated in more detail. Characters that are variable include the number of layers of guide cells in the costa, leaf curvature and length, whether the upper leaf lamina is partly bistratose or not, and whether or not spinosely projecting cell ends occur in the upper lamina.

Widespread in Europe. – Occurs both on humid to wet soil and on rocks, in forest and in more open habitats, the latter especially in mountains and in the far north.

Dicranum montanum Hedw. [*Orthodicranum montanum* (Hedw.) Loeske]

D. montanum belongs to the small species of the genus (fig. 44). Its leaves are strongly crisped and curled when dry. In habit it looks more like *Dicranoweisia cirrata* (Hedw.) Lindb. than it resembles other *Dicranum* species. From *Dicranoweisia cirrata* it can be differentiated by its denticulate rather than entire leaf margin, and by its differentiated alar cells. – We have seen a specimen of *D. cf. montanum* which deviates from typical *D. montanum* in having a partly bistratose upper leaf lamina and fragile leaves.



Fig. 44: *Dicranum montanum*, habit (dry).

Widespread in Europe. – On rotten wood, roots, tree bases, tree stems and rocks, more rarely on soil.

Dicranum muehlenbeckii Bruch & Schimp.

D. muehlenbeckii has tubular leaves that are slightly contorted when moist and strongly curled when dry. The upper leaf lamina cells are relatively thin-walled, and the margin is serrate close to the leaf apex.

This species was often confused with *D. brevifolium* earlier, and the differences between these species are mentioned in the note under the latter.

Occurs in C Europe, and is in addition known from one locality in central Sweden. – Grows on soil, rocks, occasionally on rotten wood, in calcareous or mineral-rich and dry environments.

Dicranum polysetum Sw. (*D. rugosum* Brid.; *D. undulatum* F. Weber & D. Mohr)

D. polysetum belongs to the large species in the genus. It is usually easily recognised already in the field because of its typical leaf orientation (fig. 45), with the uppermost leaves erect and those further down spreading. The leaves are in addition transversely undulate and the leaf margin is sharply dentate above. Although SMITH (1978) states that the margin is recurved below, it is actually broadly incurved.

D. polysetum occurs all over Europe. – It grows on soil, rocks, and rotten wood, both in dry habitats, such as pine heath forest, and in wet places such as swampy forest or tree-covered bogs.

Dicranum scoparium Hedw. (*D. tectorum* Warnst. & H. Klinggr.)

D. scoparium belongs to the medium-sized species of the genus. In some respects it is one of the most variable *Dicranum* species (fig. 46); both phenotypes with straight and falcate leaves are frequent, and both dwarf and large male plants occur. The species has prosenchymatous upper leaf lamina cells, and has in addition (usually four) distinct lamellae on the back of the upper costa. Differences between *D. scoparium*, *D. crassifolium*, *D. transsylvanicum*, and poorly developed plants of *D. majus* are discussed under the latter species. Plants from extreme dry or Arctic environments may lack dorsal costal lamellae completely, and could therefore be confused with *D. bonjeanii*. However, in *D. scoparium* the lower costa is strong, dorsally convex, and has several stereid bands, whereas that of *D. bonjeanii* is weak, almost flat, and has fewer stereid bands (NYHOLM 1987, FRISVOLL & ELVEBAKK 1996).

Widespread in Europe. – Found on various substrates, on soil, rock, rotten wood, tree stems etc., in both dry and humid environments.



Fig. 45: *Dicranum polysetum*, moist shoot.

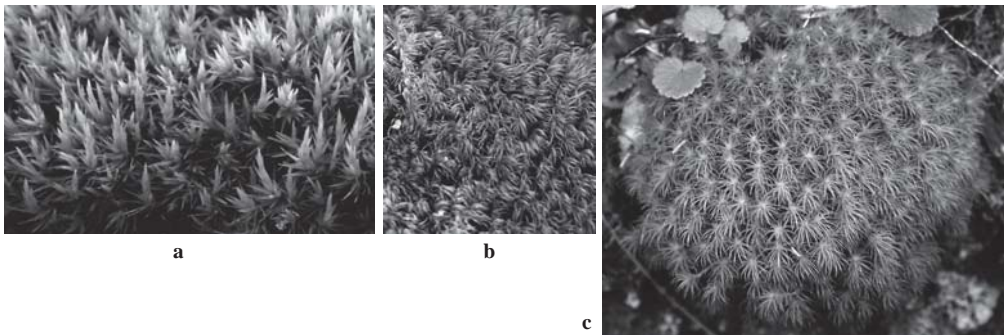


Fig. 46: *Dicranum scoparium*, examples of habit variation (moist). **a** – plants with straight leaves from pine heath forest; **b** – plants with falcate leaves from swampy forest; **c** – large plants with falcate leaves from high-altitude laurel forest on Madeira.

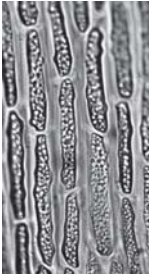


Fig. 47: *Dicranum scottianum*, basal leaf lamina cells.

Dicranum scottianum Turner ex Scott, Robert [*D. scottianum* subsp. *anglicum* Reimers; *Orthodicranum scottianum* (Turner ex Scott, Robert) G. Roth]

D. scottianum is dark green, and has rigid, hardly falcate leaves that are slightly curled when dry. The lamina has bistratose margins and the basal lamina cells are predominantly elongate (fig. 47). For differences between this species, *D. canariense* and *D. fulvum*, see the notes under the latter two.

As shown by NELSON (1997), the correct author citation for *D. scottianum* is 'Turner ex Scott, Robert'.

D. scottianum occurs in oceanic areas of Europe, and in addition in the Canary Islands and the Azores. Previously reported from Switzerland (URMI et al. 1997), but the relevant specimen (Ct. Bern, Interlaken, 1855, Bamberger, S) belongs to *D. fulvum*. – Grows on siliceous rocks, mostly in the vicinity of the seacoast.

Dicranum spadiceum J. E. Zetterst. [*D. muehlenbeckii* var. *spadiceum* (J. E. Zetterst.) Podp.; *D. neglectum* Jur. ex De Not.]

D. spadiceum belongs to the medium-sized species of the genus. Its leaves are distinctly tubular and the leaf margin is entire or in the upper part somewhat denticulate. The uppermost lamina cells are irregular, with rounded corners (fig. 48c); further down the cells gradually become more elongate and porose (fig. 48b). Sometimes the non-porose lamina cells are restricted to the very uppermost lamina portion. When dry, the leaves are erect-spreading and slightly crisped (fig. 48a).

This species has sometimes been confused with *D. muehlenbeckii*, which leaves are more strongly curled when dry, and which margins are serrate near the apex. Leaf lamina cell size (cf. NYHOLM 1987) seems to be an unreliable distinguishing character between these two species.

Widespread in mountainous areas in Europe, but probably overlooked in many areas, especially in Central Europe. – Most commonly found on moist soil or rocks, sometimes in shallow mountain mires or on rotten logs, usually at relatively high altitudes.

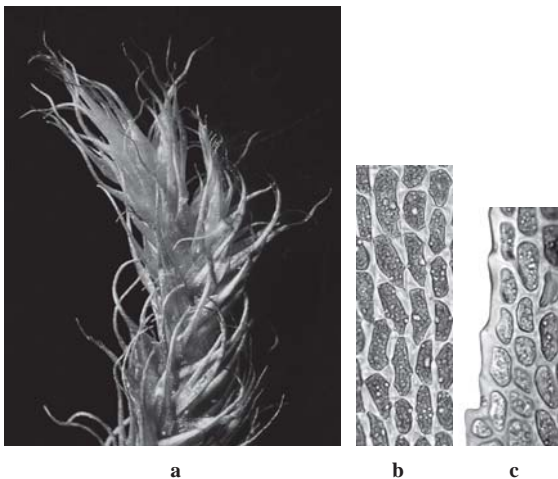


Fig. 48: *Dicranum spadiceum*. a – dry shoot; b – median leaf lamina cells; c – upper leaf lamina cells.

Dicranum spurium Hedw.

Dry plants of *D. spurium* are easily recognised by their shoot apices, which remind about lettuce heads. Otherwise, the leaves have a relatively broad basal portion, narrow suddenly to a short acumen, and the upper lamina cells are very irregular (fig. 49). On the back of the upper lamina scattered or numerous cells have usually got conical mamillae.

This species is widespread in Europe, rare or absent in the far north. – Forms dense colonies on soil or rock, in more or less dry and open forests.

Dicranum tauricum Sapjegin [*D. strictum* Schleich. ex D. Mohr; *Orthodicranum strictum* Broth.; *O. tauricum* (Sapjegin) Smirnova]

D. tauricum has straight and erect, stiff and fragile, upper leaves. It differs from the other two such species, *D. fragilifolium* and *D. viride*, in lacking stereid bands in the costa. From *D. viride* it also differs in its unistratose leaf lamina. Additional differences between this species and *D. fragilifolium* are discussed under the latter.

This species is widespread in W and C Europe, and appears to have increased in many areas, possibly due to acidification. – Occurs on tree bases and rotten wood, rarely on soil.

Dicranum transsylvanicum Lüth

D. transsylvanicum was recently described from Romania, and the following information is taken from the original description (LÜTH 2002). Like *D. crassifolium*, this species has a partly bistratose upper leaf lamina and lamellae on the upper back of the costa. However, contrary to both *D. crassifolium* and *D. scoparium*, which remind about the present species in having well-developed lamellae on the back of the costa, *D. transsylvanicum* has a strongly spinose dorsal lamina and irregularly spinose-dentate upper leaf margins (fig. 50). *D. scoparium* has in addition a unistratose leaf lamina. Only known from the Apuseni Mountains in western Romania. – The single known specimen was collected on spruce needle litter between limestone boulders, at around 1150 m a.s.l.

Dicranum undulatum Schrad. ex Brid. (*D. affine* Funck; *D. bergeri* Bland.; *D. schraderi* Wahlenb.)

D. undulatum grows in rather dense tufts. In addition, it is recognised by its straight or at most weakly curved leaves (fig. 51a), that are more or less distinctly transversely undulate, lanceolate, and narrow very gradually upwards, except that they are suddenly narrowed to the obtuse apex in

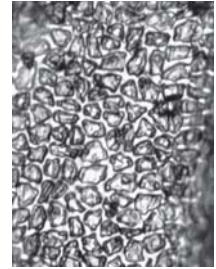


Fig. 49: *Dicranum spurium*, cells of upper leaf lamina.



Fig. 50: *Dicranum transsylvanicum*, portion of upper leaf lamina and costa seen from dorsal side (after LÜTH 2002).

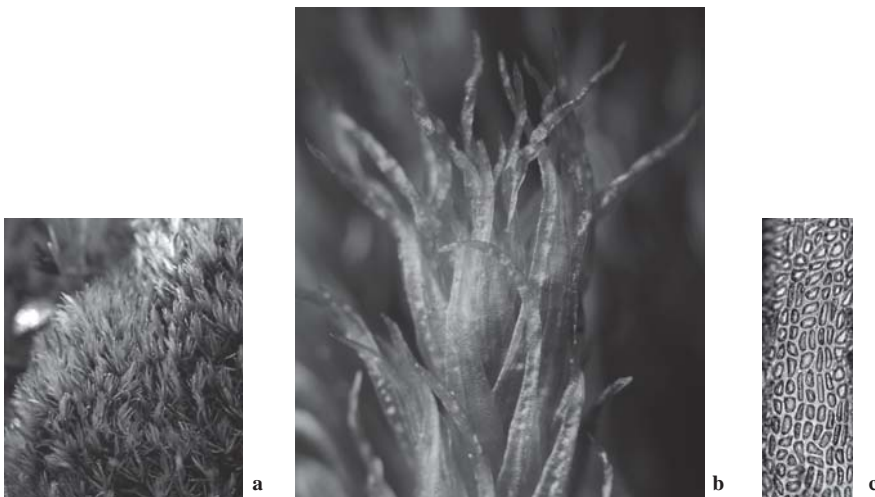


Fig. 51: *Dicranum undulatum*. a – habit (moist), b – portion of dry shoot, c – cells of upper leaf lamina.

the uppermost part (fig. 51b). Although frequently called *D. bergeri* by modern European authors, the correct name and citation for this species appears to be ‘*D. undulatum* Schrad. ex Brid., J. f. Bot. 1800, 1(2): 294. 1801’. The latter name is thus a few years older than *D. bergeri*.

D. undulatum is widespread in Europe. – Occurs on moist or wet ground, usually on bogs or hummocks in mineral-poor fens, sometimes also in meadows. In the northern boreal zone the species is in addition frequent in dry pine heath forest.

Dicranum viride (Sull. & Lesq.) Lindb. [*Paraleucobryum viride* (Sull. & Lesq.) Podp.]

D. viride belongs to the *Dicranum* species with straight and erect, stiff, and fragile leaves, among which it is characterised by its partly bistratose leaf lamina. According to NYHOLM (1987) and observations by ERZBERGER (1999) on Hungarian material, *D. viride* differs from *D. tauricum* and *D. fragilifolium* by cell wall projections which are visible in leaf cross sections (compare *D. brevifolium*; fig. 37). Additional differences between this species, *D. fragilifolium*, and *D. tauricum* are discussed under the latter two.

This species occurs in Central Europe, northwards to southern Norway and the Baltic Sea area. – Mostly found as an epiphyte on stems of deciduous trees, more rarely on coniferous trees, rocks, or soil.

Acknowledgements

We thank the participants of the *Dicranum* workshop in Zürich in April 2003, M. Sauer, and M. Siegel for suggestions that improved the key, and the “Schweizerische Akademie der Naturwissenschaften”, SANW, for supporting the travel costs in connection with the workshop.

References

- AMANN, J. 1918. Flore des mousses de la Suisse. Deuxième partie. Bryogéographie de la Suisse. – Genève.
- CORLEY, M. F. V. 1991. The habitat range of *Dicranum leioneuron* Kindb. – J. Bryol. **16**: 485–486.
- ENGLER, T.-B. 1999. *Dicranum dispersum* spec. nov. (Dicranaceae: Bryopsida: Bryophyta). – Stuttgarter Beitr. Naturk., A (Biologie) **592**: 1–8.
- ERZBERGER, P. 1999. Distribution of *Dicranum viride* and *Dicranum tauricum* in Hungary. – Studia Bot. Hung. **29**: 35–47.
- FRISVOLL, A. A. & ELVEBAKK, A. 1996. A catalogue of Svalbard plants, fungi, algae and cyanobacteria. Part 2. Bryophytes. – Norsk Polarinstittut Skrifter **198**: 57–172.
- GEISSLER, P., URMI, E. & SCHNYDER, N. 1998. Liste der Moose der Schweiz und ihrer Grenzgebiete. – In: SCHNEIDER, H. & PAULSEN, J. (ed.), Schweizer Botanik CD '98. – Basel: Botanisches Institut der Universität Basel.
- LIMPRICHT, K. G. 1886. Die Laubmoose Deutschlands, Oesterreichs und der Schweiz. I. Abtheilung. Lieferung 6 (pp. 321–384). – Leipzig: Verlag von Eduard Kummer.
- LÜTH, M. 2002. *Dicranum transsylvanicum* (Musci, Dicranaceae), a new species from Romania. – Cryptogamie, Bryol. **23**: 17–21.
- NELSON, E. C. 1997. Robert Scott's Irish mosses, *Dicranum scottianum* and *Grimmia maritima*: a note about their publication. – J. Bryol. **19**: 503–508.
- NYHOLM, E. 1987. Illustrated flora of Nordic mosses. Fasc. 1. Fissidentaceae–Seligeriaceae. – Copenhagen and Lund: Nordic Bryological Society.
- REIMERS, H. 1930. Über *Orthodicranum Allorgei* Amann et Loeske, *Dicranum canariense* Hpe und *D. scottianum* Turn. – Rev. Bryol. Lichénol. **3**: 51–61.
- SAUER, M. 1999. *Dicranum bonjeanii* De Not. – ein “Sumpfmooß” an Trockenstandorten in Baden-Württemberg. – Meylania **17**: 24–26.
- SAUER, M. 2000. Dicranaceae, Gabelzahnmoose. – In: NEBEL, M. & PHILIPPI, G. (ed.). Die Moose Baden-Württembergs. Band 1: Allgemeiner Teil. Spezieller Teil (Bryophytina I, Andreaeales bis Funariales): 129–220. – Stuttgart: Verlag Eugen Ulmer.
- SÉRGIO, C., OCHYRA, R. & SÉNECA, A. 1995. *Dicranum crassifolium* (Musci, Dicranaceae), a new species from southern Europe. – Fragm. Flor. Geobot. **40**: 203–214.

- SMITH, A. J. E. 1978. The moss flora of Britain and Ireland. – Cambridge: Cambridge University Press.
 URMI, E., SCHNYDER, N., MÜLLER, N. & BISANG, I. 1997. Artenschutz-Konzept für die Moose der Schweiz. – Bundesamt für Umwelt, Wald und Landschaft (BUWAL), Schriftenreihe Umwelt **265**: 1–47.

Manuscript accepted: 13 February 2004.

Addresses of the authors

Lars Hedenäs & Irene Bisang, Swedish Museum of Natural History, Department of Cryptogamic Botany, Box 50007, SE-104 05 Stockholm, Sweden.
 E-mail: lars.hedenas@nrm.se, irene.bisang@nrm.se

Species index

Dicranoweisia

cirrata 192

Dicranum

acutifolium 185, 186, 187, 188

affine 195

amannii 187

angustum 180, 186, 187

bergeri 195, 196

var. *acutifolium* 187

bonjeanii 180, 183, 187, 192, 193

var. *anomalum* 192

var. *integrifolium* 192

brevifolium 181, 184, 186, 187, 188, 193, 196

canariense 180, 184, 185, 188, 194

congestum 190

auct. 190

var. *flexicaule* 190

crassifolium 183, 188, 193, 195

dispersum 181, 184, 186, 187, 188

drummondii 180, 183, 189

elatum 189

elongatum 180, 186, 189, 191

subsp. *groenlandicum* 191

subsp. *sendtneri* 189, 190

flagellare 180, 181, 184, 189

flexicaule 180, 185, 190, 191

fragilifolium 180, 182, 190, 195, 196

fulvum 180, 184, 190, 191, 194

fuscescens 180, 181, 185, 189, 190, 191, 192

subsp. *congestum* 190

subsp. *congestum* of Geissler et al. 190

groenlandicum 180, 182, 189, 191

laevidens 180, 182, 191

latifolium 187

leioneuron 180, 182, 187, 192

majus 180, 181, 183, 189, 190, 192, 193

montanum 180, 181, 184, 192

muehlenbeckii 186, 188, 192, 194

auct. 188

var. *acutifolium* 187

var. *brevifolium* 188

var. *spadiceum* 194

neglectum 194

palustre 187

polysetum 180, 181, 183, 189, 193

robustum 189

rugosum 193

schraderi 195

scoparium 180, 181, 183, 187, 188, 192, 193, 195

scottianum 180, 181, 184, 185, 188, 190, 194

subsp. *anglicum* 194

sendtneri 189, 190, 191

spadiceum 182, 186, 194

spurium 180, 183, 194, 195

strictum 195

tauricum 180, 181, 182, 190, 195, 196

tectorum 193

transsylvanicum 183, 188, 193, 195

undulatum 181, 183, 195, 196

undulatum Turner 187

undulatum F. Weber & D. Mohr 193

viride 180, 181, 182, 190, 195, 196

Kiaeria

glacialis 180

Orthodicranum

flagellare 189

fragilifolium 190

montanum 192

scottianum 194

strictum 195

tauricum 195

Paraleucobryum

fulvum 190

viride 196

