

Species delimitation in four long-spored species of *Dermatocarpon* in the Nordic countries

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A group of four long-spored (> 15 µm) species of *Dermatocarpon* Eschw. is revised. *Dermatocarpon bachmannii* Anders., *D. deminuens* Vain., *D. meiophyllizum* Vain., and *D. rivulorum* (Arnold) Dalla Torre & Sarnth. are recognized. A key to the species is given and their delimitation discussed. The delimitation of *D. bachmannii* from *D. deminuens* was studied in detail by PCA and Student's *t*-test of anatomical and morphological characters. The following names are lectotypified: *D. bachmannii*, *D. bachmannii* var. *inundatum* Klem., *D. deminuens*, *D. laatokkaëense* Räsänen, *D. meiophyllizum*, and *D. meiophyllum* Vain. *Dermatocarpon bachmannii* is for the first time reported from Finland, Iceland and Norway and *D. deminuens* and *D. meiophyllizum* from Iceland.

Key words: Ascomycetes, *Dermatocarpon*, lichens, Nordic countries, taxonomy, Verrucariaceae

INTRODUCTION

The lichen genus *Dermatocarpon* Eschw. comprises foliose members of the Verrucariaceae that have a lower cortex of the *Dermatocarpon*-type (Harada 1993). The species delimitation within the genus is poorly understood for many of its species (Purvis *et al.* 1992), mainly because of the great morphological plasticity occurring in some of them. The species discussed in this paper are characterized by having spores longer than 14–15 µm and more or less single-lobed thalli. Except for the species treated here, the only *Dermatocarpon* species in the Nordic countries with spores longer than 15 µm are *D. luridum* (With.) J. R.

Laundon which is easily separated from the others because of its multi-lobed thalli, and *D. leptophyllodes* (Nyl.) Zahlbr. that has smaller lobes than the treated species, only 2–7 mm, and is very rare and not well known.

The best known species is probably *Dermatocarpon rivulorum*, which Arnold (1874) described from Tyrol. Degelius (1934) discussed this species in connection with the description of *D. arnoldianum* Degel. The species *D. deminuens*, *D. meiophyllizum*, and *D. meiophyllum* were all described by Vainio (1921). Anders (1922) described *D. bachmannii*, Räsänen (1934) *D. laatokkaëense* and Klement (Servít & Klement 1932) *D. bachmannii* var. *inundatum*.

Dermatocarpon meiophyllizum and *D. rivulorum* are different from other *Dermatocarpon* species in the Nordic countries (i.e. Denmark, the Faeroe Islands, Finland, Greenland, Iceland, Norway, and Sweden) in having a brown upper surface caused by an epinecral layer of compressed hyphae (Heiðmarsson 1996). *Dermatocarpon meiophyllizum* in the Nordic countries was discussed by Santesson (1939), and *D. rivulorum* by many authors, e.g. Degelius (1934), Dahl (1938), and Magnusson (1952). The distribution and ecology of both species in Norway and Sweden were

given by Santesson (1993). The difference between *D. deminuens* and *D. bachmannii* has been less well understood. Both species were described as having small thalli (Vainio 1921, Anders 1922), and when comparing the original descriptions there are few diagnostic characters separating them. Poelt (1969) indicated that *D. bachmannii* has a more well-developed pruina, towards the edge slightly elevated lobes ("Lappen aufsteigend"), and darker lower surface than *D. deminuens*. He also claimed the distributions to be different; *D. deminuens* occurring in Fennoscandia

Table 1. Mean, standard deviation, and range for quantitative characters measurements on *Dermatocarpon bachmannii* and *D. deminuens*. nr.s. = number of specimens studied, *n* = number of measurements.

	<i>D. bachmannii</i>	<i>D. deminuens</i>	<i>D. bachmannii</i> (small individuals)
	nr.s. = 24	nr.s. = 15	nr.s. = 6
A. Spore length (µm)	18.2 (1.9) 14.0–25.5 (<i>n</i> = 243)	17.6 (1.8) 13.0–22.0 (<i>n</i> = 130)	16.3 (2.1) 12.0–20.5 (<i>n</i> = 33)
B. Spore width (µm)	6.9 (0.8) 4.5–9.0 (<i>n</i> = 243)	6.3 (0.7) 4.5–9.0 (<i>n</i> = 130)	6.4 (0.7) 5.0–8.0 (<i>n</i> = 33)
C. Dry thickness (mm)	0.40 (0.09) 0.22–0.67 (<i>n</i> = 108)	0.32 (0.06) 0.18–0.47 (<i>n</i> = 54)	0.35 (0.08) 0.18–0.49 (<i>n</i> = 22)
D. Lobe size (mm)	18 (6) 9–40 (<i>n</i> = 107)	10 (3) 4–16 (<i>n</i> = 75)	10 (2) 7–14 (<i>n</i> = 28)
E. Upper cortex thickness (µm)	105 (22) 70–170 (<i>n</i> = 59)	88 (18) 40–130 (<i>n</i> = 52)	98 (19) 70–140 (<i>n</i> = 19)
F. Algal layer thickness (µm)	80 (26) 40–170 (<i>n</i> = 60)	62 (17) 30–90 (<i>n</i> = 50)	75 (32) 30–130 (<i>n</i> = 19)
G. Medulla thickness (µm)	170 (48) 80–290 (<i>n</i> = 61)	145 (44) 70–290 (<i>n</i> = 52)	152 (88) 70–460 (<i>n</i> = 19)
H. Lower cortex thickness (µm)	59 (14) 30–90 (<i>n</i> = 61)	54 (10) 30–90 (<i>n</i> = 52)	64 (14) 40–90 (<i>n</i> = 19)
I. Perithecia height (µm)	284 (69) 130–490 (<i>n</i> = 59)	248 (49) 160–380 (<i>n</i> = 49)	273 (35) 200–330 (<i>n</i> = 22)

and *D. bachmannii* in the Alps. Magnusson (1930) was first to report *D. bachmannii* from the Nordic countries and he also included *D. laatokkaënsë* as a synonym. However, some of Magnusson's collections in UPS have later been identified as *D. deminuens* and *D. meiophyllizum* both by R. Santesson and me. Zschacke (1934) considered it likely that Magnusson's collections belonged to *D. bachmannii* var. *inundatum*, which is synonymous with *D. meiophyllizum*. Magnusson (1930) did not indicate how to separate *D. bachmannii* from *D. deminuens* although he compared it with some other taxa such as *D. meiophyllizum*. Degelius (1934) reported *D. rivulorum* from the Nordic countries for the first time from Abisko in northern Sweden. Later Santesson (1939) reported *D. deminuens* and *D. meiophyllizum* from Sweden, and in the same paper he remarked on Magnusson's reports of *D. bachmannii* from Sweden. Actually the first confirmed report of *D. bachmannii* from the Nordic countries was by R. Santesson (Moberg 1986) from Mt. Röberg in Åsele Lappmark, Sweden.

MATERIAL AND METHODS

The study is based on field observations and my own collections from the Faeroe Islands, Finland, Iceland, Norway, and Sweden. In Finland, I collected in the province of Åland; in Iceland in Vestur-Ísland, Norður-Ísland, and Austur-Ísland; in Norway in Rogaland and Hordaland, and in Sweden in Öland, Östergötland, Närke, Södermanland, Uppland, Åsele Lappmark, and Torne Lappmark. Additional mate-

rial from the following herbaria was also studied: BG, H, LD, M, O, PRM, S, TUR, TUR-V, and UPS. All material cited, including types, has been studied. Only a selection of all studied collections have been listed, together with an estimate of the total number of collections studied.

The external morphology was studied under a dissecting microscope. Lobe size was measured with a ruler and the largest individuals in every collection were measured. The thickness of dry thalli was measured with a micrometer with an accuracy of 0.01 mm. For anatomical studies a section (ca. 15 µm thick) was made by hand or with a freezing microtome and measured in water under the light microscope. The accuracy of the anatomical measurements is 10 µm, and of the spore measurements 0.5 µm. The usual range is recorded as the mean ± 1 standard deviation rounded to the nearest whole number for spores and to the nearest ten for anatomical measurements. The extreme range of individual observations is given in parentheses.

In order to study the morphological variation of *Dermatocarpon deminuens* and *D. bachmannii* statistical methods were used. A principal component analysis (PCA) on 12 characters (9 qualitative and 3 quantitative) of 39 specimens (24 specimens of *D. bachmannii* and 15 specimens of *D. deminuens*) was carried out. PCA may help in reducing the dimensionality of the data; for a description of the method see e.g. Abbott *et al.* (1985). PCA has been used to solve similar taxonomic problems, e.g. by Arup (1992). For the PCA the program SAS (SAS Institute Inc. 1989) was used. The characters used for the PCA are listed in Tables 1 and 2. For the quantitative characters the mean were calculated for each specimen and character. Three to fifteen spores were measured per specimen and similarly three to five measurements were made of the thickness of dry lobes and the lobe size. The anatomical measurements were normally three per specimen but since SAS does exclude specimens with missing values and I considered it important to include as many collections as possible in the study, there were sometimes only one measurement for some of the

Table 2. Distribution of qualitative characters in *Dermatocarpon bachmannii* and *D. deminuens*. Figures are percentages of specimens examined that show a given character state. *n* = number of specimens studied.

	<i>D. bachmannii</i> <i>n</i> = 24	<i>D. deminuens</i> <i>n</i> = 15	<i>D. bachmannii</i> (small individuals) <i>n</i> = 6
J. Lower surface colour			
Light brown to brown	8.3	33.3	16.7
Brown to dark brown	91.7	66.7	83.3
K. Lower surface appearance			
Not reticulate	25.0	66.7	33.3
Reticulate	75.0	33.3	66.7
L. Lobe ends inrolled			
Not so	54.2	33.3	66.7
Inrolled	45.8	66.7	33.3

anatomical characters. Student's *t*-test was applied for the quantitative characters. A comparison between small thalli of *D. bachmannii* and normal-sized thalli of both *D. bachmannii* and *D. deminuens* was also included. Six collections of *D. bachmannii* were studied and five small individuals from each collection were selected and measured. They were later included in the PCA and tested pairwise with a *t*-test against normal-sized *D. bachmannii* and *D. deminuens*.

The distribution in the Nordic countries is given as a list of countries and provinces from which I have seen collections. Province abbreviations are according to Einarsson (1993) for Iceland, Hämet-Ahti *et al.* (1986) for Finland, and Santesson (1993) for Norway and Sweden. Distribution maps will be published in a later publication where all *Dermatocarpon* species in the Nordic countries will be revised.

RESULTS

Dermatocarpon meiophyllizum and *D. rivulorum* are easily distinguished by the different gross morphology. *Dermatocarpon meiophyllizum* has small lobes, a thick thallus, a more or less smooth, usually dark brown lower surface, and shorter spores than *D. rivulorum*. *Dermatocarpon rivulorum* has larger lobes, a thin thallus, a distinctly reticulate lower surface, and longer spores than *D. meiophyllizum*. *Dermatocarpon meiophyllizum* has a more southerly distribution, while *D. rivulorum* has a high alpine to arctic distribution.

The mean, standard deviation, range, and sample size for the quantitative characters used in the PCA are summarized in Table 1 and the distribu-

tion of the qualitative characters in Table 2. The results of a Student's *t*-test of the morphological variation in *Dermatocarpon bachmannii* and *D. deminuens* are summarized in Table 3. The *t*-test showed that *D. bachmannii* and *D. deminuens* were significantly different ($p \leq 0.05$) in all the quantitative characters where *t*-test was applicable and different at higher significance level ($p < 0.001$) in four of the characters. *T*-test was also made pairwise for both species versus the small individuals of *D. bachmannii*. The small individuals of *D. bachmannii* were significantly different from normal sized *D. bachmannii* in three characters ($p < 0.05$) but in five characters from *D. deminuens* ($p < 0.05$).

In the PCA the first principal component accounts for 32.2% of the total variance, the second component for 15.9%, and the third for 11.1%. The first three components account for 59.2% of the total variance. Two rather distinct groups of specimens can be recognised, corresponding to *Dermatocarpon bachmannii* and *D. deminuens* (Fig. 1). Some of the quantitative characters are reliable for separating the two species. Fig. 2 shows that lobe size along with upper cortex thickness, algal layer thickness, perithecium height, and spore width primarily contribute to the first principal component. The characters that contribute rather little to the first principal component are lower cortex thickness, lower surface colour and lower surface appearance. In a second analysis small specimens of *D. bachmannii* selected from

Table 3. Results of a statistical test on *Dermatocarpon bachmannii*, *D. deminuens*, and *D. bachmannii* (small individuals). Differences in mean values were tested with a pairwise Student's *t*-test. Significance levels: ns = not significant ($p \geq 0.05$), * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. In two cases a *t*-test is not applicable (–) because of too large a difference in standard deviation. Character abbreviation as in Tables 1 and 2.

Character	<i>D. bachmannii</i> vs. <i>D. deminuens</i>	<i>D. bachmannii</i> vs. <i>D. bachmannii</i> (small individuals)	<i>D. deminuens</i> vs. <i>D. bachmannii</i> (small individuals)
A	**	***	***
B	***	*	ns
C	***	*	ns
D	–	–	ns
E	***	ns	*
F	***	ns	*
G	**	ns	ns
H	*	ns	***
I	**	ns	*

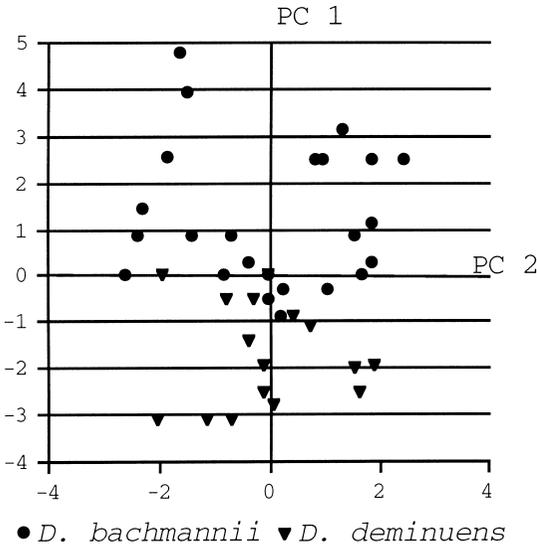


Fig. 1. Principal component analysis (PCA) of *Dermatocarpon bachmannii* and *D. deminuens*.

six collections were included (Fig. 3). Then the first principal component accounted for 30.0%, the second one for 14.8%, and the third one for 10.9% of the variance. The small specimens of *D. bachmannii* were located both along with the *D. deminuens* specimens and the *D. bachmannii* specimens or at the borders between the two species (Fig. 3).

DISCUSSION

The identification of the specimens of *Dermatocarpon bachmannii* and *D. deminuens* were made prior to the PCA. Identifications were mainly based on lobe size and thallus thickness, but also on several other characters such as the reticulation and the colour of the lower surface. The quantitative characters were all size-related and the individual specimens showed some variation. Single thalli of *D. bachmannii* may, for example, be thinner than some of the *D. deminuens* thalli.

The weak point of this analysis is the dependence upon quantitative characters and that some of these characters have mainly been used for discerning the species. But in this type of study the choice is to present the results without any multivariate statistical evaluation of the relationships

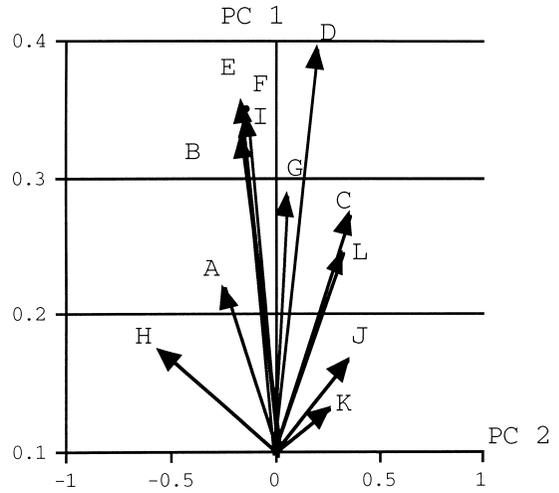


Fig. 2. Contribution of the original characters to the first principal components. Symbols as in Tables 1 and 2.

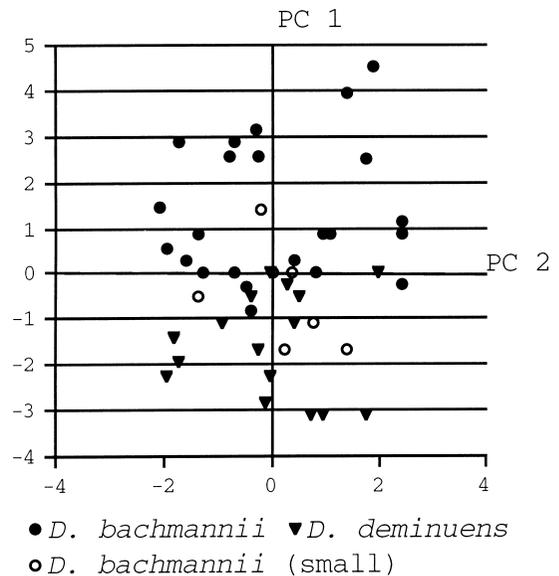


Fig. 3. Principal component analysis (PCA) of *Dermatocarpon bachmannii*, small individuals of *D. bachmannii*, and *D. deminuens*.

between the two species, or to use e.g. a PCA with some weaknesses.

Although the two species do not form two well delimited clusters in the PCA, they are polarized to the upper and lower part of Fig. 1 respectively, which in my opinion supports the separation of the two species. *Dermatocarpon bachmannii* has higher values than *D. deminuens* for all the quanti-

tative characters (Table 1) and since the ratio *D. bachmannii*/*D. deminuens* is similar for many of the characters, it can be argued that *D. bachmannii* only represents older and larger individuals of *D. deminuens*. In order to test this hypothesis, I measured five small individuals from each of six collections of *D. bachmannii* and included the results in a second PCA (Fig. 3) and tested them also with a pairwise Student's *t*-test against both species (Table 3). When I included the small individuals of *D. bachmannii* in the PCA (Fig. 3) they were located among the *D. deminuens* specimens or the *D. bachmannii* specimens, or at the border between the two species, and because of the dependence of the analysis on quantitative characters it is not surprising that they were not clearly nested with the *D. bachmannii* specimens. The fact that they were also not clearly nested with the *D. deminuens* specimens gives additional support for the separation of the two taxa. Although there are differences between large and small individuals of *D. bachmannii* in spore width and dry thickness ($p < 0.05$), differences between *D. deminuens* and small thalli of *D. bachmannii* are more prominent. In this comparison, lower cortex thickness ($p \leq 0.001$), upper cortex thickness ($p < 0.05$), perithecium height ($p < 0.05$) and algal layer thickness ($p < 0.05$) are significantly different (Table 3). The spore size indicates that the small individuals of *D. bachmannii* are not fully grown since the spores are shorter than in mature individuals of both *D. bachmannii* and *D. deminuens* (Table 1) and thinner than the spores of *D. bachmannii*.

Dermatocarpon deminuens has been reported from the Nordic countries but has not been found in the Alps. *Dermatocarpon bachmannii*, on the other hand, is found both in the Nordic countries and in the Alps. *Dermatocarpon bachmannii* has more limited distribution than *D. deminuens* in the Nordic countries but is locally common on Åland and on Mt. Röberg in Åsele Lappmark. I have never seen as large specimens from the Alps as those occurring in these two areas but more studies are needed to see if there are some consistent differences between the populations of *D. bachmannii* in the Nordic countries and in the Alps. Since *D. bachmannii* and *D. deminuens* are closely related, it can be argued that treating them on an infraspecific level would be a better solu-

tion than treating them as different species. But since the two taxa are relatively easily distinguished when mature and prefer different rock-types (*D. bachmannii* almost exclusively grows on basic rock-types) they should in my opinion be kept as separate species.

The four species treated here form a species group characterized by long spores and usually single-lobed thalli. It is nevertheless uncertain whether they represent a monophyletic group, and a hypothesis about their relationships with each other and the rest of *Dermatocarpon* will be presented later.

TAXONOMIC TREATMENT

All the treated species have umbilicate and foliose thallus and pycnidia of the *Xanthoria*-type (Vobis 1980) (= *Endocarpon*-type of Glück 1899) with ellipsoidal mitospores measuring ca. $5 \times 1 \mu\text{m}$. The hymenium turns blue in Lugol's Iodine (ca. 1%) and the thallus is Melzer's I – (ca. 1%). Measurements of some morphological and anatomical characters are given in Table 4 for all the treated species.

Key to the treated species

- 1a. Upper surface brown, epinecral layer consisting of compressed hyphae 2
- 1b. Upper surface grey, epinecral layer consisting of air filled hyphae 3
 - 2a. Thallus small (lobe size 6–12 mm), \pm rounded and thick (when dry 0.36–0.62 mm), lower surface more or less smooth 3. *D. meiophyllizum*
 - 2b. Thallus large (lobe size 13–30 mm), \pm irregularly shaped and thin (when dry 0.24–0.42 mm), lower surface distinctly reticulate 4. *D. rivulorum*
- 3a. Thallus small (lobe size 7–13 mm) and thin (when dry 0.26–0.38 mm), lower surface smooth to rugose to reticulate 2. *D. deminuens*
- 3b. Thallus large (lobe size 13–24 mm) and thick (when dry 0.31–0.51 mm) lower surface usually reticulate ..
..... 1. *D. bachmannii*

1. *Dermatocarpon bachmannii* Anders (Fig. 4A and B)

Hedwigia 63: 271. 1922. — Type: Czech Republic. Nordböhmen, Berg Bösig, ca. 550 m, 1920 Anders (UPS lecto-type, designated here).

Thallus single-lobed with the lobe ends sometimes strongly inrolled. Lobe size (9–)13–24(–40) mm. Upper surface pruinose, grey with epinecral layer consisting of air filled hyphae; lower surface in most cases distinctly reticulate, usually dark brown to almost black. Thickness of dry thallus (0.22–)0.30–0.50(–0.70) mm, of wet thallus (0.19–)0.27–0.40(–0.46) mm. Upper cortex (70–)80–130(–170) μm thick, hyaline with the outermost part (ca. 10 μm) brownish. Algal layer

(30–)50–110(–170) μm thick; photobiont regularly scattered in upper cortex and occasionally also in medulla. Size of algal cells 5–9 μm . Medulla (60–)110–220(–290) μm thick, hyaline, consisting of hyphae 2–3 μm in diam. Lower cortex (30–)50–70(–90) μm thick, hyaline with the outermost part (ca. 10 μm) brown, consisting of ca. 7 cell layers, with thick cell walls in the inner part. Perithecia common, (130–)220–350(–490) μm high and (90–)190–330(–460) μm wide, with

Table 4. Statistical measurements for *Dermatocarpon bachmannii*, *D. deminuens*, *D. meiophyllizum*, and *D. rivulorum*. \bar{X} = arithmetic mean, SD = standard deviation and n = number of measurements.

	<i>bachmannii</i>	<i>deminuens</i>	<i>meiophyllizum</i>	<i>rivulorum</i>
Lobe size (mm)	\bar{X} = 18 SD = 6 n = 126	\bar{X} = 10 SD = 3 n = 102	\bar{X} = 9 SD = 3 n = 55	\bar{X} = 22 SD = 8 n = 75
Dry thickness (mm)	\bar{X} = 0.40 SD = 0.10 n = 125	\bar{X} = 0.32 SD = 0.07 n = 61	\bar{X} = 0.49 SD = 0.13 n = 31	\bar{X} = 0.33 SD = 0.09 n = 55
Wet thickness (mm)	\bar{X} = 0.331 SD = 0.065 n = 66	\bar{X} = 0.286 SD = 0.053 n = 57	\bar{X} = 0.398 SD = 0.113 n = 31	\bar{X} = 0.271 SD = 0.082 n = 33
Upper cortex thickness (μm)	\bar{X} = 103 SD = 23 n = 63	\bar{X} = 89 SD = 23 n = 57	\bar{X} = 129 SD = 44 n = 48	\bar{X} = 68 SD = 12 n = 24
Algal layer thickness (μm)	\bar{X} = 78 SD = 27 n = 64	\bar{X} = 62 SD = 21 n = 55	\bar{X} = 91 SD = 26 n = 29	\bar{X} = 52 SD = 20 n = 36
Medulla thickness (μm)	\bar{X} = 166 SD = 52 n = 65	\bar{X} = 143 SD = 45 n = 57	\bar{X} = 191 SD = 71 n = 29	\bar{X} = 150 SD = 66 n = 36
Lower cortex thickness (μm)	\bar{X} = 58 SD = 13 n = 66	\bar{X} = 54 SD = 11 n = 57	\bar{X} = 75 SD = 15 n = 29	\bar{X} = 48 SD = 11 n = 36
Perithecia height (μm)	\bar{X} = 286 SD = 67 n = 62	\bar{X} = 248 SD = 47 n = 52	\bar{X} = 305 SD = 70 n = 60	\bar{X} = 334 SD = 68 n = 30
Perithecia width (μm)	\bar{X} = 258 SD = 72 n = 62	\bar{X} = 226 SD = 56 n = 52	\bar{X} = 242 SD = 86 n = 16	\bar{X} = 299 SD = 66 n = 30
Spore length (μm)	\bar{X} = 18.0 SD = 1.8 n = 257	\bar{X} = 17.9 SD = 2.2 n = 192	\bar{X} = 16.3 SD = 1.8 n = 89	\bar{X} = 18.3 SD = 2.4 n = 110
Spore width (μm)	\bar{X} = 6.9 SD = 0.9 n = 257	\bar{X} = 6.4 SD = 0.9 n = 192	\bar{X} = 6.9 SD = 0.9 n = 89	\bar{X} = 7.1 SD = 1.0 n = 110

hyaline, in the uppermost part brown exciple; ostiolum slightly protruding, black. Spores simple, (14–)16–20(–25) μm long, (4–)6–8(–9) μm wide. Pycnidia rare, ostiolum similar to that of the perithecia.

Ecology. *Dermatocarpon bachmannii* usually grows on basic rock-types, such as serpentine or calcareous rocks. It occurs in seasonal seepages or otherwise wet locations, usually on slightly sloping rocks but may also grow on almost vertical rocks in rather exposed situations. It often grows together with *Staurothele* spp., and has a boreal to alpine distribution.

Nordic distribution. Finland: A; Iceland: IAu; Norway: Øf, AAg; Sweden: Boh, Vg, Ög, Vrm, Srm, Upl, Mpd, ÅL.

Remarks. *Dermatocarpon bachmannii* is characterized by a grey upper surface and a lower surface that is usually distinctly reticulate and dark brown to black. It has a thicker thallus and larger lobes than *D. deminuens*. Anders originally (1922) described the species as small: “Thalli bis 5 mm im Durchmesser messend”. This may be a printer’s error since the type material has lobes up to 12 mm large and Anders (1928) later writes that *D. bachmannii* has thalli measuring 5–15 mm. The type material consists of small specimens, but their thickness and gross morphology agree with *D. bachmannii* as conceived here. Mature individuals of *D. bachmannii* are easily separated from *D. deminuens*, but since the thallus size and thickness are the diagnostic characters most easily observed, young individuals of *D. bachmannii* may be misidentified as *D. deminuens*. Anders’ herbarium is kept in Prague (PRM) but no original material of *D. bachmannii* was located there and a well developed syntype of the species in Uppsala (UPS) was chosen as a lectotype.

Selected specimens studied (ca. 40). — **Finland.** Åland: Jomala par., Kungsö. Near lake Katthavet, 1945 *Fagerström* (Räsänen, Lichenoth. Fenn. 298, UPS). **Norway.** Østfold: Rakkestad hd., Brekke ved Glomma, 1996 *Løfall* L670 (O). **Sweden.** Västergötland: Angered par., Gunnilse, 1950 *Magnusson* 22 015 (UPS); Värmland: Eskilsäter par., Rosenborg, 1966 *Sundell* 5 102 (UPS); Uppland: Bondkyrko par., Stabby vicarage, 1946 *Degelius* (UPS); Medelpad: Indal par., between Kvarndalen and the Kävsta bridge, 1952 *Santesson* (UPS); Åsele Lappmark: Vilhelmina par., Mt. Röberg 1970 *Santesson* 22 419 (Moberg, Lich. sel. exs. 5, UPS).

2. *Dermatocarpon deminuens* Vain. (Fig. 4C)

Acta Soc. Fauna Flora Fenn. 49: 15. 1921. — Type: Finland. Varsinais-Suomi, Finby, Korkmäki, 22.VIII.1920 *Vainio* (TUR-V 30 064, lectotype, designated here).

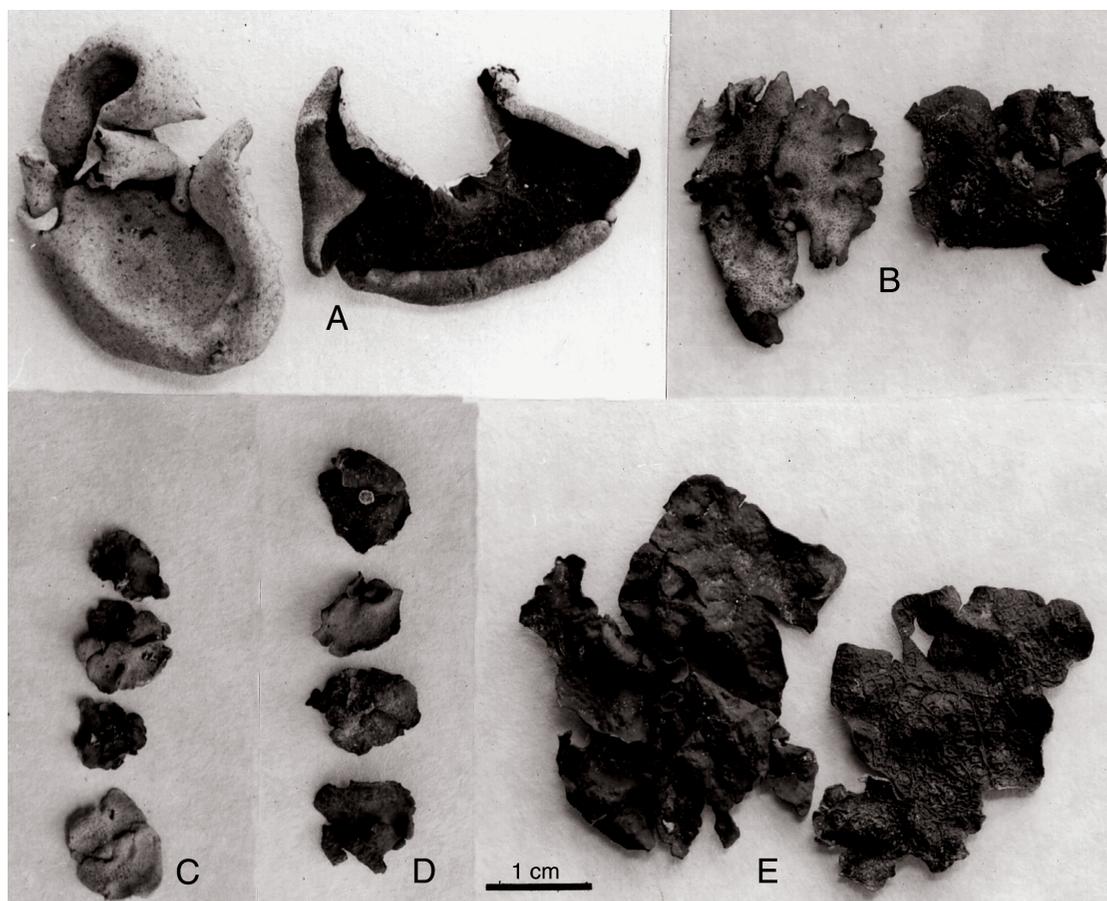
Dermatocarpon laatokkaense Räsänen, Ann. Bot. Soc. Zool.–Bot. Fenn. “Vanamo” 5: 5. 1934. — Type: Russia. Karelia ladogensis, Kurkijoki, Kuuppala, 7.IV.1923 *Räsänen* (H, lectotype, designated here).

Thallus usually single-lobed but occasionally consisting of aggregations of few lobes. Lobe size (4–)7–13(–16) mm. Upper surface pruinose, grey or occasionally slightly brownish with an epinecral layer consisting of air filled hyphae; lower surface smooth to rugose to reticulate, light to dark brown. Thickness of dry thallus (0.18–)0.26–0.39(–0.47) mm, of wet (0.19–)0.23–0.34(–0.45) mm. Upper cortex (40–)70–110(–190) μm thick, hyaline with the outermost part (ca. 10 μm) brownish. Algal layer (30–)40–80(–140) μm thick; photobiont usually arranged in clusters in the upper cortex. Size of algal cells 5–9 μm . Medulla (70–)100–190(–290) μm thick, hyaline consisting of hyphae 2–3 μm in diam. Lower cortex (30–)40–70(–90) μm thick, hyaline with the outermost part (ca. 10 μm) brown to dark brown, consisting of ca. 7 cell layers, with thick cell walls in the inner part. Perithecia common, (160–)200–300(–380) μm high and (120–)170–280(–400) μm wide with hyaline, in the uppermost part brown exciple; ostiolum immersed or slightly protruding. Spores usually simple but occasionally 1–3 septate, (11–)16–20(–23) μm long and (4–)6–7(–10) μm wide. Pycnidia not as common as perithecia, ostiolum similar to that of the perithecia.

Ecology. *Dermatocarpon deminuens* grows on both acidic and basic rock-types. It often occurs in the splash zone of lake shores or along streams or in seepages on slightly sloping rocks or occasionally on vertical rocks. It often grows together with *D. meiophyllizum*, *Staurothele* spp. and *Verrucaria* spp., and has a boreal distribution.

Nordic distribution. The Faeroe Islands; Finland: A, V, EH; Iceland: ISu, IVe, IAu; Norway: Øf, Akh, Aag, Trs; Sweden: Bl, Sm, Boh, Vg, Ög, Nrk, Srm, Vrm, Upl, ÅL.

Remarks. *Dermatocarpon deminuens* is characterized by the grey upper surface, and small and rather thin lobes. It is sometimes found growing



Figs. 4. — A: *Dermatocarpon bachmannii* (Santesson 22 419, UPS). — B: *D. bachmannii* (Heiðmarsson 604, UPS). — C: *D. deminuens* (Heiðmarsson 98, UPS). — D: *D. meiophyllizum* (Magnusson 23 906, UPS). — E: *D. rivulorum* (Moberg 7 028, UPS).

with *D. miniatum* (L) Mann., but it is then easily distinguished from small *D. miniatum* individuals by being fertile when small.

Selected specimens examined (ca. 90). — **Faeroe Islands.** Nólsoy: Nýggjaurð, 1995 Heiðmarsson 467 (UPS). **Finland.** Åland: Jomala par., Kungsö, cliffs by the lake Katthavet, 1996 Heiðmarsson 610 (UPS). **Russia.** Karelia ladogensis: Kurkijoki, Kauppakylä, 1933 Räsänen (Räsänen, Lich. Fenn. Exs. 336, UPS); Kurkijoki, Pohjii, Kaksonen, 1939 Räsänen & Ahlner (Räsänen, Lich. Fenn. Exs. 693, UPS); Kurkijoki, insula Sitturi prope Kukri, 1939 Räsänen & Pankakoski (Räsänen, Lich. Fenn. Exs. 694, UPS). **Sweden.** Västergötland: Långered par., Hällnäs udde, 1949 Magnusson 21 777 (UPS); Östergötland: Rogslösa par., N of Borghamn, 1995 Heiðmarsson 98 (UPS); Uppland: Härjarö, Härjaröudd, 1973 Santesson 24 317 (UPS).

3. *Dermatocarpon meiophyllizum* Vain. (Fig. 4D)

Acta Soc. Fauna Flora Fenn. 49: 14. 1921. — Type: Finland. Uusimaa, Helsinki, Tali, 1894 Vainio (TUR-V 30 061 lectotype, designated here).

Dermatocarpon bachmannii var. *inundatum* Klem., Věstn. Král. České. Společn. Nauk, Tř. Mat.-Přír. 2: 3. 1932. — Type: Czech Republic. Nordböhmen, Vodamühle (Bez. Karadem), 270 m, 1931 Klement (PRM-751 172 lectotype, designated here).

Dermatocarpon meiophyllum Vain. Acta Soc. Fauna Flora Fenn. 49: 16. 1921. — Type: Finland. Uusimaa, Vantaa, Tikkurila, 1906 Vainio (TUR-V 30 076 lectotype, designated here).

Thallus single-lobed with the lobe ends usually straight. Lobe size (4–)6–12(–17) mm. Up-

per surface light to dark brown, with an epinecral layer consisting of compressed hyphae; lower surface more or less smooth, usually with darker colour than the upper surface, brown to dark brown. Thickness of dry thallus (0.31–)0.36–0.62(–0.89) mm, of wet (0.20–)0.29–0.51(–0.62) mm. Upper cortex (60–)90–170(–270) μm thick, hyaline with the outermost part (ca. 10 μm) brown. Algal layer (40–)70–120(–140) μm thick; photobiont scattered in the upper cortex. Size of algal cells 6–10 μm . Medulla (60–)120–260(–320) μm thick, hyaline, consisting of hyphae 2–4 μm in diam. Lower cortex (40–)60–90(–110) μm thick, hyaline with the outermost part (10–15 μm) brown, consisting of 7–9 cell layers, with more or less angular cells 6–11 μm in diam. with thin cell walls; lower cortex may also consist of cells with thick cell walls in the innermost part. Perithecia common, 240–380 μm high and 160–330 μm wide, with hyaline, in the uppermost part brown exciple; ostiolum immersed, black. Spores simple, (11–)15–18(–21) μm long, (5–)6–8(–10) μm wide. Pycnidia common, more or less spherical, ostiolum similar to that of the perithecia.

Ecology. *Dermatocarpon meiohyllizum* grows on both acidic and basic rock-types. It often occurs in the splash zone of lake shores or along streams, or in seepages on slightly sloping rocks, or occasionally on vertical rocks. It often grows together with *D. deminuens*, *Staurothele* spp. and *Verrucaria* spp., and has a boreal distribution.

Nordic distribution. The Faeroe Islands; Finland: A, V, U, LK; Iceland: IVe; Norway: Øf, Opl, Bsk, Hrd, Nrd; Sweden: Sk, Bl, Sm, Dls, Boh, Vg, Ög, Nrk, Vrm, Srm, Upl, Dlr, Ång, Jmt, LyL, LuL.

Remarks. *Dermatocarpon meiohyllizum* is characterized by a brown upper surface and a small, umbilicate, and thick, more or less single-lobed thallus and usually a dark brown lower surface. According to the original description (Vainio 1921), the length of the spores is 11–14 μm . I have measured the spores of the lectotype and found spores up to 16 μm long although the majority of the spores were shorter. Vainio (1921) described both *D. meiohyllizum* and *D. meiohyllum*. According to him, the main differences between them is the pruinosity of the upper surface (epruinose in *D. meiohyllizum*, pruinose in *D. meiohyllum*). Part of the type collection of

D. meiohyllum is a typical *D. meiohyllizum* with brown pruinose upper surface and dark brown lower surface, but some other specimens in the same collection have a light brown lower surface. I have designated the part of the type collection that has a dark brown lower surface as the lectotype. A syntype of *D. meiohyllum* (TUR-V 30 080) with an epinecral layer made of air filled hyphae and 11–14 μm long spores belongs to some other taxa, probably *D. miniatum*. Acharius (1799(“1798”)) described *Lichen leptophyllum* (*D. leptophyllum* (Ach.) K. G. W. Lång) on heterogeneous material. The protologue fits *D. meiohyllizum* as conceived here and fig. 3 in tab. III of Methodus (Acharius 1803) likewise depicts *D. meiohyllizum*. Vainio (1921) later lectotyped *D. leptophyllum* on the small individuals of *D. leptophyllum* present in the type collection and at the same time identified the other part of the type collection as *D. meiohyllum* (= *D. meiohyllizum*).

Selected specimens examined (ca. 70). — **Faeroe Islands.** Kunoy: Byrgið, along Hjarðardalsá, 1995 *Heiðmarsson* 455 (UPS); Nólsoy: Nýggjaurð, 1995 *Heiðmarsson* 468 (UPS). **Finland.** Åland: Geta par., Dånö, 1996 *Heiðmarsson* 582 (UPS); Varsinais-Suomi: Turku, Ruissalo, 1922 *Kari* (TUR); Uusimaa: prope Helsingforsiam, Dickursby, 1880 *J. P. Norrlin* (Norrin et Nylander, Herb. Lich. Fenn. 388, UPS, LD). **Iceland.** Vestur-Ísland: Gullbringusýsla, Urtartjörn, 1996 *Heiðmarsson* 702 (UPS). **Norway.** Buskerud: Hole hd., the island Storøya in lake Tyrifjorden, southern part, 1981 *Timdal* 3 134 (O); Nordland: Vega hd., Vega island, lake Floavand, 1978 *Degelius* V-2 168 (UPS). **Sweden.** Bohuslän: Norum par., St. Askerön, W-part, 1953 *Magnusson* 23 906 (UPS); Västergötland: Långered par., Hällnäs udde, 1949 *Degelius* (UPS); Östergötland: V. Tollstad par., Hästholmen, 1995 *Heiðmarsson* 86 (UPS); Uppland: Bondkyrko par., Rickomberga backar, 1946 *Svenonius* (UPS); Dalarna: Rättvik par., by lake Siljan at the cape south of Vikarbystrand, 1938 *Santesson* 912 (UPS).

4. *Dermatocarpon rivulorum* (Arnold) Dalla Torre & Sarnth. (Fig. 4E)

Die Flechten von Tirol, Vorarlberg und Liechtenstein, 504. 1902. — *Endocarpon rivulorum* Arnold, Verh. Zool.–Bot. Ges. Wien, 24: 249. 1874. — Type: Austria. Tyrol, Rosskogel 1867 *Arnold* (M, lectotype designated by Degelius, 1934: 152).

Thallus single-lobed or consisting of a few lobes with the lobe ends sometimes inrolled. Lobe size (10–)13–30(–44) mm. Upper surface brown

to dark brown, occasionally light brown, bulging, with a thin epinecral layer consisting of compressed hyphae; lower surface with colour similar to the upper surface, distinctly reticulate with few main veins up to 2–3 mm high, and rather straight and smaller irregular veins between the main veins. Thickness of dry thallus (0.14–)0.24–0.42(–0.59) mm, of wet (0.15–)0.19–0.35(–0.52) mm. Upper cortex 60–80 µm thick, hyaline with the outermost part (10–15 µm) light brown to brown consisting of cells that are more or less isodiametric, paraplectenchymatous, 5–7 µm in diam. Algal layer 30–70(–120) µm thick; photobiont arranged in clusters in the upper cortex and sometimes reaching the medulla. Size of algal cells 6–10 µm. Medulla (50–)80–220(–380) µm thick, hyaline, consisting of rather loosely interwoven hyphae that is 2–3 µm in diam. Lower cortex (30–)40–60(–80) µm thick with the outermost part (ca. 10 µm) light brown to brown, consisting of ca. 6 cell layers of more or less angular cells which have thin cell walls and larger in the innermost part, 6–11 µm but smaller in the outermost part, 5–7 µm; lower cortex may also consist of cells with thick cell walls in the innermost part. Perithecia common, (210–)270–400(–480) µm high and (180–)230–370(–410) µm wide with hyaline, often in the uppermost part brown exciple; ostiolum immersed or slightly protruding, black. Spores usually simple but sometimes 1-septate and occasionally 2–4-septate, (14–)16–21(–26) µm long and 6–8(–10) µm wide. Pycnidia rather common more or less spherical, ostiolum similar to that of the perithecia or the pycnidia are positioned in warts that may be mistaken for a parasitic fungus.

Ecology. *Dermatocarpon rivulorum* grows in seepages or along small streams, and may be completely inundated during the summertime. It is often found in melt-water seepages below snowbeds and has an alpine to arctic distribution. In Scandinavia, *D. rivulorum* is only found in high mountains but on Iceland it grows on the shore of a lake fed by a glacial river in the lowlands.

Nordic distribution. Finland: EnL; Iceland: IAU; Greenland; Norway: Opl, Bsk, Rog, Hrd, Sfj, STr, Fnm; Sweden: Jmt, TL.

Remarks. *Dermatocarpon rivulorum* is characterized by the brown, bulging upper surface and the distinctly reticulate lower surface. The thallus is thin and the pycnidia are often located in warts.

The epinecral layer of *D. rivulorum* occasionally consists of airfilled hyphae. Fagerström (1946) gives a list of localities in the Åland Islands where “*D. rivulorum*” was found but the collections that I have seen belong to *D. bachmannii*. Degelius (1948) and Håkanson (1950) reported *D. rivulorum* from Uppland in Sweden but in both cases the collections belong to *D. bachmannii*.

Selected specimens examined (ca. 70). — **Finland.** Enontekiön Lappi: Toskalharji, 1947 *Huuskonen* (Räsänen, Lichenoth. Fenn. 372, UPS); Urtasvankka. prope lim. Norvegiae, prope lacum Luossujärvi, 1955 *Huuskonen* (Hakulinen, Lichenoth. Fenn. 900, UPS); NW-pars, W-Ridni, 1956 *Huuskonen* (Hakulinen, Lichenoth. Fenn. 925, UPS); W-Marfivaarri, 1956 *Huuskonen* (Hakulinen, Lichenoth. Fenn. 975, UPS). **Iceland.** Austur-Ísland: Suður-Múlasýsla, lake Lagarfljót, just S of Egilsstaðir, 1996 *Heiðmarsson* 618A (UPS). **Norway.** Hordaland: Ullensvang hd., Hardangervidda, Vassdalen between Valdalsæter and Litlos, 1947 *Degelius* (UPS). **Sweden.** Jämtland: Undersåker par., Sylarna, N-slope of Slottet, 1949 *Santesson* 49 255 (UPS); Torne Lappmark: Jukkasjärvi par., Njulla, just above the small lake between Njulla and Slättatjåkka, 1986 *Moberg* 7 028 (UPS).

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