

## ***Pseudomicrodochium bryophilum* – a new conidium-forming ascomycete on foliose liverworts**

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**Abstract:** Döbbeler, P. & Braun, U. 2021: *Pseudomicrodochium bryophilum* – a new conidium-forming ascomycete on foliose liverworts. *Schlechtendalia* **38**: 326–330.

A hepaticolous species of the ascomycete genus *Pseudomicrodochium* is described as *P. bryophilum* sp. nov. It forms inconspicuous, very small conidiomata and two-septate, light brown phialoconidia. The species has been recorded on *Nowellia curvifolia* and *Ptilidium pulcherrimum*. It occurs in North America (USA, Maine), Europe (Germany, Austria), and East Asia (Russia, Japan). A previously published key to the species of *Pseudomicrodochium* is updated here.

**Zusammenfassung:** Döbbeler, P. & Braun, U. 2021: *Pseudomicrodochium bryophilum* – ein neuer Konidien-bildender Ascomycet auf foliosen Lebermoosen. *Schlechtendalia* **38**: 326–330.

Eine hepaticole Art der Ascomyceten Gattung *Pseudomicrodochium* wird als *P. bryophilum* sp. nov. beschrieben. Sie bildet unauffällige, sehr kleine Conidiomata und zwei-septierte, hell braune Phialokonidien. Die Art wurde auf *Nowellia curvifolia* und *Ptilidium pulcherrimum* gefunden. Sie wird für Amerika (USA, Maine), Europa (Deutschland, Österreich) und Ostasien (Russland, Japan) nachgewiesen. Ein früher publizierter Schlüssel der Arten von *Pseudomicrodochium* wird aktualisiert.

**Key words:** Dematiaceous hyphomycetes, *Ascomycota*, bryophilous, hepaticolous.

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The vast majority of fungi that obligately develop on bryophytes belong to fruit-body forming ascomycetes. A smaller number of “imperfect fungi” are known to infect liverworts and mosses. These species are parasites or saprotrophs that also develop on the dead setae and capsules of mosses. They were comprehensively treated by Racovitza (1959). His review remains the most accurate, up-to-date overview available. However, a growing number of ascomycetes with ascomata and anamorphic hyphomycete stages have been documented by *in situ* observations. They belong predominantly to hypocrealean species on foliose liverworts (Döbbeler 2018, Döbbeler & Davison 2017).

In the course of field studies in the USA in July 2013, focusing on bryophilous ascomycetes, a microsporodochial dematiaceous hyphomycete was repeatedly collected on leaves of *Nowellia curvifolia* and *Ptilidium pulcherrimum*. Screening herbarium samples of *N. curvifolia* held in the Botanische Staatssammlung München (M) revealed more records from remote regions of the Northern Hemisphere. Attempts to cultivate and sequence the species failed. The identification of this fungus and its assignment to a particular genus was challenging. Finally, its affiliation to the genus *Pseudomicrodochium* B. Sutton (Sutton 1975) was elucidated.

This genus originally described a mucedinaceous hyphomycete, but later the generic circumscription was expanded to include species with pigmented structures. A survey of this genus, including a key to the species of *Pseudomicrodochium*, was published by Castañeda et al. (1998). The phylogeny of *Pseudomicrodochium*, based on its type species (*P. aciculare* B. Sutton), remains unknown. *P. fusarioides* B. Sutton & C.K. Campb. is the only species assigned to *Pseudomicrodochium* that has been phylogenetically analysed, although it was subsequently reallocated to *Cyphellophora* G.A. de Vries (Decock et al. 2003). Thus, *Pseudomicrodochium* can only be applied in its current sense, as outlined in Castañeda et al. (1998) and Seifert et al. (2011). Sporodochial colonies, usually monophialidic conidiogenous cells arising from superficial hyphae or hyphal aggregations, lateral or occasionally terminal, and solitary, septate conidia, are characteristic for the new bryophilous fungus, and support its placement in *Pseudomicrodochium*. There is only one other comparable species that has been assigned to the genus, viz., *P. triseptatum* Matsush. (Matsushima 1995: 32). *P. triseptatum*, described from Peru and found on the dead petioles of a palm tree species, is morphologically similar, but differs in the following conidial features: conidia usually 3-septate, olivaceous, broad subcylindrical with rounded ends, not constricted at the septa. The morphological peculiarities of the newly discovered fungus, and its unusual ecological niche on liverworts, merit its proposal as a new species.

*Pseudomicrodochium bryophilum* Döbbeler & U. Braun, **sp. nov.**

Figs 1, A–F

MycoBank, MB842112.

**Etymology:** *Bryophilus* (Gr.) = bryophilous; refers to bryophytes as substrate of the fungus.

**Holotype:** USA, Maine, Washington County, Town of Beals: Great Wass Island, Great Wass Island Preserve, Little Cape Point Trail, 44°28'52''N, 67°35'41''W, wet coastal spruce forest, on *Nowellia curvifolia*, 10 Jul 2013, P. Döbbeler 9516 (NY).

**Diagnosis:** Morphologically similar to *Pseudomicrodochium triseptatum*, but conidia 2-septate, light brown, obviously constricted at the septa, cells unequal, distal cell hemispherical, middle cell mostly thickest, proximal cell often somewhat attenuated towards the base.

**Description:** Colonies form on and between the host leaves, gregarious, sporodochial, circular, elliptical to irregular in outline with fuzzy (due to innumerable conidia), often sinuate margin, appanate to cushion-shaped, rarely semiglobose, greyish or olive brown to less often dark brown to almost black, size variable, (15–)20–70(–100) µm diam., up to about 30 µm high. Hyphae superficial or basally slightly immersed into the outermost part of the host cell wall, with ramifications and anastomoses, light brown, smooth, (1–)1.5–2(–2.5) µm wide, single or to two or several forming strands (near colonies), closely following the host's anticlinal cell walls and thus mirroring the cell net. Phialides arising from hyphae attached to the substrate, aggregated, forming plates, laterally viewed subglobose, ellipsoid or conical to broad ampulliform, 3.5–4.5 × 3–4 µm, laterally sometimes deformed by mutual pressure; phialides recognizable by an apical 0.5–1 µm large pore (visible as a light spot in transmitted light). Conidia solitary, narrowly ellipsoid, straight to sometimes slightly bent, smooth, light brown, 2-septate, rarely (1–)3-septate, (7–)7.5–9(–9.5) × (2.5–)3–4(–4.5) µm (up to 11.5 µm long, if conidia 3-septate), obviously constricted at the septa (especially in the Japanese specimen); middle cell in most cases the thickest, end cells usually unequal in shape, size, and colour, distal cell hemispherical, proximal cell often tapering towards the base, that may be truncated, but without a recognizable scar, sometimes both end-cells or even all 3 cells of the same shape and size; the middle cell typically darker than both lateral cells or, at least, darker than the proximal cell; cytoplasm of the proximal cell may react slightly with lactophenol cotton-blue.

**Hosts:** *Nowellia curvifolia* (Dicks.) Mitt. (*Cephaloziales*, *Jungermanniales*), *Ptilidium pulcherrimum* (Weber) Vain. (*Ptilidiaceae*, *Ptilidiales*).

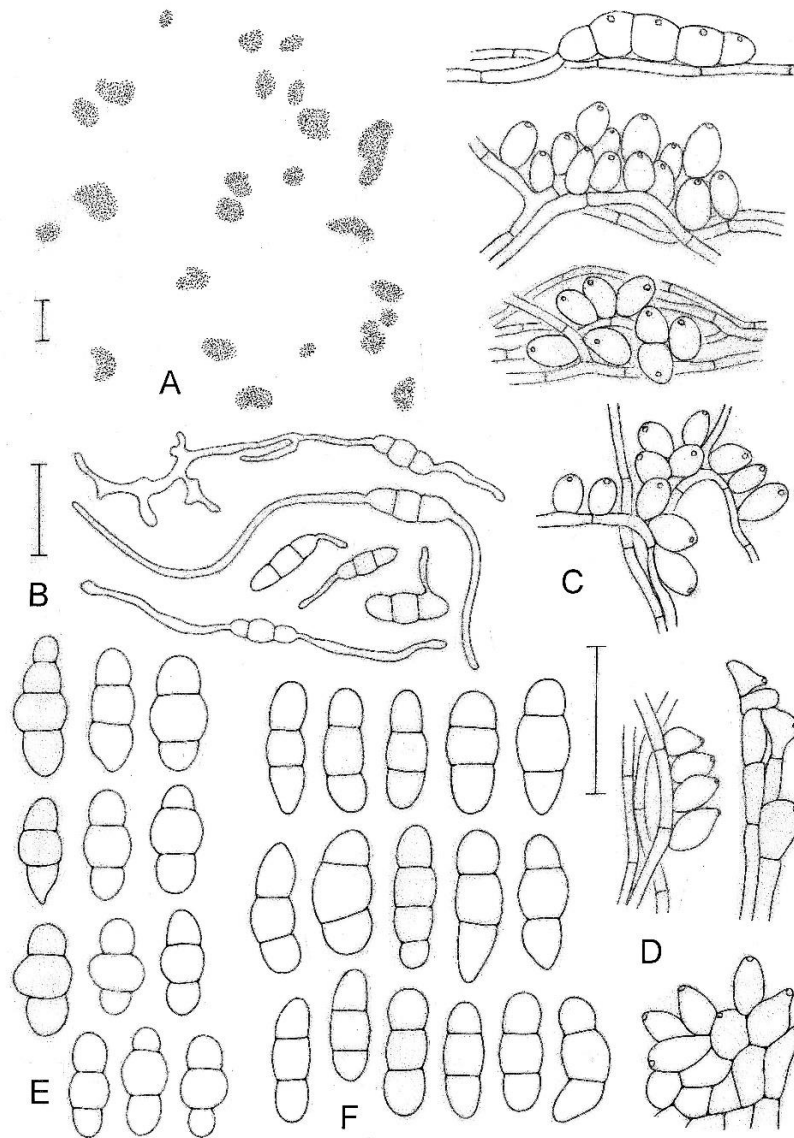
**Additional specimens examined:** USA, Maine, Washington County, Town of Steuben: Eagle Hill Institute, along Yellow Trail to Dyer Bay, 44°27'N, 67°56'W, 0–65 m alt., on *Nowellia curvifolia*, 7 Jul 2013, P. Döbbeler 9468 (M), 9470 (GZU); along Yellow Trail below Lover's Leap, 50 m alt., on *N. curvifolia* and *Ptilidium pulcherrimum*, 14 Jul 2013, P. Döbbeler 9585 (HAL 3466 F); along Red Trail off easternmost parking lot, 44°27'34''N, 67°55'53''W, 71 m alt., on *N. curvifolia*, 8 Jul 2013, P. Döbbeler 9480 (NY); Wilderness Shores, South of Wilderness Shores Road 0.8 miles west of Mogador Road at junction of Wilderness Shores Road N and S, 44°26'27''N, 67°57'16''W, 17 m alt., on *N. curvifolia*, 11 Jul 2013, P. Döbbeler 9564 (NY). Town of Beals: Great Wass Island, Great Wass Island Preserve, Little Cape Point Trail, 44°28'52''N, 67°35'41''W, on *N. curvifolia* and *P. pulcherrimum*, 10 Jul 2013, P. Döbbeler 9513 (HAL 3467 F).

Germany, Bavaria, Upper Bavaria: Landkreis Bad Tölz: Schmiedlains Valley between Lainbach Valley and Eibelsfleck Alp, southeast of Benediktbeuern, 750–1000 m alt., on *N. curvifolia*, 8 Apr 1978, P. Döbbeler 3027 (M). Landkreis Garmisch-Partenkirchen: Wamberger Ridge, slopes southeast of Wamberg near Garmisch-Partenkirchen, 1100–1250 m alt., on *N. curvifolia*, 18 Sep 1977, R. Lotto & P. Döbbeler 2859 (M). Ammergauer Alps, Katzen Valley immediately north of Oberau, 800 m alt., on *N. curvifolia*, 24 Mar 1979, H. Hertel 19768 (M).

Austria, Tyrol: Karwendel, Lalider Valley, 20 km linear distance E to ENE of Mittenwald, 47°26'N, 11°32'E, 1400 m alt., on *N. curvifolia*, 23 July 1995, H. Hertel 38689 (M).

Russia, Russian Far East, Khabarovsk Territory: Tardoki-Yani Range, southern spurs at Sukhaya Pad' Stream middle course, 2.5 km upstream of its mouth, 48°50'N, 138°06'E, 620 m alt., on *N. curvifolia*, 28 Aug 2013, V.A. Bakalin KH-45-39-13; Hep. Ross. Exs. IX, 223, sub *N. curvifolia* (M).

Japan, Wakayama Prefecture: Jodo, Oto, 450 m alt., on *N. curvifolia*, 17 Jan 1965, T. Kodama, Hep. Jap. Exs. 15, 731, sub *N. curvifolia* (M).



**Fig. 1:** *Pseudomicrodochium bryophilum*: A – Part of a heavily infected perianth with conidiomata *in situ* seen from above. B – Germinating conidia found on leaves. C, D –Fragments of microsporodochia with phialids (squash preparations). E, F – Conidia in outline. A – on *Ptilidium pulcherrimum*; B to F – on *Nowellia curvifolia*. A, D – Döbbeler 9585; B – Various collections; C, F – Döbbeler 9516 (holotype); E – Hep. Jap. Exs. 731. Scale bars: A = 50 µm; B = 10 µm, C–F = 10 µm.

**Remarks:** The host species are not taxonomically related but share the same ecology. They are pioneer species that often form extended mats on decorticated, rotting tree trunks, branches or stumps of coniferous or deciduous trees. *Nowellia curvifolia* prefers shaded, humid conditions often near rivers and streams (Paton 1999). Although only two host species have been identified so far, the actual host spectrum is probably much wider. The predominance of *N. curvifolia* is affected by the applied method. For practical reasons only material of *N. curvifolia* was screened for the novel ascomycete species, potentially causing a false bias in the representation of possible host species. Intermingled shoots of unidentified foliose liverworts were occasionally observed to be infected by *Pseudomicrodochium bryophilum*. Both host species, *N. curvifolia* and *Ptilidium pulcherrimum*, are widely distributed in the Northern hemisphere, occurring in Europe, North America and Asia (Paton 1999).

In *Nowellia*, the conidial layers develop most often at the convex abaxial leaf side, at the surface of the perianths, rarely on the adaxial leaf side and on the stems. In *Ptilidium*, they also occur on and between the leaves, preferably on the abaxial side, and on and between the cilia. Under stereomicroscopic magnification (40×) the conidiomata can easily be confused with the faeces of small animals and colonies of cyanobacteria.

The youngest colonies occur some distance behind the growing apex of infected plants. Conidiomata are formed on living leaves as well as on withering and dead ones of lower shoot regions. The morphological structure of the host leaves remains unaltered even if the production of conidiomata is high. Apart from superficial mycelia, the lumina of dead cells are regularly colonized by individual hyphae. They grow from cell to cell and across the anticlinal walls by delicate hyphal perforations. Whether both supra- and intracellular hyphae belong to the same mycelium of *Pseudomicrodochium bryophilum* is unclear. This species should be regarded as a benign, saprotrophic parasite. It does not cause severe damage to its hosts.

The very first developmental stages of the conidiomata occur on the anticlinal host cell walls because that is where the hyphae are restricted to. Growth in all directions results in a conidial layer that completely covers the surface of several leaf cells. The large number of detached conidia obscures the conidiogenous cells and causes the diffuse colony margins.

Based on the available collections and morphological analyses used, the conidiomata cannot be related to a sexual morph. However, in some collections on *Nowellia* a species of *Epibryon* (*Epibryaceae*, *Chaetothyriales*) with small, setose ascomata and one-septate ascospores is present. *Epibryon hepaticicola* (Racov.) Döbbeler was concomitantly observed on *Ptilidium*. These *Epibryon* species are common parasites of numerous hepatics and have a mycelium undistinguishable from that of *Pseudomicrodochium bryophilum*.

### Key to the species assigned to *Pseudomicrodochium*

(Based on Castañeda et al. 1998, supplemented with *P. angamosense*, *P. bryophilum* and *P. caffrum*)

1. Conidia colourless ..... 2
- 1\* Conidia pigmented ..... 9
2. Conidia aseptate ..... 3
- 2\* Conidia septate ..... 5
3. Conidia cylindrical, ends rounded, 10–16 × 2–2.5 µm, smooth ..... *P. lauri* P.M. Kirk
- 3\* Conidia not cylindrical ..... 4
4. Conidia 28–35 × 1.5–2 µm, filiform to subobclavate ..... *P. nectandrae* R.F. Castañeda et al.
- 4\* Conidia 6–12 × 1.5–2 µm, obclavate ..... *P. antillanum* R.F. Castañeda & W.B. Kendr.
- 5(2\*) Conidia 3-septate, 13–16 × 1.8–2 µm, end cells smaller than central cells, smooth  
..... *P. candidum* (Bres.) de Hoog
- 5\* Conidia 1–2-septate ..... 6
6. Conidia acicular, 1(–2)-septate, 21.5–31.5 × 1 µm, smooth ..... *P. aciculare* B. Sutton
- 6\* Conidia cylindrical, fusiform or falcate ..... 7
7. Conidia cylindrical, with slightly tapered obtuse base, 1-septate, 16–24 × 1.5–2 µm  
..... *P. cylindricum* B. Sutton
- 7\* Conidia narrowly fusiform-falcate ..... 8
8. Conidia 30–40 × 1.5–2 µm, 1-septate, ends pointed; conidiogenous cells integrated in simple or branched conidiophores, terminal or conidiophores not integrated in conidiophores, i.e., conidiophores reduced to conidiogenous cells ..... *P. caffrum* Matsush.
- 8\* Conidia 11–20 × 2–2.5 µm, base truncated, 1(–2)-septate, guttulate; conidiophores not formed .....  
*Cyphellophora fusarioides* (B. Sutton & C.K. Campb.) Decock (≡ *P. fusarioides* B. Sutton & C.K. Campb.)
- 9(1\*) Conidia (1–)3–8-septate, fusiform-falcate ..... 10
- 9\* Conidia 1–3-septate, subcylindrical-ellipsoid ..... 11
10. Conidia 18–30 × 1–1.2 µm ..... *P. suttonii* Ajello et al.
- 10\* Conidia broader, 14–40 × 1.5–2 µm ..... *P. angamosense* Matsush.
11. Conidia (1–)3-septate, not constricted at the septa, 7.5–10.5 × 3–4 µm, olivaceous, rounded at the base ..... *P. triseptatum* Matsush.
- 11\* Conidia consistently 2-septate, 7.5–9 × 3–4 µm, light brown, obviously constricted at the septa, cells unequal, distal cells hemispherical, proximal cell often somewhat attenuated towards the base  
..... *P. bryophilum* Döbbeler & U. Braun, sp. nov.

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