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## ***Octosporella erythrostroma* (Pezizales) and *Pithyella frullaniae* (Helotiales), two remarkable ascomycetes on *Frullania dilatata*<sup>1</sup>**

With 2 Maps and 16 Figures

### Summary

*Octosporella erythrostroma* comb. nova (Pezizales) (syn. *Peziza erythrostroma*, *O. urosperma*) with perithecioid ascomata and *Pithyella frullaniae* comb. nova (Helotiales) (syn. *Pithya frullaniae*) with apothecia are redescribed based on many new records from Europe. Both species occur sporadically but obligately on the corticolous hepatic *Frullania dilatata* (Jungermanniales). *Octosporella erythrostroma* was hitherto known only from very few collections, *Pithyella frullaniae* only from the type material.

### Introduction

*Frullania dilatata* (L.) DUMORT. (Jungermanniales) is one of the most frequent and well known hepatics, often forming conspicuous

<sup>1</sup> Dedicated to Dr. D. BENKERT, Potsdam, on the occasion of his 70<sup>th</sup> birthday. I will never forget meeting Dr. BENKERT at the Museum für Naturkunde der Humboldt-Universität in the Späthstraße (formerly East Berlin) more than 20 years ago on the 27<sup>th</sup> of January 1983, following his invitation to me to give a lecture on bryophilous ascomycetes. Afterwards we discussed the systematic position of *Pithya frullaniae* and biological problems concerning Pezizales associated with bryophytes. Mycology owes a great deal to BENKERT's outstanding research on octosporaceous fungi (e.g. 1987, 1993, 1995, 1998a, b). I sincerely hope that Dr. BENKERT will continue to disentangle the taxonomic difficulties of these fascinating parasites and their unique relations to mosses and hepatics.

### Zusammenfassung

*Octosporella erythrostroma* (Pezizales) und *Pithyella frullaniae* (Helotiales), zwei bemerkenswerte Ascomyceten auf *Frullania dilatata*

*Octosporella erythrostroma* comb. nova (Pezizales) (syn. *Peziza erythrostroma*, *O. urosperma*) mit perithecioiden Ascomata und *Pithyella frullaniae* comb. nova (Helotiales) (syn. *Pithya frullaniae*) mit Apothecien werden an Hand zahlreicher Neufunde aus Europa beschrieben. Beide Arten kommen sporadisch aber obligat auf dem corticolen Lebermoos *Frullania dilatata* (Jungermanniales) vor. *Octosporella erythrostroma* war bisher nur von sehr wenigen Aufsammlungen bekannt, *Pithyella frullaniae* nur vom Typusmaterial.

dark mats on the bark of trees. It is widely distributed in Europe, the Mediterranean Islands, Macaronesia, Cape Verde Islands, Iceland, Siberia, and Southwest Asia (PATON 1999). *Frullania dilatata* is one of the very few hepatics from which several ascomycetes have been recorded (RACOVITZA 1959; DÖBBELER 1978). Actually, almost 15 parasitic species are recognized as being associated with this host (DÖBBELER, unpubl.). Two of them, the only fungi on *F. dilatata* with true or modified apothecia, are presented here.

### Material and methods

During the last two decades more than 300 specimens of *Frullania dilatata* were carefully screened for the presence of fungi. Plentiful material was

available from Central Europe and Tuscany, whereas from most parts of the host's distribution area only a few specimens or none at all were studied. The vivid orange-red colour of *Octosporella erythro stigma* gradually disappears in herbarium material, making it difficult to detect the bleached ascomata. It is therefore highly recommended to study fresh material. Strong shrinkage effects (as discussed by BARAL 1992) occur in *O. erythro stigma* when living hymenial cells are treated with chemical reagents. When looking for *Pithyella frullaniae* the interior of the host mats and their ventral sides should also be studied. All measurements and illustrations, apart from ascomata, were done from mounts treated with lactophenol-cottonblue.

***Octosporella erythro stigma* (MONT.) DÖBBELER  
comb. nova**

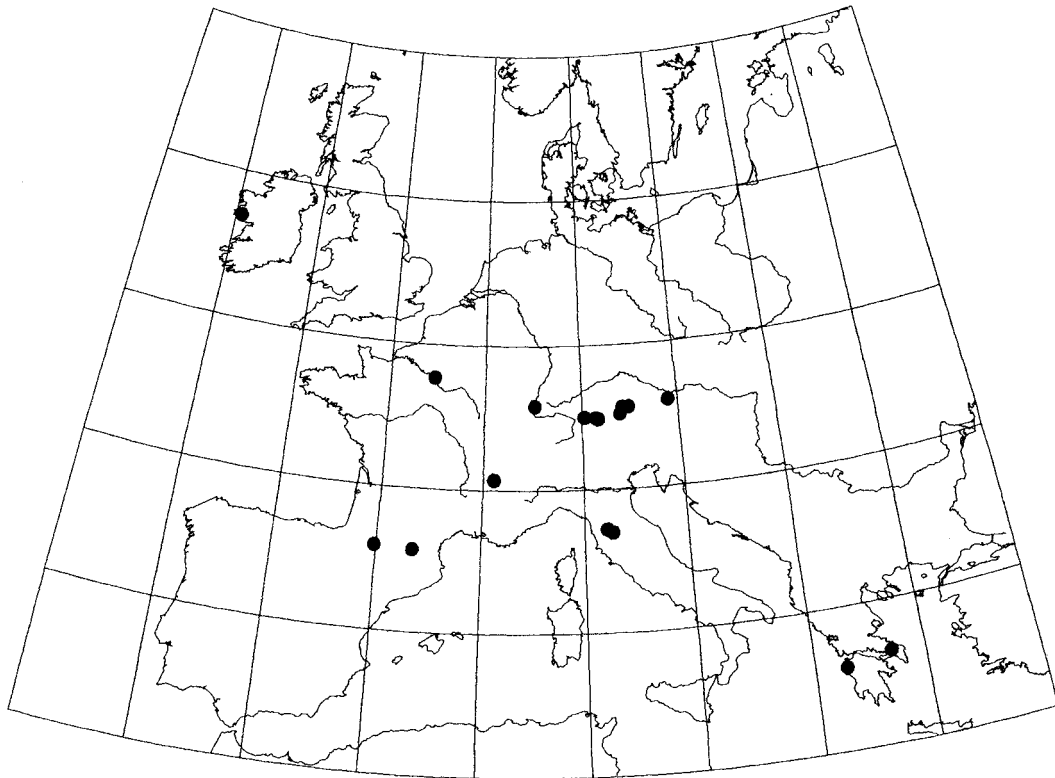
Map 1; Figs. 1–4

Basionym: *Peziza erythro stigma* MONT., Ann. Sci. Nat. Bot., 2. sér., 18: 246, no 47 (1842); Syll. gen. sp. crypt. p. 186, no. 628 (1856); non *Peziza erythro stigma* BERK. & BROOME, Ann. Mag. Nat. Hist. ser. 3, 18: 126, no 1168, pl. 4, fig. 31 (1866).

Type: France, 'ad *Frullanium dilatatum* (*Jungerman*. L.) mense septembris exeunte, prope pagum Chennevières-sur-Marne à Parisiis', MONTAGNE (PC!).

syn.: *Nectria erythro stigma* (MONT.) TUL. & C.TUL., Select. fung. carpol 3: 196 (1865).

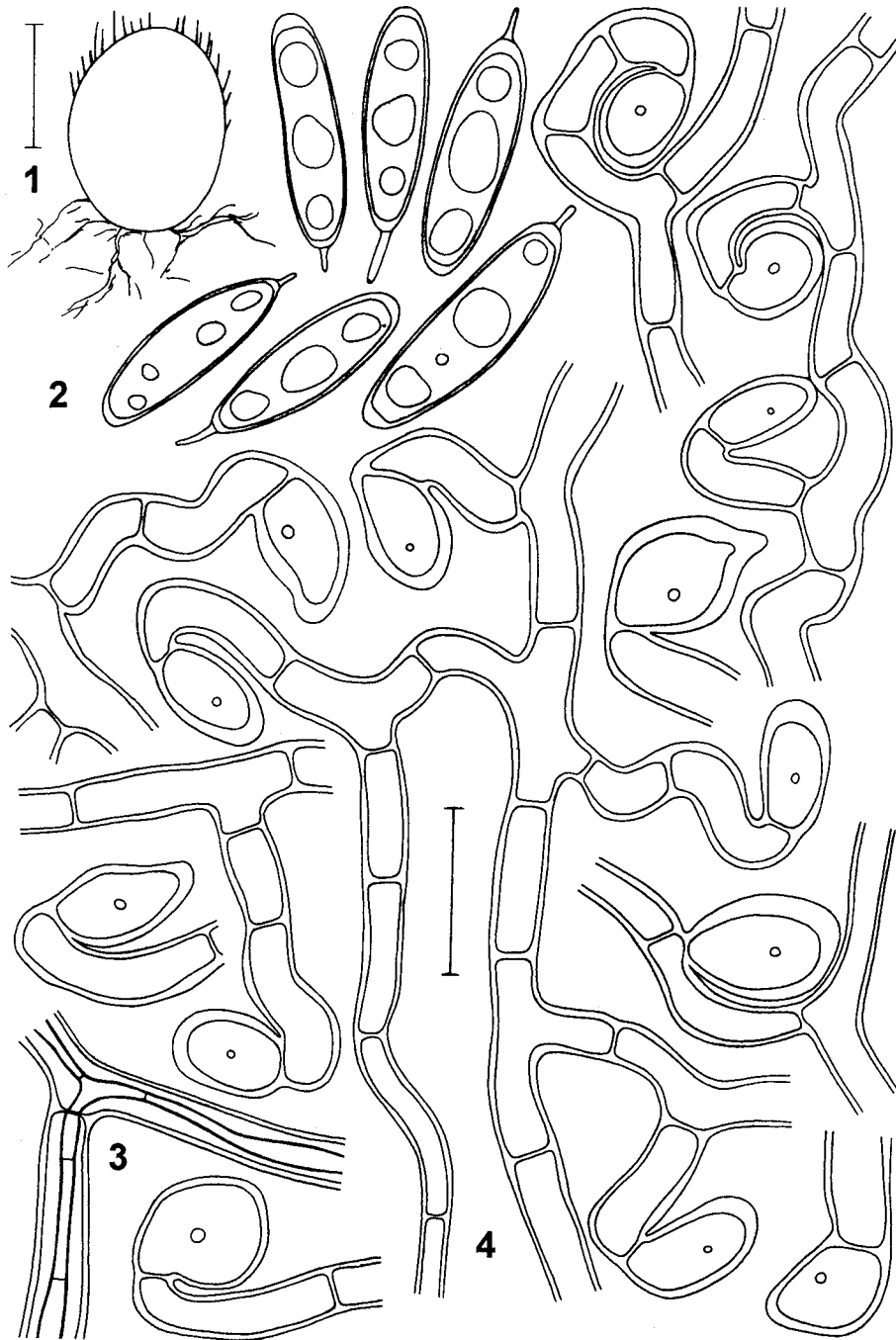
syn.: *Orbilium erythro stigma* (MONT.) SACC., Syll. fung. 8: 632 (1889).



Map 1

Distribution of *Octosporella erythro stigma*

Included are two records from Bavaria cited by DÖBBELER 1980, one of them from the same site as *P. DÖBBELER 4017*, M



Figs. 1–4

*Octosporella erythro stigma* on *Frullania dilatata* (Typus, MONTAGNE, PC)

1 — Ascoma in outline; 2 — Ascospores; 3 — Hypha within a hypha; 4 — Hyphae and appressoria

Scale bar: Fig. 1 = 150  $\mu\text{m}$ , Figs. 2–4 = 20  $\mu\text{m}$

syn.: *Nectriella erythrostigma* (MONT.) SACC., Syll. fung. 9: 942 (1891).

syn.: *Octosporella urosperma* DÖBBELER, Mitt. Bot. Staatssamml. München 16: 477, Figs. 3, 4 (1980).

Type: Germany, Bayern, Oberbayern, Bernau am Chiemsee, am Hitzelsberg, ca. 550 m alt., on *Frullania dilatata*, Feb. 1921, H. PAUL (M, holotype!).

Ascomata perithecioid, (200–)240–330 (–400) × (130–)170–250(–300) µm, ovoid or ellipsoid, rarely almost cylindrical or spherical, orange-red. Setae up to 70(–90) µm long and basally 5–8(–9) µm wide, uncoloured, straight or slightly curved, thick-walled, lumina reduced or missing, densely formed in the upper part of the ascomata. Outer excipular cells (10–)15–25(–30) µm diam., irregularly shaped, thick-walled, with yellowish droplets of varying size, mostly hidden by the setae; excipular wall 13–22(–25) µm thick. Paraphyses filamentous, 2–3(–4) µm diam., with few ramifications, anastomoses lacking, containing numerous yellowish droplets. Asci unitunicate, (70–)80–100(–115) × 15–20 µm, club-shaped, rounded at the top, without apical structures, foot short, (4-, 5-, 6-, 7-) 8-spored, spores mostly lying irregularly biseriate; iodine reaction (Lugol) negative. Ascospores (without appendage) (23–)27–33(–37) × (6–)7–9(–10) µm, narrowly ellipsoid, often slightly asymmetric, colourless, in most cases with three yellowish oil droplets, the biggest one in the middle of the spore, spore wall at both ends thickened, epispore slightly cyanophilic; spores at one end with a filamentous appendage, 2–8(–23) × 1 µm, appendage directed towards the ascus apex or to the foot within a single ascus. Hyphae (4–)5–8 µm diam., colourless, thick-walled, with ramifications and anastomoses, irregularly growing over the host cells, often with intrahyphal hyphae of the same species. Apressoria (10–)14–20(–25) × (8.5–)10–17 (–20) µm, elliptical to almost circular in outline, wall apically up to 4 µm thick, with a typically curved, 1- or 2-celled stalk. Haustoria of coiled hyphae within living cells, rich in plasmatic content; appressoria and haustoria connected by a hyphal peg which perforates the periclinal wall of the infected cell, appressoria seen from above with a central pale spot indicating the perforation.

Fruit-bodies are normally hidden with their basal parts between the dorsal lobes of vegetative shoots, rarely also between male and female bracts. Host plants bearing ascomata sometimes show signs of incipient decomposition. Two or several ascomata often develop on the same infected plant. Freshly collected ascomata remain alive for some months in the dried state. After dying off they gradually lose their pigments. Colouration of droplets in excipular cells and paraphyses and of oil guttules in the ascospores disappear. Several years old ascomata may be completely uncoloured.

MONTAGNE (1842) introduced *Octosporella erythrostigma* as one of the very first bryophilous fungi described. Although the species has strongly modified apothecia resembling perithecia, he assigned it to *Peziza* clearly recognizing its taxonomic position. Apart from the French type material the species was hitherto known only from three specimens from southern Bavaria, Germany (DÖBBELER 1980). The appendaged ascospores are a unique character within the bryophilous Pezizales making the identification of *O. erythrostigma* easy.

Host: *Frullania dilatata*.

Known distribution: Ireland, Germany, Austria, France, Italy, Greece.

Additional specimens examined:

IRELAND, West Galway (H16): Lough Corrib, Archipelago off north shore of Dooras Peninsula: 'Derry Rock North', 53°30' N, 9°22' W, 0–3 m alt., 01. May 1998, H. HERTEL 39525a (M).

GERMANY, Bayern, Oberbayern: Kreis Traunstein, Siegsdorf, Traunsteiner Aue, 600 m alt., 02. April 1953, R. GRÜTZMANN (M); Oberbayern, Umgebung von Garmisch-Partenkirchen, in der Nähe des Ortes Eibsee, um 1000 m alt., 19. Sep. 1982, P. DÖBBELER 4690 (M, herb. D. BENKERT); Schwaben, Allgäu: Straße zwischen Hinterstein und Bruck im Ostrach-Tal, ca. 840 m alt., 24. Oct. 1981, G. & P. DÖBBELER 4017 (M). – Baden-Württemberg: Landkreis Breisgau-Hochschwarzwald, südliche Umgebung von Freiburg, Hänge östlich oberhalb St. Ulrich, 800–900 m alt., 14. Sep. 1980, P. DÖBBELER 3660 (M, herb. D. BENKERT).

AUSTRIA, Tirol: Kaisergebirge, Zahmer Kaiser, Weg vom Elektrizitätswerk in Kufstein zur Vorderkaiserfelden Hütte, 1020 m alt., 03. July 2002, P. DÖBBELER 7404 (PC, TUR); with the same data, but 1030 m alt., P. DÖBBELER 7406 (E). – Niederösterreich: Sonntagsberg bei Rosenau, Aug. 1904, MATOUSCHEK (M; W. MIGULA, Crypt. Germ. Aust. Helv. Exs. 264, sub *F. dilatata*).

FRANCE, Département Isère: Couvent de la Grand Chartreuse, Avenue north of la Corrierie between la Corrierie and monastery, 940 m alt., 45°21'53" N, 5°47'30" E, 28. Aug. 2002, D. TRIEBEL & G. RAMBOLD 6465 (M). – Département Aude: Straße D 117 zwischen Quillan und Foix, kurz westlich des Ortes Puivert, 20. Sep. 1980, G. & P. DÖBBELER 3860, 3864 (M). – Département Hautes-Pyrénées: Vallée de Lesponne südwestlich Bagnères-de-Bigorre, Hänge an der D 29 kurz vor dem Ort Chiroulet, um 1060 m alt., 25. Sep. 1980, G. & P. DÖBBELER 3806 (M).

ITALY, Toskana, Prov. Firenze: Greve in Chianti, um 270 m alt., 05. Sep. 2001, P. DÖBBELER 7560 (M). – Prov. Arezzo: südliche Umgebung von Montevarchi, Waldreste kurz unterhalb des Friedhofs in San Leolino, etwa 3 km südwestlich Búcine, ca. 300 m alt., 03. Sep. 2000, P. DÖBBELER 7483 (M).

GREECE, Attiki: Párnis (nördlich von Athen) oberhalb Agia Trias, 24. Sep. 1981, G. & P. DÖBBELER 4281, 4314 (M). – Pelopónnisos: Straße etwa

33 km östlich Amaliás, etwa 1 km vor Ágia Triás, 01. Oct. 1981, G. & P. DÖBBELER 4357 (M).

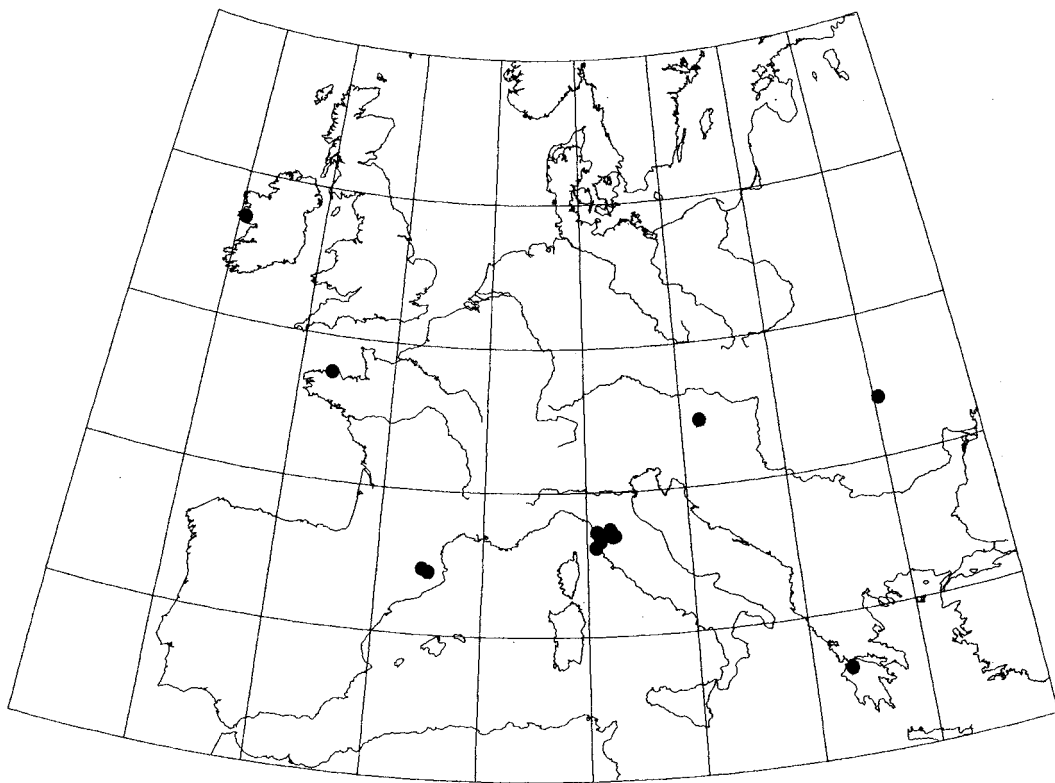
***Pithyella frullaniae* (CHALAUD) DÖBBELER comb. nova**

Map 2; Figs. 5–16

Basionym: *Pithya*<sup>2</sup> ('Pitya') *frullaniae* CHALAUD, Rev. Bryol. Lichénol. **13**: 119 (1942).

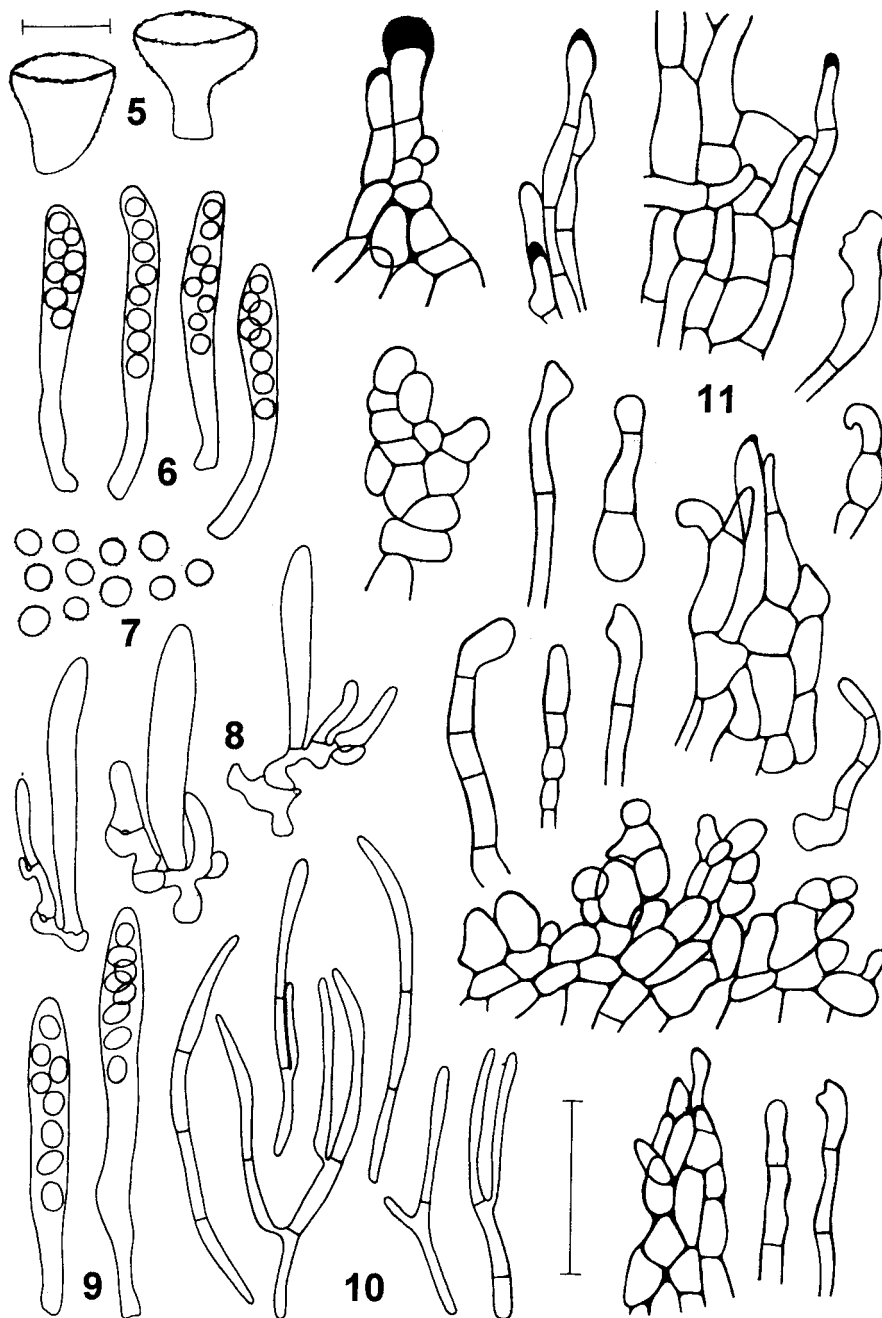
Type: France, 'sur les feuilles de *Frullania dilatata* DUM., dans la forêt de Paimpont (Bretagne)'; (not seen; only two ascomata left as indicated by CHALAUD l.c.).

Ascomata apothecioid, variable in size, 120–320(–580) µm diam., 100–200(–260) µm high, sessile or with a short stipe, ochreous to almost white, disc of the same colour or slightly paler, ascomata often of the same colour as the dead host plants; big ascomata some times undulate in outline; ascomata strongly contracting on becoming dry; setae missing,



Map 2  
Distribution of *Pithyella frullaniae*  
The Romanian record given only as 'Centralcarpathen'

<sup>2</sup> I prefer the original spelling used by FÜCKEL when introducing the genus (Symb. mycol. 317, 1870).



Figs. 5–11  
*Pithyella frullaniae*

5 — Apothecia in outline; 6 — Asci; 7 — Ascospores; 8 — Immature asci with ascogenous hyphae; 9 — Asci; 10 — Paraphyses; 11 — Appendages at the outer side of the apothecia; Figs. 5–7, 11 on *Frullania dilatata*: P. DÖBBELER 7574 (M), Figs. 8–10 on *F. teneriffae*: H. HERTEL 39537a (M)

Scale bar: Fig. 1 = 100  $\mu$ m, Figs. 6–11 = 20  $\mu$ m

but surface downy by slightly projecting irregular individual hyphae or groups of hyphae, hyphal end-cells sometimes irregularly expanded; algae, spores of other species and detritus often adhering. Excipulum and stipe composed of angular or rounded, thin-walled, slightly cyanophilic cells, (3–)4–8(–15)  $\mu\text{m}$  diam., cells apically more elongated; excipulum laterally 10–15  $\mu\text{m}$ , in the lower region to 30(–35)  $\mu\text{m}$  thick. Paraphyses filamentous, 1.5–2.5  $\mu\text{m}$  thick, with few ramifications, anastomoses missing, to the apex often slightly enlarged but without globose end-cells. Asci unilocular, (24–)28–40(–50)  $\times$  (4.5–)5–6(–7)  $\mu\text{m}$ , claviform, uniformly thin-walled, also at the apex, at the base broadly truncate, eight-spored; asci formed from croziers; iodine reaction (Lugol) negative, also after pretreatment with KOH. Ascospores (2.5–)3–3.5(–4.5)  $\mu\text{m}$ , globose, rarely subglobose, colourless or slightly brownish, more or less distinctly warted; spores uniseriate or partly biseriata. Hyphae variable, colourless, irregularly within the cell walls of the host, not restricted to the mid-lamellar region, without appendages, in leaves seen from above very delicate, often less than 1  $\mu\text{m}$  thick, in stems in transverse sections 0.5–3(–4)  $\mu\text{m}$  diam., in longitudinal sections individual cells up to 15  $\mu\text{m}$  long.

Hosts: *Frullania dilatata*, *F. teneriffae* (F. WEBER) NEES (only once).

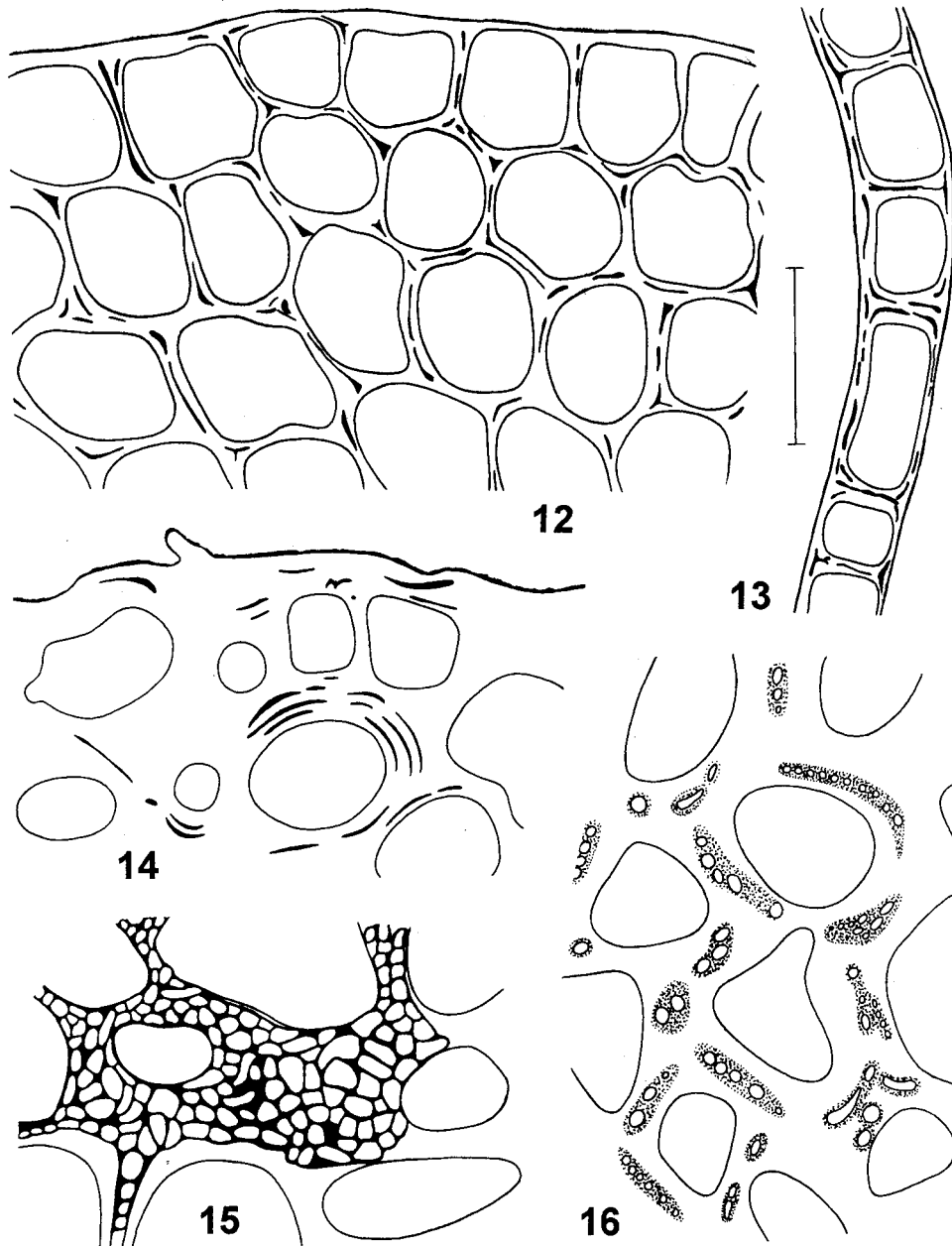
Known distribution: Ireland, Austria, France, Spain, Italy, Romania, Greece.

The species occurs very sporadically and most collections consist of few ascomata. In many cases *Pithyella frullaniae* is found on damaged or dying parts of host mats. The lower already leafless axes of plants are preferred sites for fruit-body formation. Ascomata often occur deeply immersed within the mats or even on their lower sides, but they have been observed also between male and female bracts and on the perianths. Though single apothecia may arise on rather healthy looking plant parts, the species seems to exhibit at least a marked saprotrophic tendency. Apparently, it is not necrotrophic. As far as analysed all necrotrophic parasites on bryophytes grow intracellularly. CHALAUD (1942: 118, Figs. 2c, 3) erroneously described and illustrated the species as being an 'endophyte intracellulaire' in its hyphal phase.

Sections of host stems in the vicinity of fruit-bodies reveal remarkable hyphal features. Within the outermost cell layer the hyphae form irregular and scattered perforations in the walls (Fig. 14). This type of mycelium is similar to that of the leaves (Figs. 12, 13). Individual hyphal cells are so delicate that they cannot be differentiated. Inside this outermost stem region the hyphae have a quite different aspect. There are small circular or elliptical cells within the host cell walls, as seen in transverse sections (Fig. 16). In stems longitudinally sectioned elongated hyphae can be found. Host walls are distinctly coloured by the mycelium becoming dirty bluish grey and thus contrasting to the peripheral uncoloured cell walls of the stem. Beginning from the mid-lamellar region hyphae increasingly colonize the cell walls, finally replacing them perfectly and thus copying the cell structure of the inner stem (Fig. 15). In heavily infected stems, cell wall material has almost completely disappeared apart from the unaltered outermost cell layer. Stability of the stems is mostly due to this tube-like peripheral structure. It should be noted that in *Frullania dilatata* central cells are not thin-walled. A differentiation between cortical and medullary cells does not occur. Both show firm walls and the angles are prominently thickened, which is typical for the genus as a whole (SCHUSTER 1992: 25, Fig. 775: 6).

The species definitely does not belong to the operculate genus *Pithya* FÜCKEL (Sarcoscyphaceae, Pezizales) to which it was assigned mainly due to spore characters. It fits well in the genus *Pithyella* BOUD. (Hyaloscyphaceae, Helotiales) with *P. apicalis* (BERK. & BROOME) KORF & W.Y. ZHUANG on *Macromitrium sulcatum* (HOOK.) BRID. from Ceylon (Sri Lanka) as the type species and a few additional species on mosses, fungi, fern roots (KORF & ZHUANG 1987) and fruits of *Quercus* L. (GALÁN et al. 1994). *Pithyella frullaniae* shares with the type species small non-setiferous apothecia and essentially the same hymenial features, including tiny globose ascospores with a warted epispore. Apart from *Octospora* and a few related genera, Pezizales do not enter into nutritional relationships with bryophytes.

Many Central European specimens of *F. dilatata* from the Alps or North of them



Figs. 12–16  
*Pithyella frullaniae* on *Frullania dilatata* (P. DÖBBELER 7574, M)

12 — Hyphae within the host cell walls of a leaf, optical section; 13 — Hyphae within the host cell walls of a leaf, transverse section; 14–16 — Different aspects of hyphae within the host cell walls of stems, transverse sections: Almost linear hyphae within the peripheral stem region (14), hyphae forming cellular plates (15) or discolouring the adjacent host cell walls (16) within the central stem region

Scale bar: Figs. 12–16 = 20  $\mu$ m



have been screened in vain for the presence of *P. frullaniae*. Nevertheless, I am not convinced that it is really missing there.

Specimens examined (Host is *F. dilatata* if not otherwise stated.):

IRELAND, West Galway (H16): Lough Corrib, Archipelago off N shore of Dooras Peninsula: 'Derry Rocks South', 53°30' N, 9°22' W, 0–3 m alt., 01. May 1998, H. HERTEL 39537a (on *F. teneriffae*, M), 39537b (on *F. dilatata*, M).

AUSTRIA, Burgenland: Bezirk Oberwart, Mischwald westlich über Bad Tatzmannsdorf, 09. March 1980, J. POELT (GZU).

SPAIN, Prov. Gerona: Katalanische Pyrenäen: Straße N 260 etwa 20 km westlich Figueres in Richtung Olot, 20. Aug. 1999, P. DÖBBELER 7093 (M); katalanische Pyrenäen, Straße etwa 6 km nordöstlich Camprodon in Richtung Beget, um 950 m alt., 25. Aug. 1999, P. DÖBBELER 7109 (M).

ITALY, Tuscany, Prov. Firenze: Hänge nord-nordöstlich oberhalb San Polo in Chianti, gut 10 km (Luftlinie) östlich Impruneta, um 670 m alt., 05. Sep. 2001, P. DÖBBELER 7569, 7574 (B), 7581 (TUR). – Prov. Pisa: Colline Metallifere, südöstliche Umgebung von Pomarance an der Straße 439, Waldreste in der Nähe der Wohnanlage „San Carlo“, um 350 m alt., 12. Sep. 1997, P. DÖBBELER 7035 (M); nördliche Umgebung von Paláia, Straßenränder etwa 2,5 km westlich Colléoli in Richtung San Gervásio, um 220 m alt., 26. Aug. 1998, P. DÖBBELER 7073 (E). – Prov. Livorno: nördliche Umgebung von Suvereto, Podere Nebbiaia, ca. 400 m alt., Aug./Sep. 2002, M. ERBEN (M). – Prov. Siena: Paßhöhe an der Straße etwa 2 km südwestlich oberhalb Nusenna am Abzweig nach Gaiole (in Chianti) und Siena, um 780 m alt., 08. Sep. 2000, P. DÖBBELER 7518 (M); Paßhöhe an der Straße 429 etwa 5 km (Luftlinie) östlich Radda (in Chianti) in Richtung der Kapelle Badía Coltibuono, um 660 m alt., 05. Sep. 2000, P. DÖBBELER 7490 (M). – Prov. Arezzo: Südliche Umgebung von Montevarchi, Waldreste bei San Leolino, etwa 3,5 km südwestlich Búicine, um 380 m alt., 30. Aug. 2000, P. DÖBBELER 7444 (M); ibidem, 01. Sep. 2000, P. DÖBBELER 7455 (M).

ROMANIA, „Centralcarpathen, an den Stämmen der Nadelbäume“ (without further details), KALCHBRENNER (M; RABENHORST, Hep. Eur. 156, sub *F. dilatata*).

GREECE, Pelopónnisos: Achaía, südöstliche Umgebung von Patras, *Abies*-Wald etwa 5 Straßenkilometer vor Káto Vlasía an der Strecke Chalandrítsa in Richtung Kaláyríta, 02. Oct. 1981, G. & P. DÖBBELER 4293, 4341 (M).

A second species of *Pithya* growing necrotrophically on *Porella platyphylla* (L.) PFEIFF. was described as *Pithya* ('*Pitya*') *ma-*

*dothecae* BUCHLOH (1952). It is characterized by smooth reddish apothecia, unitunicate asci and very small globose ascospores. The possible congenerity of this apparently rare species to *Pithyella* needs to be investigated.

*Octosporella erythrostigma* and *Pithyella frullaniae* are almost equally frequent. They occur in similar or identical environmental conditions, though mixed infections have not been observed. Fruit-body size is in both species comparable and both form eight-spored asci. However, the reproductive strategies are quite different. Whereas the ascospores of *O. erythrostigma* belong to the biggest recorded in ascomycetes growing on mosses and hepatics, those of *P. frullaniae* pertain to the smallest (compare the spore types in bryophilous ascomycetes drawn to the same scale in DÖBBELER 1997, Fig. 1). I guess that medium-sized ascospores of both species may vary up to the factor 100 regarding the number of spores produced.

#### Acknowledgements

Several specimens of *Frullania dilatata* from M were screened for the presence of fungi. M. Erben, H. Hertel, D. Triebel (all München), J. Poelt (†), and G. Rambold (Bayreuth) collected potential *Frullania*-hosts for my purposes. The manuscript was improved by B. Coppins (Edinburgh), S. Huhtinen (Turku), and especially by H. O. Baral (Tübingen).

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