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The rare fungicolous fungus *Pseudotrichia mutabilis* (Pers.) Wehm.: new data and a historical perspective

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Abstract: The paper reports two new records of a rare fungicolous fungus *Pseudotrichia mutabilis* (Melanommataceae, Pleosporales) from Ukraine. Both specimens were collected within protected areas in association with two xylariaceous species, *Hypoxylon crocopeplum* and *Rosellinia corticium*. The paper provides descriptions, nomenclatural data, and original illustrations of the reported species. Information on substrate specialization and nutritional strategies of *Pseudotrichia mutabilis*, as well as general distribution of the species and known localities in Ukraine are specified and summarized.

Keywords: mycoparasitism, protected areas, Melanommataceae, Pleosporales, Ukraine

INTRODUCTION

Pseudotrichia mutabilis (Pers.) Wehm. is an ascomycete currently placed in the family Melanommataceae G. Winter (Pleosporales, Dothideomycetes). It was described at the end of 18th century and since has been found in various regions of the Northern Hemisphere. Nevertheless, it is still represented by a small number of herbarium specimens and therefore it is considered to be rare across its entire distribution range (Jaklitsch & Voglmayr, 2017; GBIF, 2022). Over the past two centuries this species was classified within different genera: *Sphaeria* (Persoon, 1798), *Lasiosphaeria* (Fuckel, 1871), *Herpotrichia* (Winter, 1885), *Strickeria* (Winter, 1885), *Khekia* (Petrak, 1940), and *Pseudotrichia* (Wehmeyer, 1950). Due to its long history, the nomenclatural record is quite complex, confusing, and contains several heterotypic synonyms (Index Fungorum, 2022; MycoBank, 2022).

The species was described by Persoon (1798) as *Sphaeria mutabilis*. Its diagnosis was based on external characters of ascomata: "Fruiting bodies are spherical, solitary or developing in close groups, sometimes compressed; in the young state are covered by short, copious, densely arranged greenish or yellowish hairs; when mature the hairs disappear and the fruiting bodies become naked, brown. Ostioles are almost papillatae, glabrous". The author did not describe microstructures, although small and very schematic images of asci and ascospores were provided. The epithet "mutabilis" ("variable" in Latin) referred to the change in color of fruiting bodies that happens when yellow-green apical outgrowths on the ascomata disappear with age (Persoon, 1798). After revision of Persoon's specimen, Fries (1822) clarified that the substrate was hard oak wood lying on the soil.

More than half a century later, Peck (1887) described the new species *Lophiotrema parasiticum*, which colonized old stromata of *Hypoxylon morsei* Berk. & M.A. Curtis (a synonym of *Entoleuca mammata* (Wahlenb.) J.D. Rogers & Y.M. Ju). Placement of the species in *Lophiotrema* Sacc. was explained by partially immersed in substrate ascomata with slightly flattened ostioles. Its relation to *S. mutabilis* will be established only long after.

In 1912, Petrak distributed a specimen identified as *Calospora ambigua* Pass. in his „Flora Bohemiae et Moraviae exsiccata" under No. 132 (with the note „Maybe a new species"). This specimen was collected on a stroma of another fungus, *Diatrypella favacea* (Fr.) Ces. & De Not., near Hranice, currently in the Czech Republic. Based on the same collection, Kirschstein (1939) described the new species *Pseudotrichia stromatophila* as the type of respective new genus. *Pseudotrichia* was characterized by solitary to grouped, superficial perithecioid ascomata with solid walls and felty pubescence on the surface. In the diagnosis of the genus it was also stated that the asci are cylindrical, 8-sporous, surrounded by numerous paraphyses, the ascospores are spindle-shaped, hyaline, with several transverse septa (Kirschstein, 1939).

Wehmeyer (1941) revised Rehm's collections of fungi from Austria, including a specimen described as *Thyridaria aurata* Rehm (1912). He found that this specimen belongs to the genus *Pseudotrichia* and proposed the new combination *P. aurata* (Rehm) Wehm., and at the same time he cited *P. stromatophila* as a synonym (Wehmeyer, 1941).

Already in 1878, Cooke and Peck described *Sphaeria* (*Villosae*) *viridicoma*, based on a specimen from Canada. The type of this species was collected on decayed beech wood in association with an unidentified saprotrophic pyrenomycete. The protologue stated that the ascomata were perithecioid, initially partially submerged, later superficial, grouped in 2–3, ovate, black, and covered with abundant greenish pubescence (Peck, 1879). Subsequently, Saccardo (1883) transferred this species to *Lasiosphaeria* because of the presence of superficial pubescent perithecioid ascomata. Six decades later, Wehmeyer (1942) included it in the genus *Pseudotrichia* under the name *P. viridicoma* (Cooke & Peck) Wehm., and based on priority, he synonymized the more recent names *P. aurata* and *P. stromatophila* with *P. viridicoma*.

Sphaeria mutabilis was published much early than the taxa cited above, but Persoon's uninformative description did not readily allow to establish synonymy of all these species. Petrak (1940) gave a brief historical overview of the investigations of this species and for the first time suggested that his specimen of *P. stromatophila* and Persoon's *S. mutabilis* are conspecific. Taking Petrak's opinion into account, Wehmeyer (1950: 35) wrote in a footnote to *Pseudotrichia viridicoma* description: „The proper binomial, if *Sphaeria mutabilis* is a synonym, should be *Preudotrichia mutabilis* (Pers.) Wehm.". As this note was published prior to 1 January 1953, when the full reference to basionym was not required, the new combination *P. mutabilis* became valid. Subsequently, Bose (1961) synonymized all four names, *P. mutabilis*, *P. aurata*, *P. stromatophila*, and *P. viridicoma*, under *Herpotrichia mutabilis* (Pers.) G. Winter, later supported by Sivanesan (1971).

With the aim to clarify the nomenclature of *Sphaeria mutabilis* and its counterparts, Barr (1984) investigated the isotype of *S. viridicoma* and the holotype of *Lasiosphaeria parasiticum* and treated them as synonyms of *Pseudotrichia mutabilis*. Because the holotype of *S. mutabilis* from Persoon's collection was presumably lost, Barr studied the specimen of Fries from UPS herbarium. As a result of this work, Barr (1990) confirmed that *P. mutabilis* should be the correct name for the species, while the other names mentioned above were indicated as synonyms. Currently, the name *P. mutabilis* is generally recognized and widely used in recent publications (Mugambi & Huhndorf, 2009; Checa et al., 2013; Jaklitsch & Voglmayr, 2017; Index Fungorum, 2022).

Until recently, there was no consensus regarding the systematic position of *P. mutabilis*. For a long time, the ascomata of this species were thought to be perithecia, and it was considered a part of the large formal class Pyrenomycetes. Sivanesan (1971) recognized that the ascomata are in fact pseudothecia filled with bitunicate asci and numerous tubular pseudoparaphyses, and he transferred the species to the family Pleosporaceae Nitschke of the order Pleosporales.

Based on the features of the pseudoparaphyses and ostioles, Barr (1987) transferred *P. mutabilis* to the family Platystomaceae J. Schröt. within the newly established order Melanommatales. Twenty years later, Lumbsch & Huhndorf (2007) synonymized the orders Pleosporales and Melanommatales and transferred *P. mutabilis* to the family Melanommataceae.

Mugambi & Hundorf (2009) published a phylogenetic analysis of LSU and TEF DNA sequences for some *Pseudotrichia* species and revealed a polyphyletic origin of the genus. It was ascertained that *P. mutabilis*, represented by a North American specimen, belonged to the family Melanommataceae, while the South American species *P. guatopoensis* Huhndorf was placed within the family Platystomaceae, both within the order of Pleosporales.

Based on morphological investigations of the type specimen of *Pseudotrichia stromatophila*, Thambugala et al. (2014) suggested that the genus *Pseudotrichia* may belong to the family Montagnulaceae M.E. Barr (= Didymosphaeriaceae Munk). However, soon after the multigene analyses of Tian et al. (2015) showed that the newly described tropical species *P. rubriostiolata* Phook. & K.D. Hyde and *P. thailandica* Phook. & K.D. Hyde actually belong to the family Melanommataceae.

The most recent publication regarding the systematic position of *P. mutabilis* is the article of Jaklitsch & Voglmayr (2017). Multigene analysis of sequences from a culture derived from a fresh Austrian specimen showed that it is conspecific with American material investigated by Mugambi & Hundorf (2009), and it was confirmed to belong to the family Melanommataceae (Jaklitsch & Voglmayr, 2017).

Information about *P. mutabilis* in Ukraine was first provided in the monograph of Dudka et al. (2009) and later mentioned by Prylutskyi et al. (2017). However, both publications contain only the name of the species without any accompanying text and illustrations. Recently, *P. mutabilis* was identified for the second time among the specimens collected by V.B. Malaniuk from the territory of the Halytskyi National Nature Park. These finds are summarized below with a detailed nomenclatural summary, original descriptions and illustrations, information and discussion on substrate specificity and nutrition strategies of *Pseudotrichia mutabilis*, as well as general species distribution and known localities in Ukraine.

MATERIALS AND METHODS

The studied specimens are stored at the herbarium of Department of Mycology and Plant Resistance of V.N. Karazin Kharkiv National University – CWU (Myc). Herbarium acronym follows Index Herbariorum (2022). Studies were performed with stereomicroscope SM-6630 ZOOM Micromed and light microscope Granum R50 Trino. Measurements were made from slides mounted in 3% KOH. In summary of measurements, the highest and lowest 5% of values are presented in parentheses. Length and width of ascospores are given with accuracy of 0.1 µm, of asci – with 1 µm. The drawings are based on photos made from microscope camera.

RESULTS AND DISCUSSION

Pseudotrichia mutabilis (Pers.) Wehm., Fungi of New Brunswick, Nova Scotia and Prince Edward Island: 35 (1950). (Fig. 1).

Basionym: *Sphaeria mutabilis* Pers., Icon. Desc. Fung. Min. Cognit. 1: 24 (1798), sanctioned in Fries, Syst. Mycol. 2: 447 (1822)

≡ *Herpotrichia mutabilis* (Pers.) G. Winter, Rabenh. Krypt.-Fl., Edn 2 1(2): 209 (1885)

≡ *Khekia mutabilis* (Pers.) Petr., Annls mycol. 38(2/4): 203 (1940)

≡ *Lasiella mutabilis* (Pers.) Quél., Mém. Soc. Émul. Montbéliard, Sér. 2 5: 517 (1875)

≡ *Lasiosphaeria mutabilis* (Pers.) Fuckel, Jb. nassau. Ver. Naturk. 25-26: 302 (1871)

≡ *Lasiosphaeria mutabilis* (Pers.) Fuckel, Jb. nassau. Ver. Naturk. 25-26: 302 (1871) var. *mutabilis*

≡ *Strickeria mutabilis* (Pers.) G. Winter, Rabenh. Krypt.-Fl., Edn 2 1(2): 288 (1885)

= *Lasiosphaeria mutabilis* var. *fuckeliana* Sacc., Syll. Fung. 2: 196 (1883)

= *Lophiotrema parasiticum* Peck, Rep. (Annual) Trustees State Mus. Nat. Hist., New York 40: 71 (1887)

≡ *Lophiostoma angustilabrum* var. *parasiticum* (Peck) Chesters et A.E. Bell, Mycol. Pap. 120: 11 (1970)

= *Pseudotrichia stromatophila* Kirschst., Annls mycol. 37(1/2): 125 (1939)

= *Pseudotrichia aurata* (Rehm) Wehm., Mycol. 33(1): 60 (1941)

Basionym: *Thyridaria aurata* Rehm, Annls mycol. 10(4): 392 (1912)

= *Pseudotrichia viridicoma* (Cooke & Peck) Wehm., Can. J. Res., Sect. C 20(12): 579 (1942)

Basionym: *Sphaeria viridicoma* Cooke et Peck, in Peck, Ann. Rep. N.Y. St. Mus. nat. Hist. 29: 64 (1878) [1876].

≡ *Lasiosphaeria viridicoma* (Cooke & Peck) Sacc., Syll. Fung. 2: 193 (1883)

≡ *Lophiotricha viridicoma* (Cooke & Peck) Kauffman, Pap. Mich. Acad. Sci. 9: 189 (1929) [1928]

Misapplied name: „*Lasiella mutabilis*" (Pers.) Quél. sensu Quélet, Mém. Soc. Émul. Montbéliard, Sér. 2 5: 517 (1875). – Current name: *Thyronectria rhodochlora* (Mont.) Seeler 1940 (Sordariomycetes, Nectriaceae; see Jaklitsch & Voglmayr, 2014)

= *Pleosphaeria mutabilis* Sacc., Syll. Fung. 2: 306 (1883)

≡ *Mattirolia mutabilis* (Sacc.) Checa, M.N. Blanco et G. Moreno (2013)

≡ *Strickeria mutabilis* (Sacc.) G. Winter, Rabenh. Krypt.-Fl., ed. 2, 1(2): 288 (1885)

Icon.: Persoon (1798: fasc. 1, tab. 7, fig. 6), Barr (1987: 125, pl. 29, fig. A; 1990: 28, fig. 3 j, k); Bose (1961: 210, fig. 26); Chlebicki (1989: 87, fig. 12); Mugambi & Hundorf (2009: 110. fig. 18, A-C); Réblová & Svrček (1997: 220, Fig. 3 a-c); Sivanesan (1971: 32, fig. 16, A, B, plate 1, B); Thambugala et al. (2014: 58, fig. 1, as *Pseudotrichia stromatophila*); Wehmeyer (1941: 58, figs. 8-11, as *Pseudotrichia aurata*).

Description. *Ascomata (pseudothecia)* in groups of up to 10, subspherical, with short papillae, 500–800 µm in diameter, superficial or nearly submerged in the tissues of the host-fungus; peridium thick, two-layered with a light, gelatinous, inner layer and a dark, denser outer layer. *Ascomata surface* covered with single or densely arranged greenish-yellow hyphae with warty walls and granular contents, young ascomata becoming greenish-yellow in color; apical areas of the ascomata near the opening more or less smooth, consisting of brown compressed cells. *Ostiolar canal* lined with periphyses. *Intrascale tissue* composed of numerous tubular pseudoparaphyses immersed in a gelatinous matrix, sometimes partially reduced at maturity. *Asci* 8-spored, bitunicate, cylindrical to cylindrical-clavate, 140–195 × 15–18 µm (Bose [1961]: 120–180 × 12–18 µm; Barr [1984]: (90–) 120–155 × 12–20 µm; Kirschstein [1939]: 135–190 × 13–15 µm; Sivanesan [1971]: 120–180 × 12–18 µm; Thambugala et al. [2014]: 135–200 × 13–22 µm), with clearly visible ocular chambers. *Ascospores* arranged within the asci in biseriate or semi-biseriate manner, spindle-shaped, with almost pointed ends, straight or slightly curved, irregular, hyaline, smooth, with large droplets inside, surrounded by a wide gelatinous sheath, first with a single median septum, at maturity with two additional septa, (30.3–)34.3–38.4(–39.5) × 7.7–10.5 µm (Bose [1961]: 30–39 × 8–11 µm; Barr [1984]: 26–39 × (6–)7–9 µm; Sivanesan [1971]: 30–40 × 8–11 µm; Thambugala et al. [2014]: 35–40 × 7–12 µm). *Anamorph* unknown.

Specimens examined. Ukraine, Kharkiv reg., Zmiiv dist., Homilsha Forests National Nature Park, vicinities of the V.N. Karazin Kharkiv National University Biological station, native maple-lime-oak forest, on the ascomata of *Hypoxylon crocopeplum* on a dead half-decomposed trunk of an unidentified deciduous tree, 11.10.2003, O.Yu. Akulov [CWU (Myc) AS 1415]; Ivano-Frankivsk reg., Halych dist., Halytskyi National Nature Park, vicinities of Halych, oak-hornbeam forest, on the ascomata of *Rosellinia corticium* on fallen branches of cf. *Quercus robur*, 12.11.2016, V.B. Malaniuk [CWU (Myc) AS 6322].

Known distribution. Europe: Austria, Czech Republic, Estonia, Finland, France, Germany, Great Britain, Italy, Lithuania, Norway, Slovakia, Sweden, Switzerland, Ukraine, United Kingdom. Asia: Japan, Pakistan. North America: Canada, USA.

Notes. Although the species has a quite wide distribution range, it is infrequently recorded (GBIF, 2022). There is no consensus regarding the rarity of the species. Réblová & Svrček (1997) indicate that it is widespread at least within the Czech Republic, but it has small inconspicuous ascomata that are easily identified only in the young state before they lose their yellow-green hairs.

Substrate specificity. The species is known from stromata of hosts from Xylariales (Ascomycota), as well as on the hardwood colonized by them.

Pseudotrichia mutabilis initially was considered as a wood saprotroph (Persoon, 1798; Fries, 1822; specimen of Bucholtz reported by Parmasto, 2010; Rehm, 1912). This view still can be found in recent publications (Norden & Paltto, 2001). However, examination of additional specimens revealed that the fungus frequently inhabits the ascomata of stromatic Xylariales. As a result, this species is treated as a hypersaprobe that, in addition to wood, can inhabit senescent effete stromata of xylotrophic pyrenomycetes of xylarialean affinity (Bose, 1961; Barr, 1990; Chlebicki & Bujakiewicz, 1994; Réblová & Svrček, 1997).

However, there was a view that *P. mutabilis* could be a mycoparasite. Peck (1887) described this species as *Lophiotrema parasiticum*, choosing the species epithet on the assumption that the fungus parasitizes on stroma of *Hypoxylon morsei*, a synonym of *Entoleuca mammata*. The type specimen of *Sphaeria* (=*Pseudotrichia*)

viridicoma was also collected on beech wood in close association with an unidentified saprotrophic fungus (Peck, 1879; Wehmeyer, 1942). Petrak (1921) came to a similar conclusion, stating that the fungus parasitizes stromata of *Diatrypella aspera* (Fr.) Nitschke and *D. verruciformis* (Ehrh.) Nitschke, synonyms of *D. favacea* (Fr.) Ces. et De Not. This conclusion was adopted by Kirschstein (1939) when he described *Pseudotrichia stromatophila* on the basis of Petrak's collection. Wehmeyer (1950) initially argued that fungi are the main substrate for *P. mutabilis*, but its ascomata can also be formed on the wood colonized by its hosts (Wehmeyer, 1950). Similar views are also reflected in later publications (Sivanesan, 1971; Eriksson, 1992).

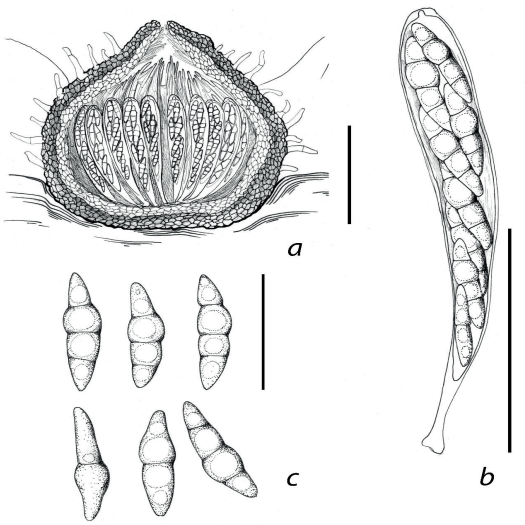

Fig. 1. *Pseudotrichia mutabilis* (Pers.) Wehm. [CWU (Myc) AS 6322]: a – pseudothecium in vertical section (bar: 300 μm), b – ascus (bar: 60 μm), c – ascospores (bar: 35 μm).

It should be noted that ascomata of *P. mutabilis* do not always develop on the old, effete stromata of the host fungus. Both findings from Ukraine were associated with mature, lively stromata of the host. The same is true for Jaklitsch's specimen from Austria (Jaklitsch & Voglmayr, 2017). Considering these facts, this species can be considered as fungicolous in the broad sense (Gams et al., 2004). However, the nature of interaction between *P. mutabilis* and its fungal hosts remains unclear.

In the present work, attempts were made to analyze which fungal species can serve as a host for *P. mutabilis*. Summarizing the literature data as well as own observations, *P. mutabilis* can be considered a highly specialized fungicolous fungus since it develops mostly on representatives from Xylariales, with a preference for stromatic hosts with large dark-colored ascospores like *Biscogniauxia marginata* (Fr.) Pouzar, *Entoleuca mammata*, *Hypoxylon* spp. (*H. crocopeplum*, *H. rubiginosum* (Pers.) Fr.) and *Rosellinia corticium* (our findings, as well as observations by Peck, 1887; Chlebicki & Bujakiewicz, 1994; Jaklitsch & Voglmayr, 2017).

However, there is also a number of records from the stromata of *Diatrypella favacea* (Fr.) Ces. et De Not., family Diatrypaceae Nitschke (Petrak, 1921, 1940; Kirschtein, 1939; Chlebicki, 1989; Holm & Holm, 1988; Eriksson, 1992). Diatrypaceae forms a phylogenetically distinct lineage within Xylariales and are characterized by much smaller, hyaline or smoky-brown, allantoid ascospores.

It should be noted that specimens of *P. mutabilis* colonizing the stromata of dark-spored representatives of the Xylariales are slightly different from the specimens which grow on *Diatrypella favacea*. Thambugala et al. (2014) and Tian et al. (2015) recently re-studied the type of *P. stromatophila* from *Diatrypella* and found that ascomatal structure, cellular, septate unbranched pseudoparaphyses, as well as long-stiped asci distinguish this specimen from other *Pseudotrichia* specimens and are more typical for representatives of the family Montagnulaceae (= Didymosphaeriaceae) rather than Melanommataceae. This is in line with Chlebicki (1989), whose description and very detailed illustrations of a *Pseudotrichia* specimen from *Diatrypella* indicate that his specimen is quite different from the Ukrainian collections associated with *Hypoxylon* and *Rosellinia*. Unfortunately, *Pseudotrichia* specimens collected on *Diatrypella* have not been sequenced so far. Therefore, to no final conclusions can be drawn about the conspecificity of specimens associated with the light- and dark-spored xylarialean hosts.

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