

NOTES ON *HYGROCYBE* SUBSECTION *SQUAMULOSAE* FROM POLAND

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Abstract. Three species belonging to *Hygrocybe* sect. *Coccineae* subsect. *Squamulosae* are commented based on material collected in Poland. *Hygrocybe calciphila* is reported for the first time from Poland. *Hygrocybe miniata* is reported from several new localities in the Tatra Mts, and the identity of one Polish collection of *Hygrocybe strangulata* is discussed. Macro- and micromorphological characters of the examined collections are described and their taxonomical status is discussed.

Key words: *Hygrocybe calciphila*, *Hygrocybe miniata*, *Hygrocybe strangulata*, Tatra Mts, Carpathians, Poland

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INTRODUCTION

Section *Coccineae* Fayod, subsect. *Squamulosae* (Bataille) Singer is represented in Europe by eight species (Kühner 1976; Candusso 1997; Borgen & Arnolds 2004), of which five have been reported from Poland: *Hygrocybe cantharellus* (Schwein.: Fr.) Murrill, *H. coccineocrenata* (P. D. Orton) M. M. Moser, *H. miniata* (Fr.: Fr.) P. Kumm., *H. substrangulata* (P. D. Orton) P. D. Orton & Watling and *H. turunda* (Fr.) P. Karsten (Gumińska 1997; Wojewoda 2003). In the Polish monograph of the family *Hygrophoraceae* (Gumińska 1997) another taxon, *H. strangulata* (P. D. Orton) Svrček is also reported. This name is widely considered a synonym of *H. miniata* (Arnolds 1990; Boertmann 1995, 2008; Candusso 1997), but the Polish collection seems to differ from typical *H. miniata* (Gumińska 1997). Here we report the results of a taxonomic analysis of representatives of *Hygrocybe* sect. *Coccineae*, subsect. *Squamulosae* collected during field work in the Tatra Mts (Carpathians). This material prompted us to examine and compare the Polish collection of *H. strangulata* in order to clarify its taxonomic position.

MATERIAL AND METHODS

Material was collected in the Polish Tatras (Carpathians) in 1999–2002. The collections are deposited in the herbarium of the Institute of Botany, Polish Academy of Sciences, Kraków (KRAM). Additionally, one specimen of *H. strangulata* from the herbarium of the Institute of Botany, Jagiellonian University, Kraków (KRA) was studied. Dried specimens were studied by microscopy. Spore shape and size as well as other characters distinguishing species within subsection *Squamulosae* were taken into account, such as the size and shape of elements in hymenophoral trama and stipititrma, shape and size of hairs at stipe apex, dimensions of terminal elements of pileipellis, and number of nuclei (Kühner 1976; Arnolds 1995; Borgen & Senn-Irlet 1995; Borgen & Arnolds 2004). The descriptions of macro- and micromorphological characters provided below are based on the examined material. The description of macro-morphological characters of the *H. strangulata* collection is translated from the monograph by Gumińska (1997). All measurements were made in 5% KOH or Congo red under an oil immersion lens. The spores for measurements were taken from natural spore deposits at the stipe apex or pileus surface or from mature spores floating in the preparation of the hymenium. Spores were measured in front view and side view. Measure-

ments were of at least 10 spores per specimen. The notation 'spores (33/1)' means that 33 measurements of spores from one collection were made. The average values and the quotients for spores observed in side view (Q_{side}) and front view (Q_{front}) were calculated, and average quotients (Q_{av}) also. Spore measurements and other measurements below 10 μm are given to an accuracy of one decimal; measurements above 10 μm are rounded to the nearest micron. Nuclei were stained with acetocarmine using the method of Clemençon (1986) as modified by Breitenbach and Kränzlin (1991). Drawings of micromorphological characters were made with the aid of a drawing tube (Nikon Y-IDT). All measurements were made directly from microscope observations (under oil immersion objective), not from the drawings.

RESULTS AND DISCUSSION

Six collections of *Hygrocybe* from sect. *Coccineae*, subsect. *Squamulosae* were examined. Two of them represent *Hygrocybe calciphila*. The remaining four represent *H. aff. miniata* and *H. miniata*. *Hygrocybe calciphila* is reported from Poland for the first time. It is also new to the Tatra Mts. Descriptions and comments on the examined collections are provided below. They are followed by a description and discussion of the Polish collection of *H. strangulata*, which has been identified as a taxon close to *H. miniata*.

Hygrocybe calciphila Arnolds Fig. 1A–H

Cap 10–25 mm in diameter, first hemispherical, then expanded with slightly depressed center, not translucently striate, dry, squamulose, orange-yellow, squamules slightly paler, yellowish, very fine. Lamellae distant, slightly ventricose, broadly adnate, yellow-orange. Stipe 20–30 \times 2–3 mm, yellow-orange, smooth, cylindrical or slightly flattened, with a whitish tomentum at base. Context orange-yellow, smell and taste none.

Spores (33/1 – coll. KRAM F-54074; from pileus surface): in side view (7.4–)7.6–9.5(–10.0) \times (5.0–)5.5–6.6(–7.0) μm , average 8.6 \times 6.1 μm , in front view 7.4–8.1(–8.8) \times 5.6–6.9 μm , average 8.0 \times 6.0 μm , $Q_{\text{side}} = 1.2$ –1.8, $Q_{\text{front}} = 1.1$ –1.5, $Q_{\text{av}} = 1.4$, ellipsoid, ovoid to subglobose, not constricted,

binucleate (Fig. 1B). Basidia 40–50 \times 9–11 μm , 4-spored (Fig. 1A); spores (25/1 – coll. KRAM F-53012; from stipe apex): in side view 8.8–10.5(–10.8) \times 5.0–6.6 μm , average 9.5 \times 5.8 μm , in front view 8.8–9.1(–9.6) \times 5.9–6.6 μm , average 9.1 \times 6.0 μm , $Q_{\text{side}} = 1.5$ –2.0, $Q_{\text{front}} = 1.4$ –1.6, $Q_{\text{av}} = 1.6$, ellipsoid, not constricted, uni- and binucleate (Fig. 1G). Basidia 42–52 \times 6.0–7.0 μm , 2(–3)-spored (Fig. 1F). Hymenophoral trama subregular, elements (34/2): (18–)22–167 \times 5–15(–17) μm , average 71 \times 9.2 μm , subcylindrical. Pileipellis a trichoderm, terminal elements (23/2): 25–75 \times 5.6–10.0(–14) μm , average 45 \times 7.9 μm , subcylindrical, obtusely fusoid to subclavate, a few narrow hyphae observed (Fig. 1C, H). Stipititrama regular, elements (45/2): (17–)27–144(–207) \times 6.9–17(–19) μm , average 82 \times 12 μm , (sub-)cylindrical (Fig. 1D–E). Stipitipellis a dry cutis, groups of more or less perpendicular hyphae, as in *H. miniata* (below) and *H. biminiata* Kühner (cf. Borgen & Arnolds 2004) were not definitively observed, only a few regular hairs, terminal elements 4.5–6.0 μm wide. Clamp connections present; in KRAM F-53012 scattered, not observed in hymenium.

SPECIMENS EXAMINED. POLAND. CARPATHIANS. West Tatra Mts, Sarnia Skala massif, summit, vegetation with *Dryas octopetala*, alt. 1376 m a.s.l., on soil, 49°15'55"N, 19°56'30"E, 20 Aug. 2002, leg. A. Ronikier, KRAM F-54074; West Tatra Mts, Kasprowy Wierch massif, NW slope, alt. 1950 m a.s.l., non-calcareous alpine meadow, on soil, 49°13'55"N, 19°58'53"E, 4 Aug. 2002, leg. A. Ronikier, M. Ronikier, KRAM F-53012.

Hygrocybe calciphila is characterized by the orange and orange-red colors of the cap covered by fine scales, and by an ecological preference for soils on calcareous bedrock (Arnolds 1985, 1986a). Microscopically it is distinguished by its broadly ellipsoid, nonconstricted spores, typically borne on 4-spored basidia. The fungus is closely related to *H. miniata* (Fr.: Fr.) P. Kumm. from which it cannot be distinguished with certainty in the field (Arnolds 1986a; Boertmann 1995).

Collection KRAM F-54074 represents a typical *H. calciphila* with all characteristic features (Fig. 1A–D). It was found on calcareous bedrock. The second collection, KRAM F-53012,

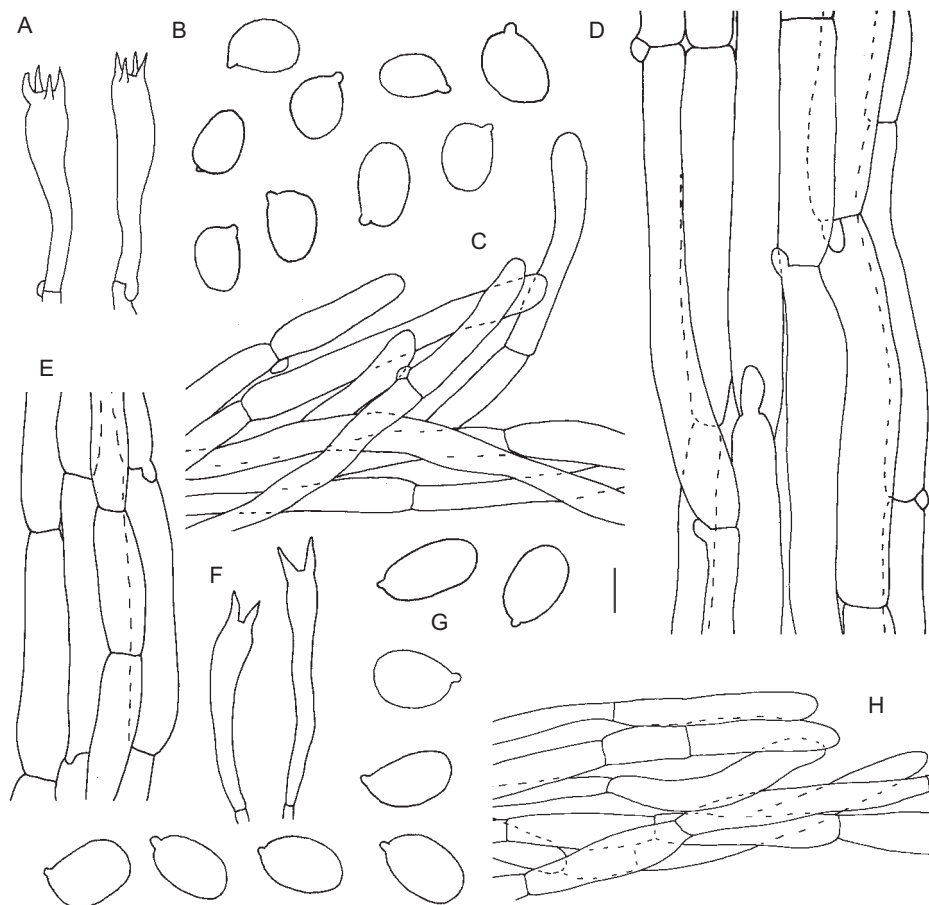


Fig. 1. *Hygrocybe calciphila* Arnolds. A – basidia; B – spores; C – pileipellis; D – stipititrama; E – stipititrama; F – basidia; G – spores; H – pileipellis. Scale bar: A, C–F & H = 10 μ m; B & G = 5 μ m (A–D: coll. KRAM F-54074; E–H: coll. KRAM F-53012).

has slightly deviating features. It was found on siliceous bedrock and it possesses 2-spored basidia (Fig. 1F). The spores are slightly bigger (longer) than those of the 4-spored collection (Fig. 1G), but the extreme values lay within the variation range of the species (Arnolds 1990; Boertmann 1995; Borgen & Senn-Irlet 1995). Clamp connections are present but sparse in the pileipellis, hymenophoral trama and trama of the pileus, and are absent from the hymenium. The 2-spored collection, although slightly different, represents *H. calciphila* in our opinion, as it has broadly ellipsoid, nonconstricted spores. To the best of our knowledge no 2-spored collection of

H. calciphila has been found so far. Our specimen originates from the alpine zone of the Tatra Mts. Kühner (1976) described a 2-spored collection of *Hygrocybe* from the subalpine zone of the Alps under the name ‘?*H. miniata* var. *mollis*’. This fungus differs from our collection in having much bigger spores (10.2–13.0 \times 6–7 μ m) which are different in shape: ‘*cylindracées à subelliptiques, parfois un peu claviformes*’ (Kühner 1976). The same author (Kühner 1976) reports 4-spored *H. miniata* with nonconstricted spores from the alpine zone of the Alps, which represent *H. calciphila* according to Arnolds (1986a, 1990) and Boertmann (1990).

Hygrocybe miniata (Fr.: Fr.) P. Kumm.

Fig. 2A–F

Cap 10–35 mm in diameter, first hemispherical, then expanded with slightly depressed center, dry, squamulose, orange-yellow, orange-reddish, paler on drying, exsiccata orange-ochraceous, brownish-orange. Lamellae distant, broadly adnate to decurrent, yellow, then yellow-orange. Stipe 20–45 × 2–3 mm, yellow-orange, smooth, cylindrical or slightly flattened. Context orange-yellow, smell and taste none.

Spores (51/2; from hymenium and pileus surface): in side view (6.9–)7.4–9.0(–9.5) × 4.5–6.1 μm, average 8.1 × 5.3 μm, in front view (6.0–)6.9–8.5 × 4.9–6.0(–7.0) μm, average 7.4 × 5.5, $Q_{side} = 1.3–1.9$, $Q_{front} = 1.1–1.5$, $Q_{av} = 1.5$, ellipsoid, ovoid to obovoid, frequently constricted, obpyriform, uninucleate (Fig. 2B). Basidia 38–50 × 6–8 μm, 4-spored (Fig. 2A). Pseudocystidia present in one collection (KRAM F-54077), narrowly cylindrical, flexuose 31–37 × 2.9–4.5 μm (Fig. 2D). Hymenophoral trama elements (33/2): (19–)22–97(–129) × 4.4–13.0(–17) μm, average 57 × 8.7 μm, (sub-)cylindrical to subinflated. Pileipellis a trichoderm, terminal elements (40/3): (15–)21–80 × 7.8–15.0 μm, average 41 × 11 μm, subcylindrical,

obtusely fusoid, rarely lanceolate, frequently with a narrow appendix, ca 3 μm wide (Fig. 2C). Stipitellis with groups or bundles of irregular, subcylindrical to somewhat tortuous ‘hairs’, (10/1): (13–)15–44 × 3.4–4.9 μm, excluding ascending terminal elements (Fig. 2E). Stipititrama regular to subregular, elements (39/2): 38–135(–193) × 8–17 μm, average: 84 × 11 μm, subcylindrical (Fig. 2F). Clamp connections present.

SPECIMENS EXAMINED. POLAND. CARPATHIANS. West Tatra Mts, Sarnia Skała massif, at Ścieżka nad Reglami hiking trail, SW above Polana Białego valley, alt. 1250 m a.s.l., upper montane belt, spruce forest with *Sorbus aucuparia*, on soil, 49°15'43"N, 19°56'52"E, 23 Sept. 1999, leg. A. Ronikier, KRAM F-50042; West Tatra Mts, Sarnia Skała massif, upper part of Dolina ku Dziurze valley, N slopes, alt. 1100 m a.s.l., windfall with *Sorbus aucuparia*, on soil, 49°16'11"N, 19°56'42"E, 20 Aug. 2002, leg. A. Ronikier, KRAM F-54076; upper part of Dolina ku Dziurze valley, N slopes, alt. 1120 m a.s.l., windfall with *Sorbus aucuparia*, on soil, 49°16'7"N, 19°56'37"E, 20 Aug. 2002, leg. A. Ronikier, KRAM F-54077.

In the Polish material we found fusoid to lanceolate terminal elements of the pileipellis with frequent narrow, short or long appendices ca 3 μm wide (Fig. 2C). Such structures are typi-

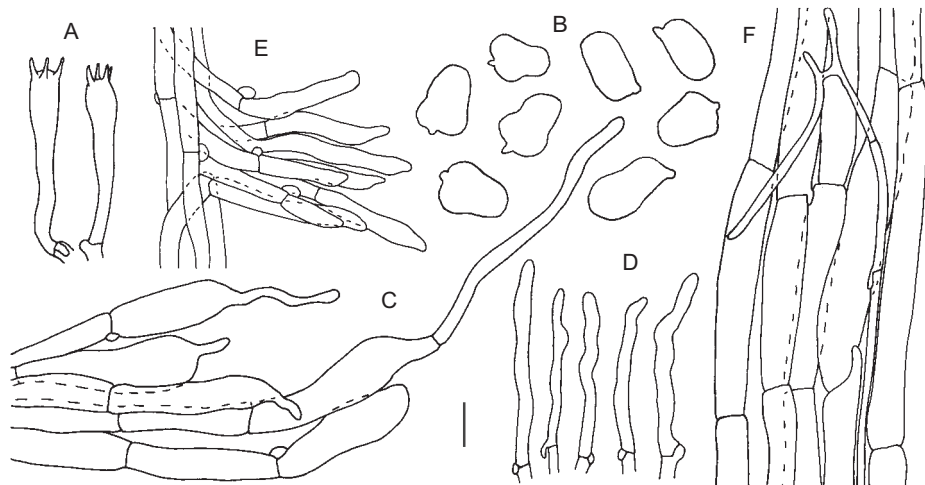


Fig. 2. *Hygrocybe miniata* (Fr.: Fr.) P. Kumm. A – basidia; B – spores; C – pileipellis; D – cheilocystidia; E – a bundle of ‘hairs’ from stipe surface; F – stipititrama. Scale bar: A & C–F = 10 μm; B = 5 μm (A–B, E–F: coll. KRAM F-50042; C: coll. KRAM F-54076; D: coll. KRAM F-54077).

cally not reported as occurring in species belonging to the genus *Hygrocybe*, but have occasionally been mentioned in the literature for *H. miniata* (Borgen & Senn-Irlet 1995). This character was present in all our collections, most frequently in KRAM F-54076. Because the Polish collections agree in all other essential features with the neotype of *H. miniata* described by Arnolds (1986b) and with other collections of that species described elsewhere (e.g., Boertmann 1995, 2008; Candusso 1997; Borgen & Arnolds 2004), we consider them typical representatives of *H. miniata*. We do not consider the discrepancies in the shape of terminal elements of the pileipellis to be taxonomically important.

Hygrocybe aff. *miniata* (Fr.: Fr.) P. Kumm.
Fig. 3A–D

H. strangulata sensu Gumińska (1997)

Pileus 10–25 mm in diameter, hemispherical, convex, flat or slightly depressed in center, surface smooth, not glutinous but slightly shiny during moist weather, greasy, translucently striate at margin, cinnabar-red with orange tint especially at margin, becoming paler, pale orange, yellow or yellow-buff on drying. Surface of dry pileus covered by tiny and thin golden-yellow fibrils (lens). Stipe 15–35 × 2–4 mm, cylindrical, often curved, smooth, dry, silky, greasy during moist weather, red-orange, in lower part paler, chrome-yellow, becoming paler upon drying (like pileus). Flesh not changing, cinnabar-red in pileus and red-orange in stipe, very thin, taste mild, smell none. Lamellae yellow-orange, distant, adnate or slightly decurrent. Spore print white.

Spores (39/1, from pileus surface): in side view (7.1–)7.5–10.0(–10.5) × (4.4–)4.5–6.0(–6.5) μm, average 8.5 × 5.1 μm, in front view (6.9–)7.6 × 8.8(–10.3) μm, average 8.3 × 5.2 μm, $Q_{\text{side}} = 1.2\text{--}2.3$, $Q_{\text{front}} = 1.4\text{--}1.7$, $Q_{\text{av}} = 1.7$, mostly ellipsoid, less frequently obovoid, pyriform or obpyriform, occasionally with suprahilar depression, frequently constricted, 25% in side-view, 45% in frontal view, ?uni- and binucleate (Fig. 3C). Basidia 40–57 × 6–8 μm, 4-spored (Fig. 3D). Hymenophoral trama subregular, elements (15/1):

(17–)22–98(–135) × 5.4–15.0 μm, predominantly subcylindrical. Pileipellis a trichoderm at least in places, terminal elements (21/1): (21–)25–47(–52) × (5.0–)5.4–9.3 μm, average 34 × 6.9 μm, exceptionally narrow (e.g. 2.5 μm wide) towards apex, predominantly subcylindrical (Fig. 3B). Stipitipellis with some ascending hyphae, but bundles of ‘hairs’ not observed. Stipititrama elements (19/1): (24–)47–135 × (6–)8–15(–20) μm, (sub-)cylindrical, average 81 × 12 μm (Fig. 3A). Clamp connections present.

SPECIMENS EXAMINED. POLAND. CARPATHIANS, Gorce Mts, Stare Wierchy massif, at summit (towards Rabka town), in grassland, among grasses, 25 Sept. 1978, leg. K. Turnau, KRA 1978-63.

Hygrophorus strangulatus P. D. Orton has been described as a fungus characterized by having a reddish, dry, minutely-scurfy cap, pileipellis in the form of a cutis, and ellipsoid-oblong, constricted spores (Orton 1960). It was later reported from the Netherlands (Arnolds 1977). Some years later, Arnolds (1986b) demonstrated that Orton’s type collection was identical with *Hygrocybe miniata*, which is why he included *H. strangulata* as a synonym of *H. miniata*. The fungus previously treated by him as *H. strangulata* (Arnolds 1977) was later described as a new species, *H. constrictospora* Arnolds (1986a). This belongs to the subsection *Sicca* Boertm. (cf. Boertmann 1995) because of the pileipellis structure.

Gumińska (1997) considers *H. strangulata* a species separate from *H. miniata*. The provided description and the spores of *H. strangulata* depicted by Gumińska (1997) indicate that the species could be conspecific with *H. constrictospora* (Arnolds 1977). A re-examination of the collection of *H. strangulata* (KRA 1978-63) mentioned by Gumińska (1997) demonstrates that the spores are indeed similar in size and shape to those of *H. constrictospora* (Fig. 3C) but that the pileipellis forms a distinct trichoderm (Fig. 3B), which is why the specimen surely belongs to subsect. *Squamulosae*. Its identity is uncertain, however. Spores of this collection are similar in shape to those of *H. substrangulata*, but they are much shorter, up to 10.5 μm versus 9.0–14.5 μm for the latter (Boertmann 1995;

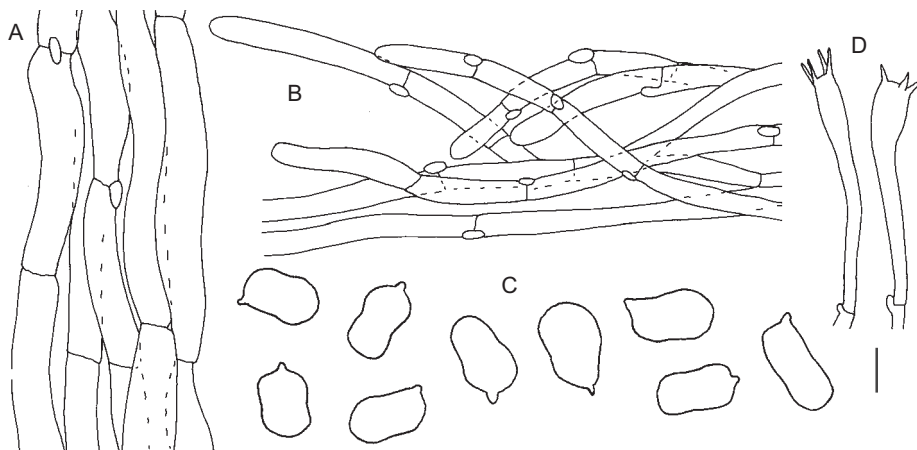


Fig. 3. *Hygrocybe* aff. *miniata* (Fr.: Fr.) P. Kumm. A – stipititrama; B – pileipellis; C – spores; D – basidia. Scale bar: A, B & D = 10 μ m; C = 5 μ m (A–D: coll. KRA 1978-63).

Candusso 1997). The terminal elements of the pileipellis of the Polish collection are also shorter and narrower ($21\text{--}52 \times 5.0\text{--}9.3 \mu\text{m}$) than those of *H. substrangulata* ($22\text{--}120 \times 6\text{--}25 \mu\text{m}$) (Boertmann 1995; Candusso 1997). The size of terminal elements of the pileipellis and stipititrama as well as spores lie within the range of *H. miniata*, but the spores deviate in shape, not being obpyriform.

The remaining species belonging to subsect. *Squamulosae* differ in various characters: for example, *H. calciphila* in having broadly ellipsoid, non-constricted spores, and *H. cantharellus*, *H. coccineocrenata* and *H. turunda* in having large elements in stipititrama (Borgen & Senn-Irlet 1995; Candusso 1997; Borgen & Arnolds 2004). According to Borgen and Senn-Irlet (1995), Borgen and Arnolds (2004), Candusso (1997) and Boertmann (1995, 2008), the distinctly decurrent lamellae are a good additional differentiating character of the latter three species, but this should be considered with caution because specimens of *H. miniata* with distinctly decurrent lamellae have been observed as well (Borgen, unpublished data). All in all, the Polish collection of *H. strangulata* is not identical with typical *H. miniata* mainly because of the deviating spore shape. Nevertheless, it seems close to *H. miniata* or may represent a deviating collection of *H. miniata*; more material is needed to resolve its taxonomic position.

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