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PANAEOLUS SUBFIRMUS (AGARICALES, BASIDIOMYCOTA), A SPECIES NEW FOR POLAND

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Abstract: *Panaeolus subfirmus* P. Karst. is reported for the first time from Poland, and described and illustrated based on Polish specimens. Its ecology, general distribution and taxonomy are also presented. A key for determination all Polish species of *Panaeolus* (Fr.) Quél. is provided.

Key words: coprophilous Agaricales, fimicolous basidiomycetes, *Panaeolus*, Polish mycobiota

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Introduction

The genus *Panaeolus* (Fr.) Quél. (Psathyrellaceae) comprises 13–16 species in Europe (Gerhardt 1996; Pegler & Henrici 1998; Senn-Irlet *et al.* 1999; Ludwig 2001; Kirk *et al.* 2008) and so far 9 of them have been reported from Poland: *P. acuminatus* (Schaeff.) Gillet, *P. alcis* M. M. Moser, *P. antillarum* (Fr.) Dennis, *P. cinctulus* (Bolton) Sacc., *P. fimicola* (Pers.: Fr.) Gillet, *P. guttulatus* Bres., *P. olivaceus* F. H. Møller, *P. papilionaceus* (Bull.: Fr.) Quél. and *P. semiovatus* (Sowerby: Fr.) S. Lundell (Wojewoda 2003; Kujawa 2012; Halama *et al*. 2014).

In 2012, *P. subfirmus* P. Karst., a species new for Poland, was found in northeastern Poland (Fig. 1). *Panaeolus subfirmus* was originally described at the end of the nineteenth century from material collected in southern Finland (Karsten 1889) and subsequently reported from Denmark, Sweden, Great Britain and the Netherlands (Orton 1969; Andersson & Gilsenius 1982; Gerhardt 1996; Van der Bergh & Noordeloos 1996; Noordeloos 1998; Ludwig 2001; Gerhardt 2008). It was presumed not to be cosmopolitan but rather a mainly Northern European species (cf. Henrici 2002; Doveri 2010), recorded mostly from heavily manured soils or cattle, horse and sheep dung on heaths, moors, meadows, rough pastures and grazed dune areas (Orton 1969; Watling & Gregory 1987; Van der Bergh & Noordeloos 1996; Noordeloos 1998; Ludwig 2001). More recently, however, *P. subfirmus* has been collected in France (Bon & Courtecuisse 2003), Italy (Doveri 2004, 2010, 2011), Turkey (Afyon & Yağız 2004; Sesli & Denchev 2008; as *P. speciosus*) and Russia (Marina 2006). There are also reports of its occurrence in Australia (Hilton 1988 after Watling & Richardson 2010; as *P. speciosus*), New Zealand (Bell 1988; as *P. speciosus*) and the Falkland Islands (Watling & Richardson 2010). My finding in Poland extends the known distribution of *P. subfirmus* to Central Europe. In this paper the Polish collection is described in detail, illustrated, and compared with reports in the literature from other regions. A key for determination all Polish species of *Panaeolus* is provided.

Material and methods

The macroscopic features were studied from fresh material of three collections comprising 16 basidiomata in different stages of development, collected from old cow-dung in a grazed pasture in the Rutka Inanimate Nature Reserve (NE Poland). Microcharacters of basidiomata were observed with a Nikon Eclipse E–400 light microscope fitted with a Nikon digital camera

(DS-Fi1). All microscopic structures were observed in dried material. Freehand sections of rehydrated pieces of basidiomata were examined in 5% NH_3 H_2O and Congo red reagent. Image-grabbing and biometric analyses were done with NIS-Elements D 3.1 imaging software. Dimensions of microcharacters are given as (minimum) average ± standard deviation (maximum), and additionally in the form of the main data range (10–90 percentile values). The Q value is the length/width ratio of basidiospores. For basidiospore size measurements, randomly selected mature spores were measured without the hilar appendix. The length of basidia was measured excluding sterigmata. Statistical computations employed Statistica (StatSoft). Morphological terminology follows Vellinga (1988). Details of the microcharacters were drawn freehand on tracing paper over photographs. The studied collections are deposited in the Museum of Natural History, Wrocław University, Wrocław, Poland (WRSL).

Fig. 1. Distribution of *Panaeolus subfirmus* P. Karst. in Poland.

Results and discussion

Panaeolus subfirmus P. Karst. Figs 1–4

Hedwigia **28**(6): 365. 1889. – *Panaeolus speciosus* P. D. Orton, Notes Roy. Bot. Gard. Edinburgh **29**(1): 108. 1969.

Illustrations: Orton (1969: 97, fig. 7h–i), Gerhardt (1996: 104, fig. 68), Van der Bergh & Noordeloos (1996: 76, fig. 1–5), Noordeloos (1998: 43, fig. 16; photo 16), Ludwig (2000: 128, fig. 59.16; 492); Phillips (2006: 262, photo a).

Basidiomata generally scattered. Pileus 15–50 mm, first convex to conical then expanded-conical, expanded-convex to plane-convex or nearly plane, with somewhat deflexed margin exceeding gills, distinctly hygrophanous, honey-brown to honey-grey, fading to ochraceous, pale grey or cream, with darker brown submarginal zone and center often tinged tawny-buff when dry entirely greyish or pale ochraceous-buff, matte, sometimes slightly rugulose or even cracked in places. Lamellae, L = 20–30, I = 3–5, medium-spaced to fairly crowded, ventricose to broadly ventricose, adnate to seceding, first milky coffee then brownish, dark brown and blackish, clearly mottled, with conspicuously white flocculose edge. Stipe 30–165 × 3–5 mm, cylindrical or slightly evenly thickening towards base and upwards, regularly broadened at base, hollow with narrow cavity, straight to curved, pale pinkish-ochraceous or tinged buff when fresh, fading whitish to ochraceous, entirely whitish pruinose when fresh, holding drops of water when wet, especially near apex, base whitish tomentose (Fig. 2). Context in pileus concolorous or ochraceous-buff over lamellae, in stipe sharply marked off, ochraceous-buff at apex, and often deep brown in lower part. Smell not distinctive, faint, fungussy. Taste not verified. Spore print color almost black.

Basidiospores (14.5) 16.4 ± 1.0 (20.1) × (9.0) 11.0 ± 0.6 (12.3) × (7.3) 9.5 ± 0.7 (11.1) µm, 15.1–17.4 × 10.2–11.6 × 8.7–10.6 µm, Q_w = (1.4) 1.7 ± 0.2 (2.1), Q_w = 1.5–2.0, Q_b = (1.3) 1.5 ± 0.1 (1.9), Q_b = 1.4–1.6 (n = 214), ellipsoid-oblong in side view, limoniform or (sub)angular-limoniform to ovoid in frontal view, flattened ventrally (adaxially), with dark, smooth, thickened wall, with ± prominent, central germ pore, (0.8) 1.5 ±0.3 (2.5), 1.2–1.9 µm. Basidia (24.8) 32.3 ±2.8 (39.1) × (11.5) 13.9 ±0.9 (15.9) µm, 28.8–36.0 × 12.7–15.0 µm (n = 131), 4-spored, clavate, clamped. Lamella edge sterile. Cheilocystidia (28.4) 44.6 ± 8.8 (68.9) × (3.5) 7.5 ± 2.1 (12.4) × (4.0) 6.7 ± 1.1 (9.7) µm, 35.2–56.6 × 4.9–10.5 × 5.4–8.2 µm (n = 213), cylindrical to narrowly lageniform, not infrequently with ± swollen apex (not distinctly capitate), thin-walled, colorless, middle part often

Fig. 2. *Panaeolus subfirmus* P. Karst. Top, side and bottom views of basidiomata (A & B – WRSL 22072012.394; C – WRSL 22072012.394 & 22072012.503).

flexuous. Another type of ± short broadly clavate cheilocystidioid element also present rarely. Pleurocystidia absent. Chrysocystidia-like sulphidia absent. Caulocystidia (22.7) 46.3 ± 11.1 (76.7) × (3.9) 6.4 ± 1.3 (11.6) × (3.3) 5.5 ± 1.1 (8.5) µm, 32.7–60.4 × 4.8–8.3 × 4.1–6.8 µm (n = 130), abundant, present at apex, similar to cheilocystidia, more flexuous (Figs 3 & 4). Pileipellis a hymeniderm made up of broad clavate to globose elements, 10.1–34.1 µm wide, pigment yellow-brownish, parietal. Stipitipellis a cutis made up of cylindrical, 4.0–15 µm wide hyphae, pigment yellow-brownish, parietal and intracellular. Clamp-connections abundant in all tissues.

Specimens examined: POLAND, Pojezierze Wschodniosuwalskie. Rutka nature reserve, grazed pasture, on old cow-dung, alt. 232 m a.s.l., 54°13′12″N, 22°50′51″E, 22 July 2012, *leg. M. Halama* (WRSL MH-22072012.394, MH-22072012.396 & MH-22072012.503).

Notes on morphology, ecology and distribution

Panaeolus subfirmus is characterized by its relatively large basidiomata and visually striking, hygrophanous and typically pale buff pileus. Microscopically it is distinguished by its large (reaching 18–20 µm in length), opaque, somewhat angular (hexagonal, with nearly parallel sidelines) and distinctly flattened basidiospores, as well as the absence of chrysocystidia-like sulphidia (Gerhardt 1996, 2008). Although *P. subfirmus* seems to be such a striking species that it can hardly be confused with other taxa macroscopically, some faded cream-colored or whitish, not very fresh specimens of it bear a superficial resemblance to *P. antillarum* and may be confused with it.

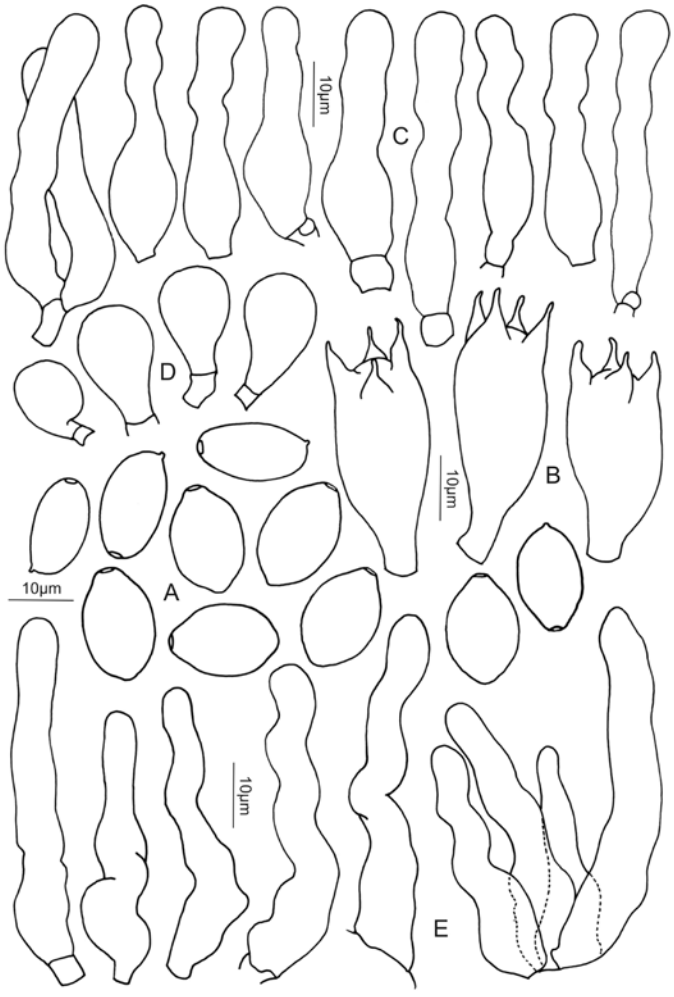

Fig. 3. Microcharacters of *Panaeolus subfirmus* P. Karst. A – basidiospores, B – basidia, C – cheilocystidia, D – cheilocystidioid elements, E – caulocystidia. All drawn from WRSL 22072012.503.

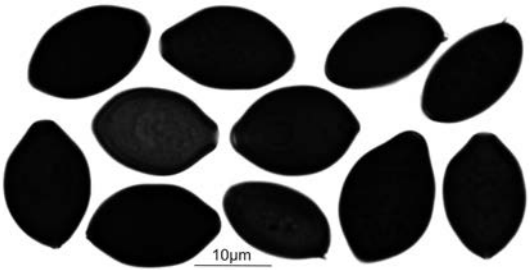

Fig. 4. Basidiospores of *Panaeolus subfirmus* P. Karst. (WRSL 22072012.394).

In general the *P. subfirmus* specimens collected in Poland are fairly typical for the species and agree closely with the description and drawings provided by Gerhardt (1996, 2008) and supplemented by other authors (e.g., Orton 1969; Noordeloos 1998), but it should be mentioned that the pale buff tinge of the cap surface was not very obvious in some fresh basidiomata. This fading was more prominent only in specimens exposed to excessive sunlight. Microscopic examination of the collected material and a survey of the literature data (Orton 1969; Watling & Gregory 1987; Gerhardt 1996; Van der Bergh & Noordeloos 1996; Noordeloos 1998) indicate that *P. subfirmus* is not conspicuously heterogeneous in its characteristic morphological features. In my review I found that little attention has been paid to some details of the basidiospore: germ pore dimensions, length/width ratio and length/breadth ratio. This study fills some of the gap in these data. Moreover, the gills of *P. subfirmus* are reported to lack any short clavate cheilocystidioid elements. I found such elements in several specimens from one collection but they do not occur consistently and appear to be missing in other studied material.

Panaeolus subfirmus seems to have a northern distribution in Europe, with clusters of localities in the southern part of Northern Europe and probably in the northernmost parts of Western Europe but only very scattered records from southern regions. It is everywhere considered rare, marked by very sparse occurrence (Watling & Gregory 1987; Gerhardt 1996, 2008). According to Noordeloos (1998), however, in the mid-1990s this fungus was abundant in the Netherlands, particularly in dune areas where it was observed at various localities along the coast. It should be stressed that *P. subfirmus* had never been found in the Netherlands before 1992. In the past the species was treated in the Netherlands as under threat but at present it does not seem to be endangered (Arnolds & Veerkamp 2008). Generally, *P. subfirmus* is not common in the Rutka Reserve. It was observed only once during three years of occasional visits to the area. It was found in the second half of July in two places, each time on old cow-dung. More searches for the species in Poland are required before definite conclusions about its distribution are reached.

Key to the Polish species of *Panaeolus*

1. Basidiospores under immersion smooth 2
1*. Basidiospores under immersion very faintly roughened . . . . . ***P. olivaceus*** F. H. Møller
2. Veil present (at least in young specimens), remnants of a veil present at pileus margin (as dentate fragments or fragments adpressed to cap margins) or stipe surface (as a ring). Pileus not or only slightly hygrophanous 3
2*. Veil absent. Pileus often distinctly hygrophanous (except *P. antillarum*) 5
3. Pleurocystidia present as thin-walled chrysocystidia-like sulphidia turning wine-red in sulphovanillin. Pileus stropharioid, comparatively fleshy, viscid to dry. Basidiospores 18–24 × 10.5–13 × 9.5–11.5 µm, elongate-ellipsoid in side and frontal view 4
3*. Pleurocystidia absent. Pileus mycenoid, not fleshy, dry. Basidiospores 13–18 × 8–13 × 7.0–10 µm, ellipsoid to amygdaliform in side view, angular-limoniform in frontal view (with nearly parallel sides), rarely submitriform . . . . . ***P. papilionaceus*** (Bull.: Fr.) Quél.
4. Stem with an ascending ring. Pileus typically semiovoid . . . . . ***P. semiovatus*** (Sowerby: Fr.) S. Lundell var. ***semiovatus***
4*. Stem ringless. Pileus semiglobate, campanulate or convex . . . . . ***P. semiovatus*** (Sowerby: Fr.) S. Lundell var. ***phalaenarum*** (Fr.) Ew. Gerhardt
5. Basidiospores on average > 11 µm long 6
5*. Basidiospores on average < 11 µm long . . . . . ***P. guttulatus*** Bres.
6. Facial chrysocystidia-like sulphidia present . . . 7
6*. Facial chrysocystidia-like sulphidia absent . . . 8

7. Basidiospores 9.515 × 7–9 × 6–8 µm, with ± eccentric germ pore, translucent. In manured soil, in grassy habitats . . . . . ***P. fimicola*** (Pers.: Fr.) Gillet

7*. Basidiospores 7–11 × 4.5–5.5 × 4–5 µm, with central germ pore, opaque. On dung of horse or cow and dung/straw mixtures . . . ***P. antillarum*** (Fr.) Dennis

8. Basidiospores on average < 15.5 µm long 9

8*. Basidiospores on average > 15.5 µm long . . . 10

9. Pileus 5–40 mm in diameter, stipe 30–130 × 1.5–3 mm. Basidiospores rhomboid to somewhat mitriform in frontal view . . . . . ***P. acuminatus*** (Schaeff.) Gillet

9*. Pileus 10–80 mm in diameter, stipe 30–120 × 3–8 mm. Basidiospores ovoid to subrhomboid in frontal view . . . . . ***P. cinctulus*** (Bolton) Sacc.

10. Pileus 15–75 mm in diameter, stipe 30–175 × 2–5 mm. Basidiospores angular- or subangular-limoniform in frontal view. On heavily manured soil or old cattle, horse and sheep dung . . . . . ***P. subfirmus*** P. Karst.

10*. Pileus 4–10 mm in diameter, stipe 20–90 × 0.5–1.5 mm. Basidiospores not angular or exceptionally slightly subangular in frontal view. On elk, rarely on roe-deer, reindeer or horse dung . . . . . ***P. alcis*** M. M. Moser

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