

## First records of gasteromycete *Queletia mirabilis* in the Czech Republic

MARTIN KRÍŽ<sup>1</sup>, VLADIMÍR ZÍTA<sup>2</sup>

<sup>1</sup>National Museum, Mycological Department, Cirkusová 1740, CZ-193 00 Praha 9, Czech Republic; mmartin.kriz@seznam.cz

<sup>2</sup>Opavská 2626, CZ-415 01 Teplice, Czech Republic; vladimir.zita@email.cz

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The paper reports on the first collections of *Queletia mirabilis* in the Czech Republic, supplemented with photographs of fresh fruitbodies. The authors present a macro- and microscopic description of this species based on a study of material collected at a locality in North Bohemia. Ecology and distribution of this very rare gasteroid fungus are summarised and potential confusion with similar species is discussed.

**Key words:** tulostomatoid fungi, *Agaricaceae*, Basidiomycota, ecology, distribution, North Bohemia.

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Článek informuje o prvních nálezech quéletovky podivné – *Queletia mirabilis* v České republice, připojeny jsou fotografie čerstvých plodnic. Autoři článku předkládají makroskopický a mikroskopický popis tohoto druhu založený na studiu materiálu sbíraného na lokalitě v severních Čechách. Jsou shrnuty poznatky o ekologii a rozšíření této velmi vzácné břichatkovité houby a diskutována je možnost záměny s podobnými druhy.

### INTRODUCTION

The weather in 2015 was exceptionally unfavourable for the growth of fungi in the Czech Republic. Central Europe was hit by an unusually strong heat and drought. However, these conditions may contribute to the occurrence of unusual fungal species for this area, primarily species known from southern Europe. In September 2015, after some moderate rainfalls, during a mycological survey in the vicinity of the town of Roudnice nad Labem (North Bohemia, Czech Republic), Dalibor Marounek found rather old fruitbodies of a gasteromycete. Neither of the authors of this article was initially certain of the exact species it represented, until October 2015, when fresh fruitbodies were found. Microscopic char-

acters together with macroscopic features in good condition indicated that it is *Queletia mirabilis* Fr., a species known from only a few finds in Europe.

The aim of this paper is to report on the first collections of this extremely rare gasteroid species in the Czech Republic and to publish colour photographs of the fruitbodies from a rich find including fresh young specimens.

#### MATERIAL AND METHODS

Macroscopic characters of the gasteromycete described below were studied on fruitbodies growing near the village of Bechlín in the vicinity of the town of Roudnice nad Labem. Microscopic mounts were made from dried mature specimens in a 5% KOH solution and studied under an Olympus CX21 light microscope with an oil-immersion lens at a magnification of 1000×. Spore sizes of 30 randomly selected spores measured are presented in the form of the main data range, complemented with extreme values in parentheses.  $Q_{av}$  is the average value of spore length and width ratio.

Herbarium specimens have been deposited in the Mycological Department, National Museum, Prague (PRM) and in the personal herbaria of Vladimír Zíta and Lucie Zíbarová. Abbreviations of public herbaria follow Thiers (on-line).

#### RESULTS

*Queletia mirabilis* Fr., Öfvers. K. Vetensk.-Akad. Förh. 28: 171, 1872 (“1871”) Figs. 1–9

**Macroscopic characters.** Fruitbodies sharply divided into head and stipe.

Sporiferous head initially low-hemispherical, then often flattened at the top (rounded thimble-shaped), in maturity mostly protuberant like a puffball (enlarged in height and width), or also flattened-globose, but often irregular from deformation caused by underground development and pressure of neighbouring fruitbodies (often growing in clusters). Width of the head 6–7 cm, height of the gleba 3–4 cm.

Peridium thin, in young specimens approximately 1 mm thick, later only 0.5 mm, at maturity breaking up into irregular patches, at first smooth, but soon minutely perforated (caused by insects), initially sordid whitish to sordid brownish, often dirty from the substrate.



**Fig. 1.** *Queletia mirabilis* (old fruitbodies), Bechlín (North Bohemia, Czech Republic), on old woody debris, 13 Sept. 2015, leg. D. Marounek (PRM 934823). Photo D. Marounek.



**Fig. 2.** *Queletia mirabilis*, Bechlín (North Bohemia, Czech Republic), on old woody debris, 10 Oct. 2015, leg. D. Marounek, L. Zibarová & M. Kříž (PRM 934551). Photo M. Kříž.



**Fig. 3.** *Queletia mirabilis*, Bechlín (North Bohemia, Czech Republic), on old woody debris, 10 Oct. 2015, leg. D. Marounek, L. Zíbarová & M. Kříž (PRM 934551; some fruitbodies collected on 11 Oct. 2015 in PRM 934822). Photo M. Kříž.



**Fig. 4.** *Queletia mirabilis*, Bechlín (North Bohemia, Czech Republic), on old woody debris, 11 Oct. 2015, leg. D. Marounek, M. Kříž, V. Zíta & E. Skála (PRM 934822). Photo M. Kříž.



**Fig. 5.** *Queletia mirabilis*, Bechlín (North Bohemia, Czech Republic), on old woody debris, 11 Oct. 2015, leg. D. Marounek, M. Kříž, V. Zíta & E. Skála (PRM 934822). Photo M. Kříž.



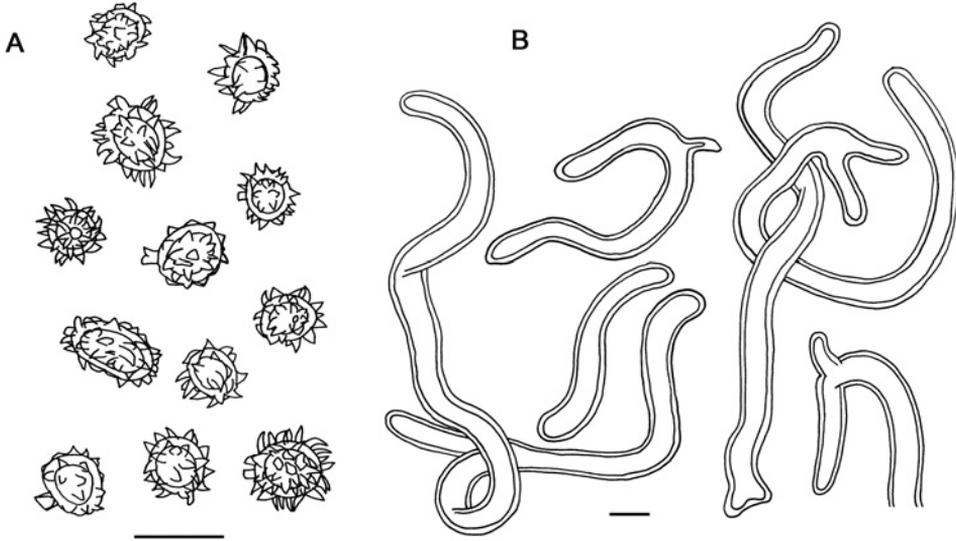
**Fig. 6.** *Queletia mirabilis*, Bechlín (North Bohemia, Czech Republic), on old woody debris, 11 Oct. 2015, leg. D. Marounek, M. Kříž, V. Zíta & E. Skála (PRM 934822). Photo V. Zíta.



**Fig. 7.** *Queletia mirabilis*, Bechlín (North Bohemia, Czech Republic), on old woody debris, 11 Oct. 2015, leg. D. Marounek, M. Kříž, V. Zíta & E. Skála (PRM 934822). Photo V. Zíta.



**Fig. 8.** *Queletia mirabilis*, Bechlín (North Bohemia, Czech Republic), on old woody debris, 12 Oct. 2015, leg. D. Marounek. Photo D. Marounek.



**Fig. 9.** *Queletia mirabilis* (PRM 934822). **A** – basidiospores, **B** – capillitium. Scale bars = 10  $\mu$ m. Del. M. Kříž.

Gleba sharply delimited from context of the stipe, in young specimens gradually changing colour from whitish to ochre, in mature specimens cinnamon-brown, in old specimens with a tendency to crumble in relation with decaying peridium. The lower edge of the head is usually separated from the stipe by a narrow gap, forming a sharp, often whitish and irregularly dentate collar – with adhering material broken off from outer layer of the stipe (material of various sizes, sometimes even with thick pieces detached from the cracking stipe and turned upwards). The entire fertile part of the fruitbody is fragile and brittle, often breaking in a young stage, especially at margin.

Stipe at first relatively short, cylindrical to widened upwards, at maturity long, cylindrical and often curved, 10–11  $\times$  3–4 cm, white, fleshy, with narrow cavity of about 0.5 cm wide, but sometimes only hardly developed; surface consisting of erect scales: the fibrillose surface gradually differentiates into scales oriented upward and curved outward, the scales initially being concolorous (white), at maturity and during drying becoming yellow-brown. The head more or less readily breaks off the stipe, which may remain in the ground, thus being unnoticed. The fruitbody can reach a total height of 14 cm.

Context of the stipe pure white. Taste mild, unspecific. Smell none or only somewhat pleasant after cutting very young fruitbodies; old and rotting specimens smell disagreeably musty.

**Microscopic characters.** Basidiospores  $(5.7)6.0\text{--}8.5(9.5) \times (5.3)5.8\text{--}7.5(8.0) \mu\text{m}$ , excluding ornamentation,  $Q_{av} = 1.13$ , globose to subglobose, rarely broadly ellipsoid, thick-walled, golden yellow, hilar appendix indistinct to conspicuous,  $1.5\text{--}3.0 \mu\text{m}$  long and  $1.6\text{--}2.2 \mu\text{m}$  wide, in ellipsoid spores not attached apically but laterally, ornamentation consisting of pointed verrucae to thin and thick spines, often  $\pm$  disarranged (oriented obliquely or curved), height of ornamentation  $1.0\text{--}2.0 \mu\text{m}$ . Basidia not detected. Capillitium abundant, hyphae cylindrical, twisted, thick-walled (wall  $1.0\text{--}2.0 \mu\text{m}$  thick), generally without protuberances but poorly branched,  $5.0\text{--}15.0 \mu\text{m}$  wide, at maturity consisting of mostly  $100\text{--}300 \mu\text{m}$  long pieces.

**Habitat.** On old and deep woody debris deposited in a low ravine. The fruitbodies developed under the upper layer which was then lifted by them. The substrate consisted of strongly rotten pieces of bark and spent tan, without herbaceous vegetation cover.

#### Material examined

Czech Republic. Bohemia. Bechlín near Roudnice nad Labem (North Bohemia, Dolnooharská tabule plateau), ravine with deposited biodegradable material, 13 Sept. 2015, leg. D. Marounek, det. M. Kříž (PRM 934823); *ibid.*, 19 Sept. 2015, leg. D. Marounek, M. Kříž & L. Novák, det. M. Kříž (PRM 934824); *ibid.*, 10 Oct. 2015, leg. D. Marounek, L. Zíbarová & M. Kříž, det. M. Kříž (PRM 934551; herb. L. Zíbarová 5168); *ibid.*, 11 Oct. 2015, leg. D. Marounek, M. Kříž, V. Zíta & E. Skála, det. M. Kříž (PRM 934822; herb. V. Zíta 1361).

## DISCUSSION

### Taxonomic position

*Queletia mirabilis* is a species described by E. Fries based on a find from Sochaux (Doubs department, France) in 1868. Traditionally, the genus *Queletia* was classified together with the genera *Battarraea*, *Battarraeoides*, *Chlamydropus*, *Phellorinia*, *Schizostoma* and *Tulostoma* in the family *Tulostomataceae* of the order *Sclerodermatales* (Moravec 1958). At present it is considered, based on molecular data, as a member of the order *Agaricales*, family *Agaricaceae* s. l. (including the *Tulostomataceae* as one of the five major subclades), see e.g. Gube (2009), Gube & Dörfelt (2012).

The genus *Queletia* is characterised by a globose to flattened-globose fertile part with a collar at the lower edge, and by a thick stipe with a fibrillose surface breaking up into scales. The peridium is simple according to the original diagnosis (Fries 1872), but duplex according to Pegler et al. (1995). We have observed a simple peridium in most fruitbodies. Only in a few specimens (in PRM 934824) perhaps hardly visible inconspicuous remnants of an exoperidium were ob-

served. We found the detection of a presumable duplex peridium to be problematic, especially because it was not apparently diversified into two layers in a young stage and often collapsed soon afterwards. Peridium dehiscing irregularly, without formation of an apical stoma, exposing the gleba, composed of free and mostly unbranched filaments of capillitium. Basidia pleurosporous (Dumée & Maire 1913 – with illustration), but absent at maturity (very soon disintegrating). *Queletia mirabilis* is distinctive by its lignicolous habit, while other members of *Tulostomataceae* are predominantly terrestrial.

### Similar taxa

Although the fresh fruitbodies collected at the locality near the village of Bechlín had a unique appearance, in the literature we can find some related species which are similarly rare and unknown from the Czech Republic, especially in the genera *Dictyocephalos* and *Schizostoma*. *Dictyocephalos attenuatus* (Peck) Long & Plunkett, a species known from North America, Africa and Central Asia, was found for the first time in Europe in the Iberian Peninsula, Spain (Wright et al. 1993, Moreno et al. 1997). Its fruitbodies are very similar, but have a peridium of (more distinctly) two layers (Long & Plunkett 1940) and sometimes a visible volva-like structure at the base of the stipe. Important differences are found in microscopic characters: the gleba of *D. attenuatus* does not contain free capillitium and differs also by the persisting basidia (having the shape of subglobose cells and being arranged in fascicles). Finally, the ornamentation of the spores is lower, not forming spines (for SEM photographs, see Moreno et al. 1997). Moreover, *D. attenuatus* has different ecological requirements – the fruitbodies grow mostly on dry sandy soil in xeric regions.

*Schizostoma laceratum* (Ehrenb. ex Fr.) Lév. has a likewise southern distribution, with its type locality in Nubia, Africa (Long & Stouffer 1943). Its fruitbodies are characterised by a duplex peridium dehiscing along irregular stellate rays. The membranous endoperidium usually remains intact long after the gleba has disappeared. Even though the stellate endoperidium is mentioned in the literature as the main macroscopic feature distinguishing this genus from *Queletia* (e.g. Zeller 1949), we have observed such a form of peridial dehiscence also in some older fruitbodies of *Queletia mirabilis*, resembling another and more common gasteromycete, *Mycenastrum corium* (Guers.) Desv. On the contrary, sometimes this stellate type of dehiscence is unclear in *Schizostoma laceratum* (see Sarasini 2005, p. 352). However, its spores are completely smooth. The ecology is different as well: just as in *Dictyocephalos attenuatus*, the fruitbodies of *Schizostoma laceratum* grow on sandy or gravelly soil in open, dry places such as desert dunes.

## Ecology and distribution

*Queletia mirabilis* is a very rare species occurring in Europe and North America. According to Kreisel (2001), it has been introduced into Europe from unknown origin. It is reported from France (Dumée & Maire 1913, Mornand 1989), Italy (see photo in Cetto 2005), United Kingdom (Ramsbottom 1953, Pilát 1955, Pegler et al. 1995), and recently from the Canary Islands, Spain (Moreno et al. 2012), in all cases from warm-temperate areas.

In the Czech Republic, the only locality lies in the thermophytic region, in the Litoměřice District in northern Bohemia. The altitude is 200 m a.s.l. It is a shallow ravine which used to be backfilled with wood debris (bark, spent tan) in the 1970s. This biodegradable waste material, which is at a progressive stage of decay now, was covered with a layer of ashes and later topsoil. After the year 2000 it was partially mucked for horticultural purposes. To date, the active decomposing process is causing warming of the substrate. The temperature of the substrate just under the surface measured by Dalibor Marounek was 39 °C. This self-heating substrate perfectly fits the aggregate data of Kreisel (2001). Recently, many other rare macromycetes have been found at this notable locality: especially surprising are hundreds of fruitbodies of *Tremiscus helvelloides* (DC.) Donk, as well as less common species of gilled fungi, such as *Conocybe inocybeoides* Watling, *C. laricina* (Kühner) Kühner, *Coprinellus heterothrix* (Kühner) Redhead, Vilgalys & Moncalvo, *Hohenbuehelia petaloides* (Bull.) Schulzer, *Leucoagaricus americanus* (Peck) Vellinga, *L. meleagris* (Gray) Singer, *Leucocoprinus cepistipes* (Sowerby) Pat., *Myxomphalia maura* (Fr.) Hora, and *Volvariella bombycina* (Schaeff.) Singer (see Kříž et al. 2015). Also some interesting species within the Animalia have been found, e.g. the beetle *Oryctes nasicornis*.

We propose including *Queletia mirabilis* into the next edition of the Red list of macromycetes of the Czech Republic and classifying it in the Critically Endangered (CR) category, despite the man-made habitat.

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