

***Erysiphe azaleae* (*Erysiphales*) – a new species of powdery mildew for Slovakia and further records from the Czech Republic**

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*Erysiphe azaleae*, a powdery mildew growing on deciduous *Rhododendron* species is reported from the Slovak and Czech Republics. A detailed description is given and its distribution in Europe is discussed.

**Key words:** *Erysiphaceae*, powdery mildew, *Rhododendron*, *Azalea*, Central Europe

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*Erysiphe azaleae*, padlí na opadavých druhoch rodu *Rhododendron*, bylo nalezeno na území Slovenska a České republiky. Je uveden popis druhu a údaje o jeho rozšíření v Evropě.

#### INTRODUCTION

Recently an increasing number of reports on the appearance of new powdery mildew species (*Erysiphales*) in various parts of Europe have been published, and the distribution areas have been extended: e. g. *Erysiphe vanbruntiana* (W. R. Gerard) U. Braun et S. Takam. on *Sambucus racemosa* and *Sambucus nigra*, *Erysiphe palczewskii* (Jacz.) U. Braun et S. Takam. on *Caragana arborescens* (Romaszewska-Sałata et al. 1982, 1986), *Erysiphe syringae* Schwein. on *Syringa vulgaris* (Braun 1995), *Erysiphe flexuosa* (Peck) U. Braun et S. Takam. on *Aesculus hippocastanum* (Ale-Agha et al. 2000, Ing and Spooner 2002, Piątek 2002, Zimmermannová-Pastirčáková and Pastirčák 2002, Zimmermannová-Pastirčáková et al. 2002, Wołczańska and Mułenko 2002), *Erysiphe syringae-japonicae* (U. Braun) U. Braun et S. Takam. on various *Syringa* species in Poland (Piątek 2003), *Erysiphe elevata* (Burrill) U. Braun et S. Takam. on *Catalpa* species (Ale-Agha et al. 2004) and *Phyllactinia corni* H. D. Shin et Y. J. La on *Cornus mas* (Bacigálová et al. 2005).

An outbreak of powdery mildew was noticed also on various *Rhododendron* species in Europe. At first the fungus was found only in the anamorph state and could not be exactly identified (Watling 1985, Braun 1987, Basden and Helfer 1995, Labanowski and Orlikowski 1997, Ing 2000, Inman et al. 2000). The powdery mildew species parasitising on *Rhododendron* were described as *Oidium ericinum* Erikss., *Erysiphe vaccinii* Schwein. (Braun 1987), *Microsphaera azaleae* U. Braun (now *Erysiphe azaleae* (U. Braun) U. Braun et S. Takam.) (Braun and Takamatsu 2000), *Microsphaera penicillata* (Wallr.: Fr.) Lév. (Labanowski and Orlikowski 1997) and *Microsphaera digitata* A. J. Inman et U. Braun (Inman et al. 2000).

*Erysiphe azaleae* (U. Braun) U. Braun et S. Takam. is a native North American powdery mildew originally described as *Microsphaera azaleae* by Braun (1982) based on a North American collection of infected leaves of *Rhododendron nudiflorum* (L.) Torr.

The first record of the teleomorph state of *Erysiphe azaleae* in Europe was published from Germany (Braun 1997). Later, the fungus ascomata (cleistothecia) were also found on various *Rhododendron* species in Switzerland (Inman et al. 2000, Bolay 2001), England (Ing 2000), Italy (Garibaldi et al. 2002), Poland (Piątek 2003, Shin and Mułenko 2004) and in the Czech Republic (Lebeda et al. 2006). First finds of *Erysiphe azaleae* from the Slovak Republic are reported here.

#### MATERIAL AND METHODS

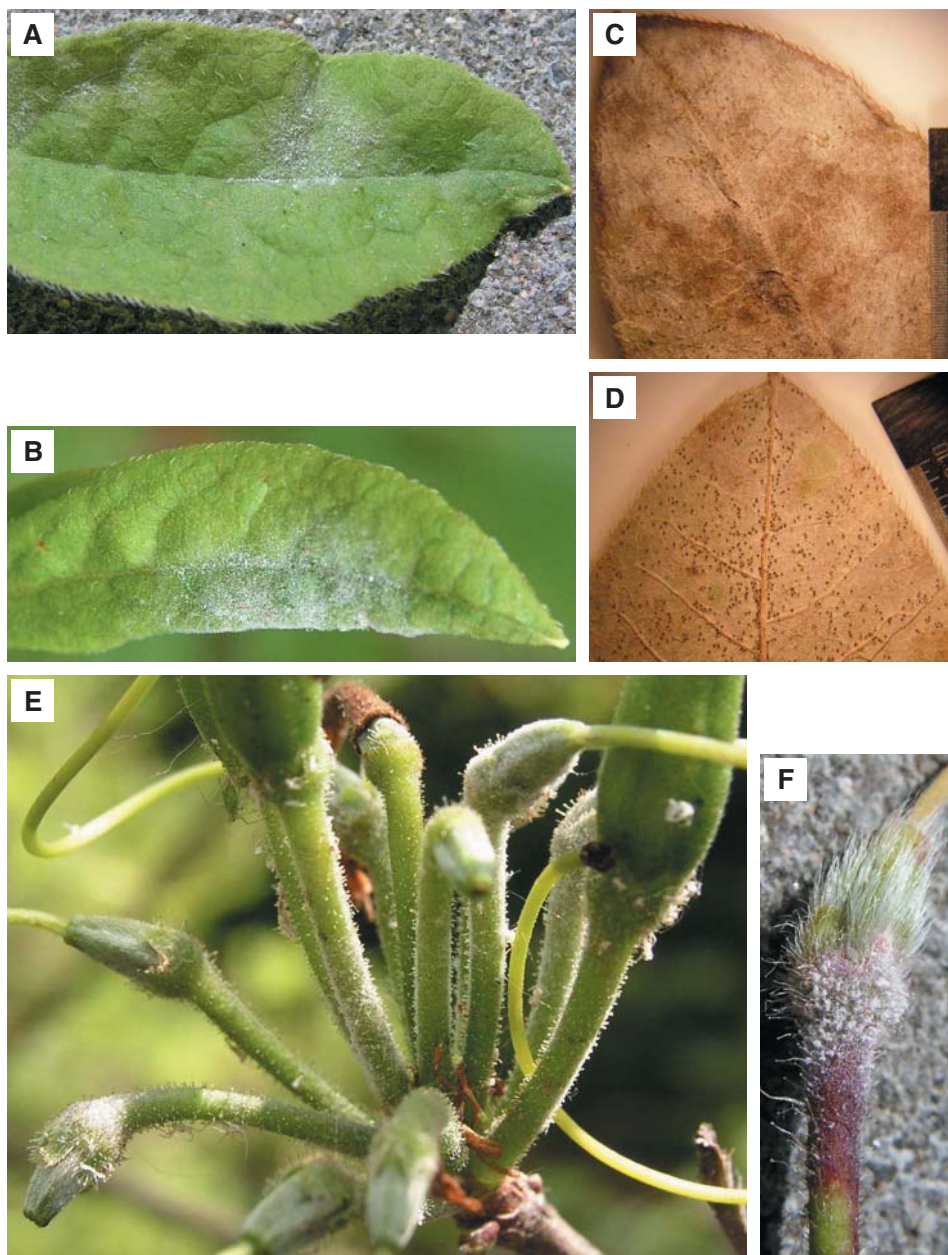
##### Material examined

On *Rhododendron luteum* Sweet, Slovakia: Podunajská nížina Basin, Tesárske Mlyňany, Arboretum, 7. X. 2005, leg. K. Bacigálová, SAV; Podunajská nížina Basin, Bratislava, Botanical Garden, 11. X. 2005, 28. X. 2005, leg. K. Bacigálová, SAV; Podunajská nížina Basin, Bratislava-Prievoz, Parková street, 30. X. 2005, leg. A. Petřík, SAV; Czech Republic: Praha, Botanical Garden of Charles University, 20. IX. 2005, leg. J. Marková, PRC; western Bohemia: Klenčí pod Čerchovem, Díly, 18. IX. 2005, leg. D. Kozáková, PRC.

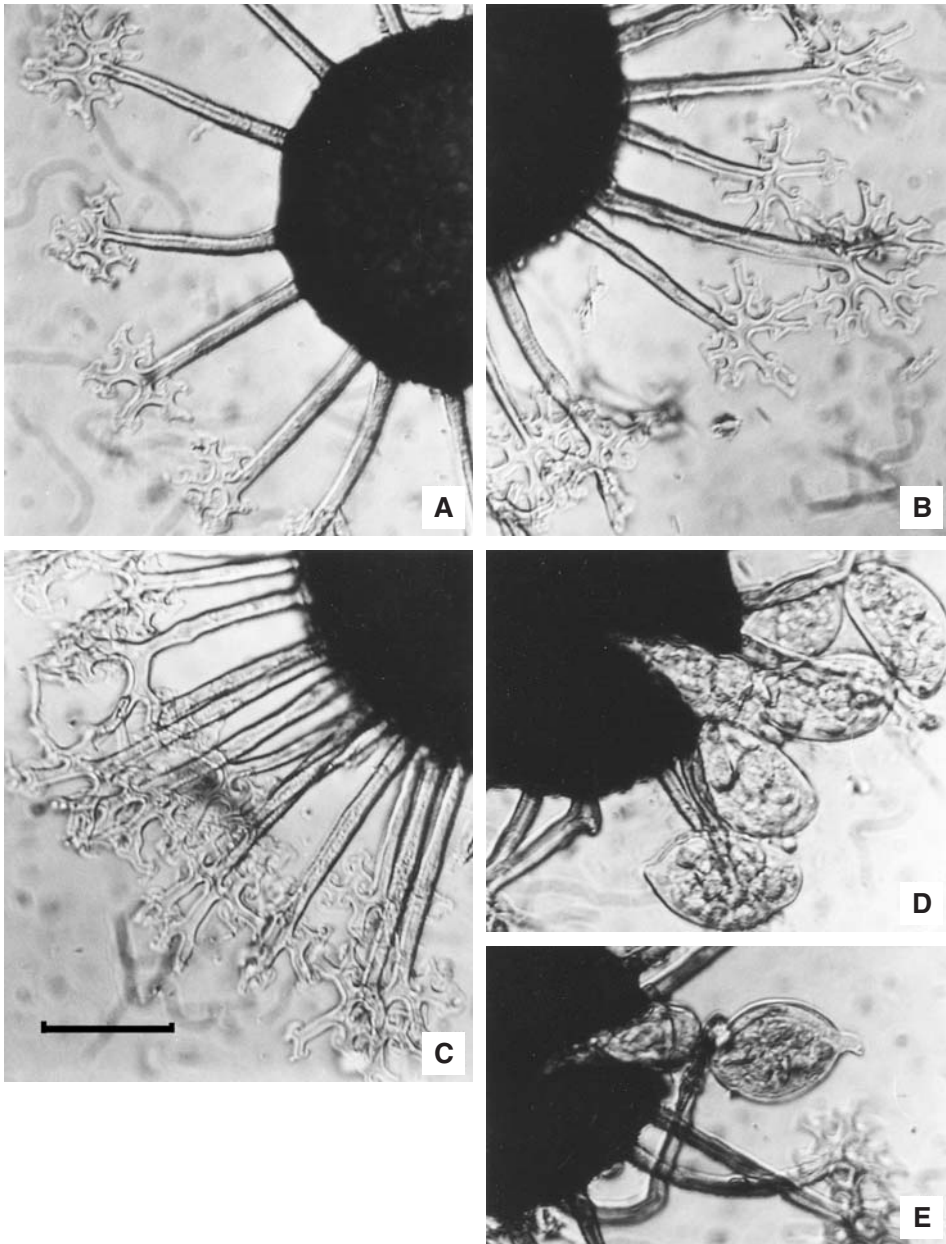
On *Rhododendron canadense* Torr., Slovakia: Podunajská nížina Basin, Tesárske Mlyňany, Arboretum, 7. X. 2005, leg. K. Bacigálová, SAV.

On *Rhododendron* seedling, Slovakia: Podunajská nížina Basin, Tesárske Mlyňany, Arboretum, 7. X. 2005, leg. K. Bacigálová, SAV.

On *Rhododendron* hybrids, cv. Berryrose, cv. Christopher Wren, cv. Exbury White, cv. Golden Sunset, cv. Homebush, cv. Hortulanus H. Witte, cv. Persil, cv. Pontica, cv. Samba, cv. Sylphides, Slovakia: Podunajská nížina Basin, Tesárske Mlyňany, Arboretum, 7. X. 2005, leg. K. Bacigálová, SAV; cv. Mollis von Gneist, Podunajská nížina Basin, Bratislava, Botanical Garden, 11. X. 2005, leg. K. Bacigálová, SAV; cv. Feuerwerk, cv. Strawberry Ice; Czech Republic: central Bohemia, Mirošovice near Praha,



**Fig. 1.** *Erysiphe azaleae* – symptoms on *Rhododendron* cv. Feuerwerk: A, B, C – upper side of leaves; D – lower side with ascomata; E, F – anamorph on flowers and fruits.



**Fig. 2.** *Erysiphe azaleae* – teleomorphic characteristics: **A, B, C** – ascoma showing variability in number and branching of appendages; appendages are thick-walled at the base and thinner upwards, branching is regular, close and compact with recurved apex; **D** – several sessile asci with ascospores; **E** – ascus with short stalk. Bar = 50  $\mu$ m.

28. IX. 2005 and 8. VII. 2006, leg. J. Marková, PRC; cv. div., Praha, Botanical Garden of Charles University, 20. IX. 2005, leg. J. Marková, PRC.

For identification of the fungus both visual symptoms of infected plants and anatomical-morphological characteristics were used. The teleomorph and anamorph state were observed in a drop of 50 % lactic acid coloured with methylen blue. For observations a Zeiss light microscope with a microphotographic attachment was employed. For cleistothecia, asci and ascospores 100 cleistothecia, asci and ascospores were measured,  $n = 100$ . In Tab. 1., the following abbreviations are used:  $\bar{x}$  – arithmetical mean of all cleistothecia,  $N$  – the most frequent number of appendages, asci and ascospores.

The collected material was deposited in the Mycological Herbarium of the Institute of Botany of the Slovak Academy of Sciences (SAV) and the Herbarium of the Faculty of Natural Sciences, Charles University, Prague (PRC).

#### RESULTS AND DISCUSSION

***Erysiphe azaleae*** (U. Braun) U. Braun et S. Takamatsu

Syn. *Microsphaera azaleae* U. Braun

**Mycelium** on leaves amphigenous, mostly epiphyllous, whitish to pale grey, rather persistent, forming small patches on the upper leaf surface ( Figs. 1 A, B, C) and moreover on fruits (Figs. 1 E, F).

**Cleistothecia** usually hypophyllous (Fig. 1 D), gregarious, brownish, 92–183 ( $\bar{x}$  128)  $\mu\text{m}$  diam., cells irregularly polygonal, with numerous appendages (Tab. 1), equatorial, hyaline, (61–)92–199  $\mu\text{m}$  long, aseptate or with one septum at the base, thick-walled towards the base, thinner upwards, apex 4–6 times regularly branched, close, with re-curved apex (Figs. 2 A, B, C).

**Asci** 4–9, sessile or short-stalked, (52–)55–73  $\times$  30–49  $\mu\text{m}$ , ascospores 4–8 per ascus; ellipsoid or slightly ovoid, hyaline, 18–25  $\times$  12  $\mu\text{m}$  (Tab. 1, Figs. 2 D, E).

**Conidial state:** hyphae hyaline, substraight to wavy, geniculate, 31–70  $\times$  4–7  $\mu\text{m}$ , mostly branching at right angles, usually with a septum near the branching point (Fig. 3 A). **Appressoria** well developed, multilobed to moderately lobed, in pairs or single. **Conidiophores** (primary and secondary) single on a hyphal cell, arising from the upper or lateral part of mother cells, mostly in central position, 31–80  $\times$  5–7  $\mu\text{m}$  in epiphyllous ones, 45–125  $\times$  4–7  $\mu\text{m}$  in hypophyllous ones, usually becoming broader upwards, neither constricted nor swollen at the branching point of the mycelium, producing single conidia followed by 1(–2) immature cells and a rather long foot-cell (25–50  $\mu\text{m}$ ), thus mostly composed of 3 cells when mature, occasionally appearing as forming short chains by somewhat broadening or swelling of the second cell, twisted or kinked to flexu-

ous at the base of foot-cells, with a basal septum at the branching point of the mycelium (Figs. 3 A, D, E).

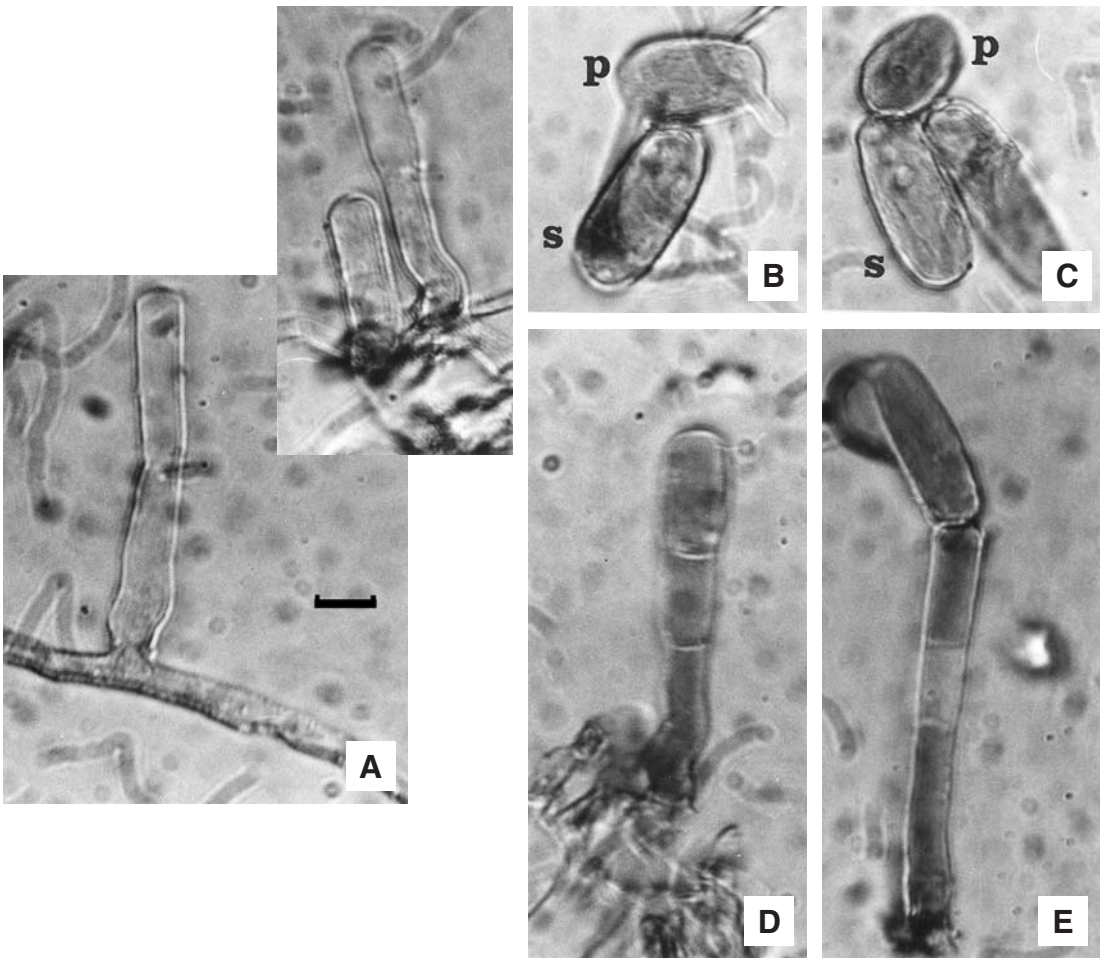
Primary conidia differentiated from secondary conidia by having a rounded apex and subtruncate base, mostly smaller than the secondary ones, 20–25–34 × 12–18 µm, broadest part non-median, obovoid with broad subtruncate base, producing germ tubes at the basal or terminal end.

Secondary conidia oblong to cylindrical, mostly symmetric at both ends, 20–46 × 12–18 µm without fibrosin bodies, producing terminal germ tubes (Figs. 3 B, C).

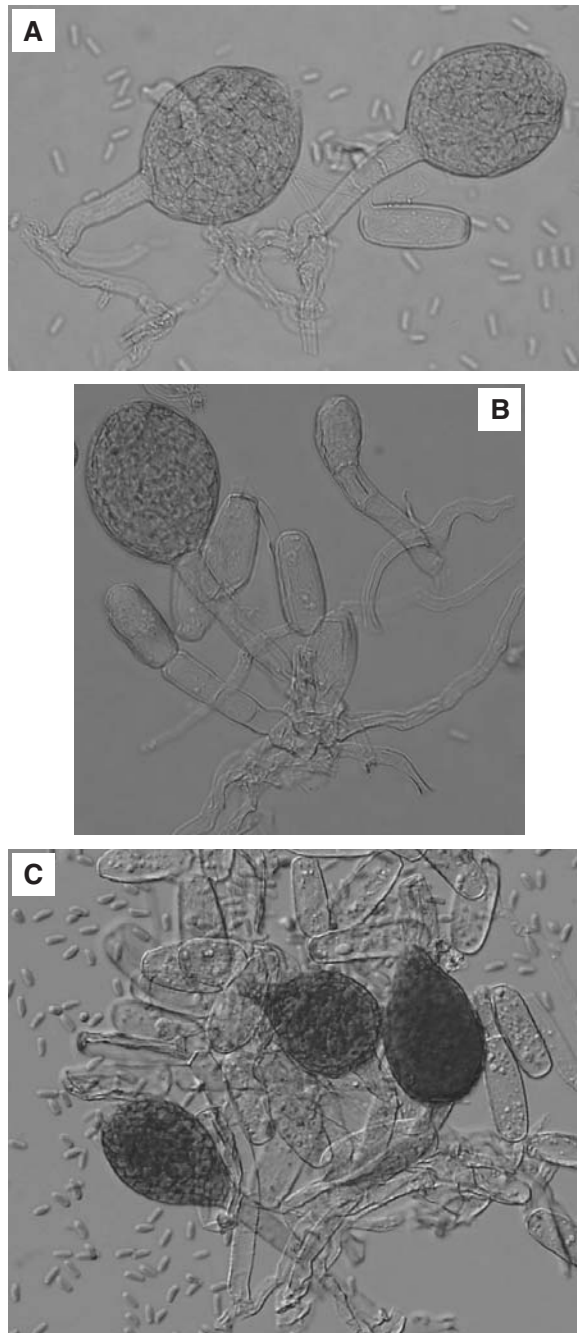
Note. The cleistothecia of *E. azaleae* in our collection show some variability in both number of appendages and branching of the apex of the appendages (Figs. 2 A, B, C) in correspondence with the characteristics by Braun (1982). The anamorph state of *E. azaleae* is positively consistent with the anamorphic characteristics by Shin and Muienko (2004). The most distinctive features were the kinking of the basal part of the conidiophore foot-cells (Fig. 3), and a differentiation of conidiophores composed of 2–4 cells. The primary conidiophore bearing a primary conidium at the apex (Figs. 3 B, D) and a subtruncate apex of the apical cell characterises the secondary conidiophore with 2–4 cells (Fig. 3 E) having symmetric ends (Figs. 3 B, C).

The mycoparasite *Ampelomyces quisqualis* Ces. (Fig. 4), an antagonist of powdery mildews, has appeared on the leaves of *Rhododendron* cv. Feuerwerk (collected 8. July 2006 in Mirošovce) and *R. luteum* (coll. 11 October 2005 in Botanical Garden Bratislava), covered by a powdery mildew anamorph and has prevented formation of cleistothecia all the vegetative season round. This is the first record of this mycoparasite on powdery mildew *Erysiphe azaleae* from *Rhododendron* in our ecological conditions and we hope it will initiate further studies.

Our finds (Czech and Slovak Republics) represent the sixth and seventh European countries in which *Erysiphe azaleae* has been detected. The Slovak finds come from *Rhododendron luteum* and various cultivars grown in Arboretum Mlyňany, Slovak Academy of Science (southwest Slovakia) and in the Town Garden Centre in Bratislava-Prievoz. The Czech material was collected in central and western Bohemia. The *Rhododendron* species were severely infected by the powdery mildew. According to personal communication with the gardener, the occurrence of powdery mildew on deciduous *Rhododendron* species in the Botanical Garden of Charles University in Prague was remarkable even in the autumn of 2004. *Erysiphe azaleae* occurred also in Olomouc, Ostrava and Zlín (Lebeda et al. 2006) and in the Arboretum of Mendel University of Agriculture and Forestry in Brno in 2004–2006 (personal communication). The all samples of our collection contained a great number of mature ascomata on both sides of the leaves together with a sparse conidial state. In the territory of Bratislava, Botanical Garden, *Erysiphe azaleae* has been found for the first time only in *Oidium state*. The records from the Czech and Slovak territories indicate that the fungus is spreading eastwards in Europe.



**Fig. 3.** *Erysiphe azaleae* – anamorphic characteristics: **A** – the kinked mother cell at the base of foot-cell conidiophores; **B, C** – primary conidia (**p**) and secondary conidia (**s**); **D** – primary conidiophore; **E** – secondary conidiophore. Bar = 10 µm.



**Fig. 4.** Mycoparasite *Ampelomyces quisqualis*: **A, B** – pycnidia formed within conidiophores of powdery mildew; **C** – the same stained with cotton blue.



**Tab. 1.** Comparative characters of the teleomorph state of *Erysiphe azaleae* on *Rhododendron* species in Slovakia and Czech Republic.

<i>Rhododendron</i> species (locality)	Cleistothecia ( $\mu\text{m}$ )	Appendage (N) / ( $\mu\text{m}$ )	Ascus (N) / ( $\mu\text{m}$ )	Ascospore (N) / ( $\mu\text{m}$ )
<i>Rhododendron canadense</i> (Arboretum Mlyňany)	120 ( $\bar{x}$ 120)	(20–23) 61–122	immature	immature
<i>Rhododendron luteum</i> (Arboretum Mlyňany)	92–122 ( $\bar{x}$ 104)	(15–16) 145–199	(6) 61–67 $\times$ 30–36	(6) 21–25 $\times$ 12
<i>R. luteum</i> (Bratislava-Prievoz)	110–153 ( $\bar{x}$ 124)	(14–22) 131–189	(8) 67–73 $\times$ 36–43	(6–8) 18–21 $\times$ 12
<i>R. luteum</i> (Praha – Botanical Garden)	116–141 ( $\bar{x}$ 131)	(18–22) 141–168	(6) 55–61 $\times$ 36–43	(6–8) 21 $\times$ 12
<i>R. luteum</i> (Díly near Klenčí)	110–153 ( $\bar{x}$ 129)	(18–22) 98–153	(4) 55 $\times$ 37	(6) 21 $\times$ 12
<i>Rhododendron</i> cv. Berryrose (Arboretum Mlyňany)	130–147 ( $\bar{x}$ 138)	(17–18) 92–122	(7) 67–73 $\times$ 36–43	(4–5) 21 $\times$ 12
<i>R.</i> cv. Christopher Wren (Arboretum Mlyňany)	128–174 ( $\bar{x}$ 140)	(16–18) 122–137	(4) 73 $\times$ 48	(6) 18 $\times$ 12
<i>R.</i> cv. Exbury White (Arboretum Mlyňany)	104–153 ( $\bar{x}$ 122)	(12) 104–130	(6–9) 55–67 $\times$ 30–43	(6–8) 21 $\times$ 12
<i>R.</i> cv. Golden Sunset (Arboretum Mlyňany)	110–141 ( $\bar{x}$ 129)	(16–18) 120–137	(6–8) 61–64 $\times$ 37–43	(6) 21 $\times$ 12
<i>R.</i> cv. Homebush (Arboretum Mlyňany)	116–153 ( $\bar{x}$ 137)	(22–26) 137–153	(6) 55–67 $\times$ 30–43	(8) 24 $\times$ 12
<i>R.</i> cv. Hortulanus H. Witte (Arboretum Mlyňany)	116–160 ( $\bar{x}$ 141)	(16–21) 92–122	(6–8) 55–73 $\times$ 31–49	(6–8) 18 $\times$ 12
<i>R.</i> cv. Persil (Arboretum Mlyňany)	122–183 ( $\bar{x}$ 142)	(20–26) 92–183	(7) 61–73 $\times$ 30–42	(6) 25 $\times$ 12
<i>R.</i> cv. Pontica (Arboretum Mlyňany)	110–134 ( $\bar{x}$ 124)	(24–33) 92–122	(6) 61–67 $\times$ 36–43	(6) 21 $\times$ 12
<i>R.</i> cv. Samba (Arboretum Mlyňany)	122–153 ( $\bar{x}$ 139)	(16–25) 107–122	(6–7) 55–67 $\times$ 36–42	(6) 18 $\times$ 12
<i>R.</i> cv. Sylphides (Arboretum Mlyňany)	104–153 ( $\bar{x}$ 122)	(15–19) 92–107	(6–8) 52–55 $\times$ 30–40	(6) 21 $\times$ 12
<i>R.</i> cv. Strawberry Ice (Mirošovice)	104–153 ( $\bar{x}$ 122)	(22–27) 92–122	(6–8) 55–70 $\times$ 37–43	(6) 18–21 $\times$ 12
<i>R.</i> seedling (Arboretum Mlyňany)	128–147 ( $\bar{x}$ 137)	(16–22) 122–153	(6–8) 61–67 $\times$ 37–43	(6) 25 $\times$ 12
<i>R.</i> cv. div. (Praha – Botanical Garden)	110–116 ( $\bar{x}$ 113)	(20–25) 92–122	(4–8) 55–67 $\times$ 37–43	(6) 21 $\times$ 12

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