

Rust Fungi on *Bellis perennis* in Central Europe: Delimitation and distribution

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The taxonomy, morphology and distribution of rust species on *Bellis perennis* L. (Asteraceae) in Central Europe was studied. *Aecidium bellidis* Thüm. is considered as *nomen anamorphosis* of *Puccinia obscura* J. Schröt. *P. obscura* can be delimited from *P. lagenophorae* mainly by the formation of pycnia, circular arrangement of aecia, larger size of aeciospores and peridial cells. *P. lagenophorae*, an introduced species, could be recorded for the first time on *B. perennis* in the European mainland. A recent epidemic spread on this host plant in Central Europe is described and discussed.

Keywords: *Aecidium bellidis*, *Puccinia lagenophorae*, *Puccinia obscura*, *Bellis*, Europe.

Three rust species are known to grow on *Bellis perennis* L. (Asteraceae) in Central Europe. *Puccinia obscura* J. Schröt. is a heteroecious rust forming stages 0 and I on *Bellis* spp. and II/III on *Luzula* spp. (Juncaceae). This species is distributed throughout the northern hemisphere (Gäumann 1959: 608). In Central Europe it can be found wherever the telial hosts are present. Although common on the telial host(s), there are only few records on the aecial host (*B. perennis*). In North America, it could not yet be found on the aecial host. The second species, *P. lagenophorae* Cooke, is an autoecious oopsis-form, forming 0, I and III. In Australia and New Zealand pycnia are rarely developed [McAlpine, 1906; Cunningham, 1931 (according to Wilson & al., 1965: 506); Viennot-Bourgin, 1964], but in Europe they have so far never been observed. *P. lagenophorae* is polyphagous on numerous host species belonging to the Asteroideae. It is a rust native to Australia and New Zealand that has been introduced in Europe. Little is known of the third species, *Aecidium bellidis* Thüm., with only few records and no details about its distribution. Some authors, e. g. Plowright (1889), Sydow & Sydow (1904: 645), Klebahn (1914: 446), and Savulescu (1953: 810), considered this species to be the anamorph of *P. obscura*, although I do not know of any studies that proved this assumption to be correct. Most of the recent records of

P. lagenophorae on *B. perennis* have been erroneously identified as *P. obscura* or *A. bellidis*. Rarely formed telia and the uncertainty of pycnium formation in *P. lagenophorae* seem to be the reason for the difficulties to delimit the three taxa concerned. In addition, the three species cannot be differentiated by ecological parameters like horizontal and vertical distribution, vegetation types, or phenology. Therefore, a detailed morphological study on rust fungi on *B. perennis* in Central Europe, with special emphasis on the aecia, is presented here. Furthermore, a recent epidemic spread of *P. lagenophorae* on *B. perennis* in Central Europe is described.

Morphological and taxonomical studies

Microscopic studies are based on dry herbarium material only.

Puccinia obscura J. Schröt., in Pass., N. Giorn. Bot. Ital. 9: 256 (1877).

Pycnia first honey-coloured, later brown, 90–200 µm diam., mostly on leaf blades, amphigenous but mostly epiphyllous, formed in roundish clusters of different size. – Aecia mostly on leaf blades, rarely near the veins, amphigenous, but mostly epiphyllous, sometimes on leaf stipules, leaves sometimes deformed, on leaf blade mostly in 1–4 circles (Fig. 1a), depending on the size of the leaf, or rarely in irregular groups; aecia replacing pycnia from the outer part of the cluster, but not the inner pycnia (Fig. 1a), around the inner pycnia

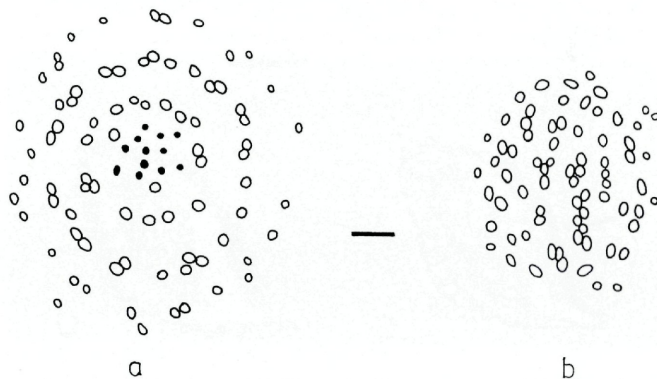


Fig. 1. – Characteristic arrangement of aecia on leaf surface of *Bellis perennis*. – a. *P. obscura* (small black spots are pycnia). – b. *Puccinia lagenophorae* (schematic). – Bar = 1 mm.

the tissue is decaying earlier, leaving a hole; acelia round to elongated, 200–300(–320) μm diam., cup-shaped, white peridium with torn margin. – Peridial cells (Fig. 2a,b) very different in shape and size, more or less rhomboid, diagonal length \times diagonal width \times depth (28.0–)32.0–48.0(–53.0) \times 12.5–20.0(–23.0) \times (13.5–)18.5–28.0 μm , outer wall (2.5–)3.5–6.5(–8.0) μm thick, finely striate, inner wall 2.5–4.0

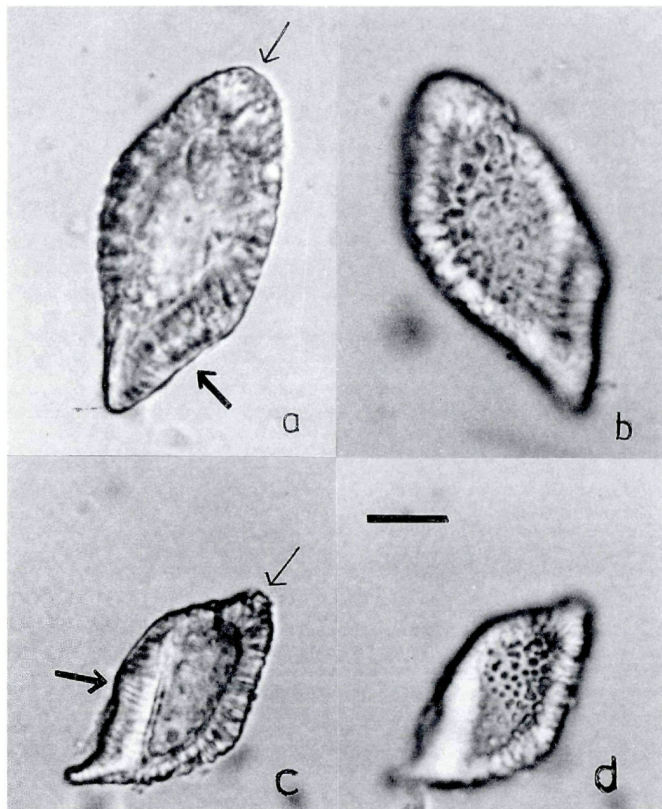


Fig. 2. – Differential interference contrast photographs of peridial cells. – Bar = 10 μm . – Thin arrow = thickened upper angular wall, thick arrow = outer finely striate wall. – a, b. *Puccinia obscura*: cells in medium focus (a) and in surface focus (b). – c, d. *Puccinia lagenophorae*: cells in medium focus (c) and in surface focus (d).

(–5.5) μm thick, irregularly warted with warts of different shape and size, 0.3–2.0 μm diam., distance less than 1 μm , wall at the upper angle thickened 5.5–12.5 μm wide. – Aeciospores subglobose to oval or somewhat angular, (16.0–)17.5–22.0(–23.5) \times (13.0–)14.5–19.0(–20.0) μm , wall less than 1 μm thick, hyaline, finely verrucose, warts less than 1 μm distant, several hyaline plugs present, 2–5 μm diam.

Specimens examined. – BELGIUM: date?, Environs de Namur, C. Roumeguère in C. Roumeguère Fungi Gallici exsiccati No. 3515 (herb. P). – CZECH REPUBLIC: 13. 8. 1952, Silesia, Beskydy, Ostravice, 420 m, J. Müller (only 0, herb. J. Müller). – FRANCE: 29. 3. 1910, Pornic, Loire-Inferieure, A. Maublanc in Sydow Uredineen No. 2322 (herb. P); 12. 8. 1910, Saint Claud, Ludwig (herb. P); 18. 12. 1941, Normandie, Calvados, Verson, H. Buhr (herb. JE); 31. 3. 1943, Bretagne, La Baule les Pins, H. Buhr (herb. JE); 22. 9. 1943, Bretagne, La Baule les Pin, H. Buhr (herb. JE); 16. 10. 1943, Bretagne, La Baule/Escoublac, H. Buhr (herb. JE) (fide Buhr 1958). – GERMANY: 4. 10. 1995, Sachsen, Erzgebirge, Pöhlberg, 750 m, W. Dietrich (herb. W. Dietrich No. 383/95). – GREAT BRITAIN: 12. 9. 1948, Alderrey, M. B. Ellis & J. P. Ellis (herb. IMI No. 31886); 17. 9. 1948, Little Sark, M. B. Ellis & J. P. Ellis (herb. IMI No. 31883); 12. 11. 1958, Pickering, W. G. Bramly (herb. IMI No. 75484). – POLAND: October (date probably \pm 1870), Silesia, Neurode bei Liegnitz (former Germany), J. Gerhardt (herb. B).

***Puccinia lagenophorae* Cooke, Grevillea 13: 6 (1884).**

Concerning the numerous synonyms see Wilson & al. (1965) and Scholler (1993).

Pycnia lacking. – Aecia mostly on leaf blades, amphigenous, mostly epiphyllous, sometimes on leaf stipes, blossom stipes and rarely on involucreal leaves, infected parts sometimes deformed, aecia very rarely in circles, mostly in irregular groups forming elongated rows or (on larger leaves) rounded clusters (Fig. 1b), sori round to elongated, (160–)200–300(–350) μm diam., peridium often not or only poorly developed, when well-developed with torn margin, white. – Peridial cells (Fig. 2c, d) very different in shape and size, more or less rhomboid, diagonal length \times diagonal width \times depth (25.0–)30.0–42.5(–46.0) \times 12.5–17.5(–21.0) \times (12.5–)15.5–23.0 μm , outer wall (2.5–)3.5–7.0(–8.0) μm thick, finely striate, inner wall 2.5–4.0(–5.5) μm thick, irregularly warted with warts of different shape and size, warts 0.2–1.7 μm diam., roundish to elongated, distance 0.2–1.0 μm , up to 1.5 μm in the lower part of the cell, wall at the upper angle thickened up to (3.0–)4.5–8.0(–10.0) μm . – Aeciospores subglobose to oval or somewhat angular, (12.5–)13.0–17.5(–18.5) \times (10.0–)11.0–15.0(–16.0) μm , wall hyaline, finely verrucose, less than 1 μm distant, several plugs present, hyaline, 1.5–4.5 μm diam. – Telia rarely and sparsely formed between aecia on blossom stipes or leaves.

Specimens examined. – AUSTRIA: 23. 5. 1993, Wien, Ebersbrunn, Privatgarten, H. Prillinger (herb. H. Prillinger, cf. Poelt & Zwetko, 1997). GERMANY: 2. 8. 1995, Bayern, Regensburg, Badener Weg, Garten, L. Krieglsteiner (herb. Krieglsteiner No. 645/95); 15. 8. 1995, Bayern, Karlstadt, Burgruine Karlbürg,

L. Krieglsteiner (herb. REG); 17. 9. 1995, Bayern, München, Moosach, S of the settlement "Lerchener See", lawn, 505 m (herb. M, will be published in G. Triebel, *Microfungi exsiccati*); 11. 10. 1966, Nordrhein-Westfalen, Bonn, Pharmakognostischer Garten, Endenicher Allee, W. Brandenburger (herb. W. Brandenburger No. 662, herb. M. Scholler No. 1/66); 6. 11. 1994, Sachsen, Dresden-Mitte, nahe Frauenkirche, F. Klenke (herb. F. Klenke No. 119/94); 14. 10. 1995, Sachsen, Dresden, Straßburger Platz, H. Jage (herb. H. Jage No. 1978/95); 26. 9. 93, Sachsen-Anhalt, Merseburg, am Gotthardtsteich, U. Richter (herb. H. Jage No. 574/95); 5. 5. 1995, 9. 5. 1995 (I+III), 17. 6. 1995, 22. 6. 1995, 2. 9. 1995, 18. 10. 1995, Sachsen-Anhalt, Bergwitz, H. Jage (herb. H. Jage No. 362/95, 404/95, 699/95, 752/95, 2098/95); 6. 6. 1995, Sachsen-Anhalt, Ermsleben, Ufer der Selke, D. Hanelt (herb. D. Hanelt); 5. 7. 1995, Sachsen-Anhalt, Halle/Saale, Botanischer Garten, H. Jage (herb. H. Jage No. 878/95); 1. 10. 1995, Sachsen-Anhalt, Querfurt, Burg, H. Jage (herb. H. Jage No. 1852/95); 9. 10. 1995, Sachsen-Anhalt, Kemberg, H. Jage (herb. Jage No. 1967/95); 17. 10. 1995, Freyburg/Unstrut, H. Jage (herb. H. Jage No. 2036/95); 21. 10. 1995, Sachsen-Anhalt, Gräfenhainichen, Wörlitzer Park, H. Jage (herb. H. Jage No. 2108/95); 29. 10. 1995, Memleben, H. Jage (herb. H. Jage No. 2177/95). – SWITZERLAND: 14. 4. 1994, Genève, Cointrin, Aéroport, massif sous la galerie d'observation, A. Bolay (herb. G); 31. 8. 1995, VD, Lutry, Avenue William, A. Bolay (herb. G, I+III). 24. 4. 1996, VD, Lutry, Massif au bord du Lac, A. Bolay (herb. G); 17. 7. 1996, VD, Nyon, Chaussee de Bonmont 7, A. Bolay (herb. G, I+III).

Aecidium bellidis Thüm., *Fungi austriaci*, No. 635 (1876) and Österr. Bot. Zeitschr. 26: 21 (1876).

The studied material matches perfectly the pycnia/aecia of *P. obscura*. Therefore, the assumption that *A. bellidis* is the *nomen anamorphosis* of *P. obscura* is probably correct. De Thümen's description of *A. bellidis* is based on the material distributed as *Fungi austriaci* No. 635 (see below). Hence, a part of this material, deposited in B, is proposed to serve as lectotype and all duplicates become isolectotypes.

Material examined. – CZECH REPUBLIC: Autumn 1872, Bohemia, Teplitz (former Austria), de Thümen in de Thümen, *Fungi austriaci*, No. 635 (Herb. B).

The present investigations show that there are some features that allow one to distinguish the aecia of *P. obscura* from those of *P. lagenophorae*. The differences are summarized in Tab. 1. Klebahn (1914: 446 ff.) provided a detailed description of the aecia of *P. obscura*. This description was later obviously copied in other European rust floras (e. g., Gäumann 1959: 605, Majewski 1979: 227). Klebahn (l.c.) published a clearly smaller aeciospore size (13–17 µm diam.) compared to my studies and those of other authors (e. g., Wilson & Henderson 1966, Savulescu 1953, Gjørnum 1974). Klebahn (l.c., p. 446) mentioned that he studied material from "Liegnitz" and that he used it for his drawings (p. 444). On p. 447 more details on the origin of this collection are given: "Schlesien, Neurode, Liegnitz, leg. Gerhardt". This specimen, however, is identical with the specimen from herb. B listed above, in which I measured aeciospores of (16.5–)17.5–20.0(–20.5) × (12.5–)14.0–16.0(–17.5) µm. Although the

Tab. 1. – Differences between *Puccinia obscura* and *P. lagenophorae* on *Bellis perennis*.

	<i>P. obscura</i>	<i>P. lagenophorae</i>
formation of 0	yes	no
arrangement of I	often in circles	rarely in circles
size of aeciospores (µm)	(16.0–)17.5–22.0(–23.5) × (13.0–)14.5–19.0(–20.0)	(12.5–)13.0–17.5(–18.5) × (10.0–)11.0–15.0(–16.0)
size of peridial cells (µm)	(28.0–)32.0–48.0(–53.0) × 12.5–20.0 (–23.0) × (13.5–)18.5–26.0(–28.0)	(25.0–) 30.0–42.5 (–46.0) × 12.5–17.5(–21.0) × (12.5–)15.5–23.0(–25.0)
width of upper angular peridial cell wall (µm)	5.5–10.0(–12.5)	(3.0–)4.5–8.0(–10.0)
formation of III	no (on telial host)	rarely

spores are somewhat smaller than those of other collections studied, they are clearly larger than described by Klebahn (l.c.).

Distribution and expansion of *P. lagenophorae* on *B. perennis* in Central Europe

Within Europe, *P. lagenophorae* was recorded for the first time in France in 1960 (Mayor, 1962). Up to now this species has reached nearly all Europe except parts of North Europe and East Europe. This statement is based on published as well as unpublished data. In Europe, the fungus is known on more than ten different species of the Asteroideae with *Senecio vulgaris* L. as main host. The other hosts were only rarely recorded. *B. perennis* has been known as host plant in Australia for a long time, whereas in Europe a natural infection was only recorded once in Great Britain in 1972 (Henderson & Bennell, 1979). Furthermore *B. perennis* was proven as host by inoculation (Wilson & al. 1965). With this revision, *B. perennis* becomes the fifth host plant in Central Europe besides *Calendula officinalis* L., *Senecio aegypticus* L.¹, *S. vernalis* Waldst. & Kit. and *S. vulgaris* L. In addition, it could be shown that this fungus was already present on *B. perennis* in 1966 in Bonn (Germany; see list of material examined above). After 1966, however, there are countless records on *S. vulgaris* in Europe but none on *B. perennis* until 1993 when it was found in Vienna (Austria) in May and in Merseburg (East Germany) in September. In the following years this pathotype

¹ *S. aegypticus* is rarely grown as ornamental plant in Central Europe. The only record on this host has so far not been published: Switzerland: 15. 9. 1964, Neuchâtel, Botanical Garden, C. Terrier (herb. BUCM No. 43923; G. Negrean, in litt.).

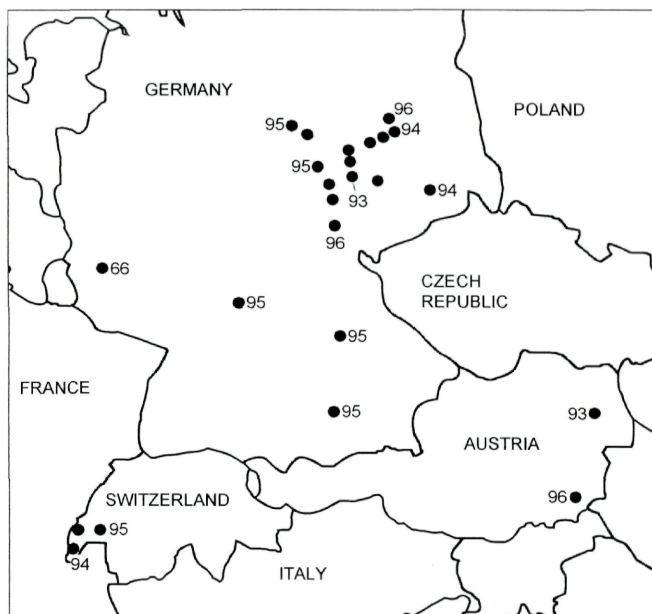


Fig. 3. – *Puccinia lagenophorae* on *Bellis perennis* in Central Europe. Distribution and year of first observation in definite geographical regions.

quickly spread and from 1995 onward *B. perennis* outnumbered *S. vulgaris* as main host at least in the eastern German Federal States Sachsen, Sachsen-Anhalt, and Thüringen (H. Jage, pers. comm.). The map in Fig. 3 shows the distribution and first records of *P. lagenophorae* on *B. perennis* in Central Europe. For this map additional data delivered by D. Hanelt, F. Klenke, L. Krieglsteiner, H. Jage and P. Zwetko have been used. It seems impossible to understand where this pathotype evolved and how it spread in the last years. It is sure, however, that it has not arrived in the region south of Wittenberg (Sachsen-Anhalt) and Karlstadt (North Bayern) before 1994 and 1995, respectively. These regions have been thoroughly investigated in the preceding years. Furthermore, it is sure that this pathotype has not yet reached Northeast Germany, because several mycologists have intensively searched rust fungi on *B. perennis* in this region. It is noteworthy that the pathotype can infect wild

daisies as well as cultivars and that it is probably able to infect *S. vulgaris*, too, because infected daisies were observed several times in direct neighbourhood to infected groundsels.

In 1997 the *Puccinia lagenophorae* pathotype on *Bellis perennis* spread northward and could be found at two locations in North Germany as well: From 8. 6. 1997 on, Mecklenburg-Vorpommern, Greifswald, new cemetery, M. Scholler (several specimens in herb. M. Scholler, I, from August on I+III). 23. 8. 1997, Hamburg, Harburg, Neuenfelde, cemetery, J. Hechler (herb. M. Scholler, I+III).

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