

NEW COLLECTIONS OF POWDERY MILDEWS (ERYSIPHALES) IN POLAND

AGATA WOŁCZAŃSKA & WIESŁAW MUŁENKO

Abstract: New hosts and records of powdery mildews (Erysiphales) in Poland are discussed. *Erysiphe adunca* (Wallr.) Fr. was found on a host new for this fungus: *Salix repens* L. subsp. *arenaria* (L.) Hiitonen. Two other species – *Golovinomyces cichoracearum* (DC.) V. P. Gelyuta var. *cichoracearum* (on *Chondrilla juncea* L.) and *Erysiphe syringae* Schwein. (on *Ligustrum vulgare* L.) – were collected on host plants new for Poland. The anamorphic as well as teleomorphic (cleistothecia with ascospores) state of *Erysiphe syringae* was observed on *Ligustrum vulgare* and *Syringa vulgaris* L.; hitherto this fungus has formed mature cleistothecia only in North America. *Erysiphe flexuosa* (Peck) U. Braun & S. Takamatsu has been introduced from North America to Europe recently. *Aesculus pavia* L. and *A. × carnea* Hayne are new hosts for this fungus in Poland. *Golovinomyces cichoracearum* var. *cichoracearum* [on *Cirsium canum* (L.) All.] and *Podosphaera spiraeae* (Sawada) U. Braun & S. Takamatsu (on *Spiraea* cf. *japonica* L.) are recorded on rare host plants.

Key words: taxonomy, ecology, parasitic fungi, Ascomycota, Erysiphales, *Erysiphe*, *Golovinomyces*, *Podosphaera*

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INTRODUCTION

In recent years an increasing number of reports on the appearance of new powdery mildew species (Erysiphales) in Poland and other parts of Europe have been published, and the distribution areas have been extended (e.g., Romaszewska-Sałata *et al.* 1982; Mułenko 1993; Wołczańska 1995; Braun 1998; Dynowska *et al.* 1999; Ing 2000; Ruskiewicz 2000; Piątek 2000, 2002; Adamska 2001; Czerniawska 2001; Wołczańska & Oklejewicz 2001). Teleomorphs of powdery mildew fungi hitherto only known as anamorphs are also encountered.

Since 1750, 22 species of Ascomycota have been introduced in Europe, including 18 members of Erysiphales (80%) (Kreisel & Scholler 1994). These fungi were introduced to European countries accidentally or else came spontaneously from other continents. A classic example in recent years is the rapid migration of two East Asiatic species of the genus *Erysiphe* DC. *emend.* U. Braun & S. Takamatsu [*E. vanbruntiana* (W. R. Gerard) U. Braun & S. Takamatsu and *E. palczewskii* (Jacz.) U. Braun & S. Takamatsu (Romaszewska-Sałata *et al.* 1982, 1986)]. These fungi have already spread almost throughout Europe (Braun 1995). A recent migration in the opposite direction can be

observed for two other species: *Erysiphe syringae* Schwein. (Braun 1987, 1995) and *Erysiphe flexuosa* (Peck) U. Braun & S. Takamatsu (Ale-Agha *et al.* 2000; Ing & Spooner 2002; Piątek 2002; Zimmermannová-Pastirčáková & Pastirčák 2002; Zimmermannová-Pastirčáková *et al.* 2002).

The spread of Erysiphales depends on many factors. The principal one is the presence of host plants, but not all potential hosts are attacked by parasites and not under all conditions. Besides the genetic resistance of plants to parasitic infections and fungal virulence, development of diseases depends on appropriate environmental conditions. These dependencies are illustrated by the so-called ‘disease triangle’, commonly accepted and cited by many authors, which characterizes the basic factors indispensable for disease development (e.g., Agrios 1997).

With regard to the Erysiphales, insolation, temperature and humidity are most important, especially temperature during the vegetation period (Karis 1995), but also high temperature and low humidity in the period of ascocarp formation (Lai-bach 1930; Blumer 1948; Braun 1995). Such conditions during full vegetation seasons have been

observed not only in Poland but also the rest of Europe for several years, producing ecological conditions favorable to powdery mildews.

Here we describe the extension of the distribution areas of several powdery mildew species, give records of new host plants or hosts new to Poland, and discuss some rare hosts of common species.

TAXONOMIC AND ECOLOGICAL NOTES

Recently the nomenclature of mildew fungi has changed considerably as a result of molecular studies based on analysis of ITS rDNA sequences (Braun & Takamatsu 2000). Two names of fungi are given, the first according to Braun and Takamatsu (2000), followed by names based on Braun (1987, 1995). The nomenclature of host plants follows Mirek *et al.* (1995). All species mentioned below are described in detail and illustrated in Braun (1987, 1995). All samples cited in the 'Host and locality' sections have been deposited in the mycological herbarium (LBLM) of the Department of General Botany, Maria Curie-Skłodowska University (Lublin, Poland). The localities are presented in Fig. 1. Photographs of some leaves infected by powdery mildew are presented in Fig. 2, and horse chestnut trees (*Aesculus hippocastanum* L.) affected by powdery mildew fungus and butterfly are presented in Fig. 3.

Erysiphe adunca (Wallr.) Fr.

Uncinula adunca (Wallr.: Fr.) Lév. var. *adunca*

Mycelium external on leaves, delicate, whitish, rather inconspicuous among the tomenta. Conidia cylindrical or cylindrical-ellipsoid, 20–30 × 12–13 µm, formed singly (pseudoidium type). Cleistothecia not found.

HOST AND LOCALITY. On *Salix repens* L. subsp. *arenaria* (L.) Hiitonen (= *Salix arenaria* L.): HEL PENINSULA. Hel-Bór, in sand-dune shrubs, single locality, 9 Sept. 1999, leg. A. Wołczańska (LBLM ASC-7144).

REMARKS. The dimensions of the conidia of the fungus found are somewhat smaller than those given previously. According to Sałata (1985), they



Fig. 1. Sites of powdery mildew species in Poland. A – *Erysiphe adunca* on *Salix repens* subsp. *arenaria*; B – *Golovinomyces cichoracearum* var. *cichoracearum*. on: *Chondrilla juncea* (B1) and *Cirsium canum* (B2); C – *Erysiphe lonicerae* on *Lonicera xylosteum*; D – *Erysiphe syringae* on: *Ligustrum vulgare* (D1) and *Syringa vulgaris* (D2); E – *Podosphaera spiraeae* on *Spiraea* cf. *japonica*; F – *Erysiphe flexuosa* on: *Aesculus hippocastanum* (F1), *Aesculus pavia* (F2) and *Aesculus × carnea* (F3). – localities known from literature, – sampling sites

range from 25 to 40 × 12 to 20 µm (mainly 30–36 × 15–18 µm). Braun (1995) gave somewhat smaller dimensions for this species, ranging from 24.0 to 35.0 × 12.5 to 18.0 µm. The present material from Poland well fits the description in Shin (2000) from South Korea, with conidia 24–30 × 11–14 µm.

This fungus is almost circumglobal on numerous hosts of the family Salicaceae (e.g., *Chosenia*, *Populus*, *Salix*, *Toisusu*) (Braun 1987, 1995). In Poland it is known on 19 host species of the genera *Populus* and *Salix* (Sałata 1985). However, *Salix repens* subsp. *arenaria* is a new host for this parasite.

Golovinomyces cichoracearum (DC.) V. P. Gelyuta var. *cichoracearum*

Erysiphe cichoracearum DC. var. *cichoracearum*

Mycelium on both sides of leaves, arachnoid, rather inconspicuous. Conidia cylindrical, cylind-

rical-ellipsoid or ellipsoid, $24\text{--}30 \times 12\text{--}16 \mu\text{m}$, formed in chains (euoidium type). Cleistothecia not found.

HOSTS AND LOCALITIES. 1 – On *Chondrilla juncea* L.: HEL PENINSULA. Jastarnia village, railway embankment, single locality, 31 Aug. 2001, leg. A. Wołczańska (LBLM ASC-7127); 2 – On *Cirsium canum* (L.) All.: DOŁY JASIELSKO-SANOCKIE BASIN. Rymanów village, common on wet meadows, 16 Aug. 2001, leg. A. Wołczańska (LBLM ASC-7128).

REMARKS. This species is a common powdery mildew on numerous composites with a circum-global distribution (Braun 1987, 1995). In Europe it is known on *Chondrilla juncea* from Bulgaria, Spain, France, Greece, Italy, Portugal, Romania, the European part of Russia, Ukraine and Yugoslavia (Braun 1995). However, in Poland this fungus has not yet been collected on this host plant.

On *Cirsium canum* this fungus was recorded only from five European countries: Switzerland, the Czech Republic, Rumania, Hungary and Poland (Braun 1995). In Poland it was known before from only one locality, the Skorocice Reserve near Busko Zdrój (Sałata 1985).

Erysiphe lonicerae DC.

Microsphaera lonicerae (DC.) G. Winter var. *lonicerae*

Mycelium external, whitish, visible on leaves as subcircular patches. Cleistothecia present, external on leaves. Measurements of conidia, ascocarps, appendages, asci and ascospores correspond to those described by Sałata (1985) and Braun (1995).

HOST AND LOCALITY. On *Lonicera xylosteum* L.: WYŻYNA LUBELSKA UPLAND. Lublin-Center, roadside, 8 Sept. 2001, leg. A. Wołczańska (LBLM ASC-7129).

REMARKS. The main areas of this parasite are Europe, North Asia (Braun 1987) and in North America the United States (Farr *et al.* 1989). The northernmost locality is on the Kola Peninsula (Karis 1995). In Europe this species is reported on *Lonicera xylosteum* from 15 countries (Braun 1995).

In Poland this fungus was reported on four species of the genus *Lonicera* (*L. caprifolium*, *L. periclymenum*, *L. tatarica* and *L. xylostem*). How-

ever, the collection data for *L. xylosteum* from the Mory locality near Warsaw are doubtful and not verified (Sałata 1985). The first confirmed locality of this fungus on *L. xylosteum* is in the vicinity of Płock (Dynowska *et al.* 1999). The present collection is the second locality of this fungus in Poland.

Erysiphe syringae Schwein.

Microsphaera syringae (Schwein.) Magnus

Mycelium external, whitish, conspicuous, initially in subcircular patches, later confluent and covering the entire leaf blade. Conidia cylindrical, $22\text{--}32 \times 12\text{--}14 \mu\text{m}$, formed singly (pseudoidium type). Cleistothecia $(70\text{--})80\text{--}90\text{--}(110) \mu\text{m}$ diam., on both sides of leaves, with 9–14 appendages, equatorially arising, short, only 1.0–1.5 times as long as diameter of cleistothecia, mostly (3)–5 times dichotomously branched, at base brown, hyaline at apex. Asci 4–6, $(30\text{--})34 \times 60\text{--}(66) \mu\text{m}$ (on average $40\text{--}50 \times 25\text{--}30 \mu\text{m}$). Ascospores 4–6, $(16\text{--})18\text{--}20 \times 9\text{--}11 \mu\text{m}$.

This species was also collected and measured in the United States (Illinois) by Dr. Joanna Romaszewska-Sałata in 1991:

– on *Syringa vulgaris* L.: conidia $(23\text{--})27 \times 11\text{--}14\text{--}(16) \mu\text{m}$, cleistothecia $(62\text{--})73\text{--}110\text{--}(115) \mu\text{m}$ diam., number of appendages (6)9–12(14), number of asci 4–6, size of asci $(39\text{--})46\text{--}57 \times 27\text{--}35 \mu\text{m}$, number of ascospores 4–7, size of ascospores $(14\text{--})16\text{--}23 \times 9\text{--}12 \mu\text{m}$. On this host species the hyperparasite *Ampelomyces quisqualis* Cesati (anamorphic fungi) was also noted [sampling sites: Elgin near Chicago, 10 Aug. 1991 (LBLM ASC-7156); 17 Aug. 1991 (LBLM ASC-7157); Wauconda, 9 Sept. 1994 (LBLM ASC-7158)].

– on *Ligustrum vulgare*: conidia $25\text{--}34 \times 11\text{--}14 \mu\text{m}$, cleistothecia $80 \times 96\text{--}(103) \mu\text{m}$ diam., number of appendages (6)–8–12, number of asci 4–6, size of asci $31 \times 56 \mu\text{m}$, number of ascospores 4–7, size of ascospores $21\text{--}37 \times 9\text{--}14 \mu\text{m}$ (no specimens in herbarium).

HOSTS AND LOCALITIES. 1 – On *Ligustrum vulgare* L.: WYŻYNA LUBELSKA UPLAND. Lublin-Center, 17 Oct. 2001, leg. A. Wołczańska (LBLM ASC-7130); Lublin-Czechów, 8 Sept. 2001, leg. W. Mułenko (LBLM ASC-

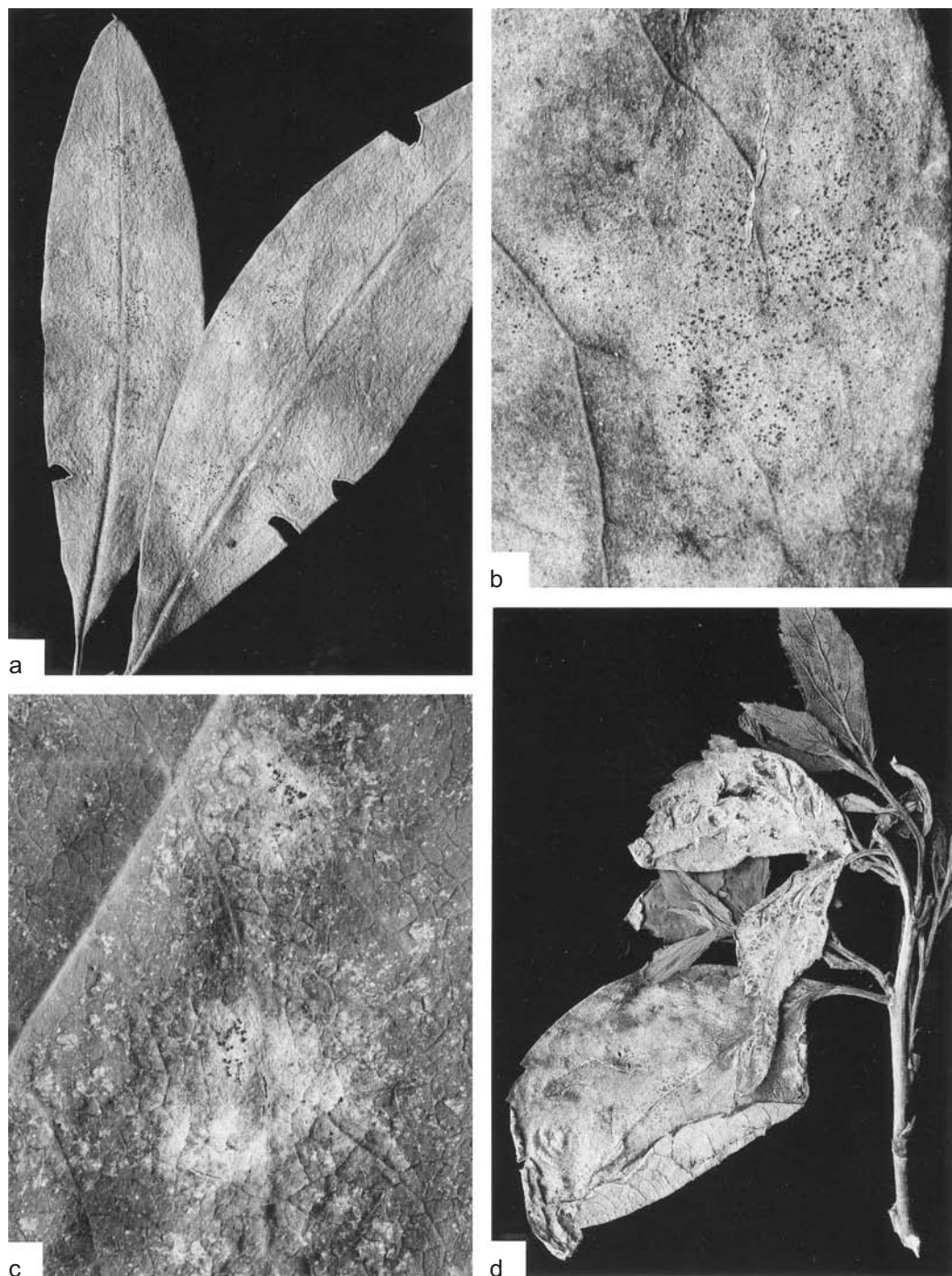


Fig. 2. Anamorphic and/or teleomorphic states of *Erysiphe syringae* Schwein. on: a – *Ligustrum vulgare* L. and b – *Syringa vulgaris* L.; c – *Erysiphe lonicerae* DC. on *Lonicera xylosteum* L.; d – *Podosphaera spiraeae* (Sawada) U. Braun & S. Takamatsu on *Spiraea cf. japonica* L.

7131); Lublin-University, 8 Sept. 2001, *leg. W. Mułenko* (LBLM ASC-7131), on all localities in hedges;. 2 – On *Syringa vulgaris* L.: WYŻYNA LUBELSKA UPLAND. Lublin-University, in hedges, 5 Oct. 1995, *leg. J. Romaszewska-Sałata* (LBLM ASC-7159, 7160, 7161, 7162, 7163); Lublin-Czechów, roadside, 25 Aug. 2001, *leg. W. Mułenko* (LBLM ASC-7134); Lublin-Botanical Garden, 26 July 2000, *leg. W. Mułenko* (LBLM ASC-7132); Lublin-LSM, 12 Sept. 2002, *leg. M. Kozłowska* (LBLM ASC-7137); Nałęczów near Lublin, urban park, 9 Sept. 2000, *leg. W. Mułenko* (LBLM ASC-7133); KOTLINA SANDOMIERSKA BASIN. Boleszasyce near Przemyśl, arboretum, 26 Oct. 2001, *leg. W. Mułenko* (LBLM ASC-7136); DOŁY JASIELSKO-SANOCKIE BASIN. Krosno, roadside, 14 Aug. 2001, *leg. A. Wołczańska* (LBLM ASC-7135).

REMARKS. *Erysiphe syringae* is the most interesting species in our collection. The original area of its occurrence is North America, where it is widespread and common, occurring mainly on *Syringa vulgaris* as an anamorph and teleomorph and regularly producing asci and ascospores. Besides *Syringa*, this fungus also infects other representatives of the family Oleaceae (*Chionanthus*, *Forestiera*, *Fraxinus* and *Ligustrum*). As already mentioned, it was introduced to Asia and Australia (Kreisel & Scholler 1994; Braun 1987, 1995). In North Asia this species was collected only in the Far East, where it does not exceed 60°N latitude (Karis 1995). In Europe this species is fairly common on *Syringa vulgaris*, but only in its conidial state. Cleistothecia were only very rarely formed, and without asci and ascospores (Braun 1995). On *Ligustrum vulgare* it was reported only from Rumania and Germany (Braun 1995).

In Poland this fungus has been observed on *Syringa vulgaris* for a long time, particularly in the southeast (Sałata 1985). At present it seems to occur frequently throughout Poland, but detailed data on its distribution have not been published yet. A locality reported recently is in northern Poland, Słowiński National Park (Adamska 2001). As in other European countries, this fungus has been noted so far above all in its conidial state associated with immature cleistothecia.

In 2001 this fungus was found not only on *Syringa vulgaris* but also on *Ligustrum vulgare*. On both plants it occurred in two states, as an ana-

morph (conidia) and teleomorph (cleistothecia), forming mature asci with spores. This is the first European report of this fungus with its full cycle of development.

Podosphaera spiraeae (Sawada) U. Braun & S. Takamatsu

Sphaerotheca spiraeae Sawada

Mycelium external, whitish, conspicuous, on both sides of leaves, mainly at apex of sprouts and also on stalks and leaf petioles. Leaves usually very infected and deformed. Conidia ellipsoid or cylindrical-ellipsoid, 24–28 × 10–13 μm, formed in chains (euodium type). Cleistothecia not found.

HOST AND LOCALITY. On *Spiraea* cf. *japonica* L.: WYŻYNA LUBELSKA UPLAND. Lublin-Center, roadside, numerous, 10 Sept. 2001, 25 June 2002, *leg. A. Wołczańska* (LBLM ASC-7141, 7143); KOTLINA SANDOMIERSKA BASIN. Sandomierz, hedge, 10 July 2002, *leg. W. Mułenko* (LBLM ASC-7142).

REMARKS. The fungus occurs on many host species of the genera *Filipendula* and *Spiraea* (Rosaceae) in Europe, North America and Asia (Braun 1987). The first information about the occurrence of *Podosphaera spiraeae* on *Spiraea* cf. *japonica* was published by Piątek (2000) from Kraków-Nowa Huta.

Erysiphe flexuosa (Peck) U. Braun & S. Takamatsu

Uncinula flexuosa Peck

Mycelium external, whitish, delicate, mainly on upper side of leaves. Conidia 26–40 × 12–16 μm, formed singly (pseudoidium type). Cleistothecia 108–140 μm diam., visible on both sides of leaves, more numerous on lower side. Appendages helicoid, equatorially arising, 1.0–1.5 times as long as diameter of cleistothecia. Asci 40–60 × 22–28 μm, containing 6–8 ellipsoid or ellipsoid-ovoid spores, 14–20 × 9–11 μm.

HOSTS AND LOCALITIES. 1 – On *Aesculus hippocastanum* L.: POJEZIERZE POMORSKIE LAKE DISTRICT. Dziwnów, roadside, 22 Sept. 2001, *leg. M. Ruszkiewicz-Michalska* (LOD 457 PF); WYŻYNA LUBELSKA UPLAND. Lublin-Czechów, 3 Sept. 2002, *leg. W. Mułenko* (LBLM

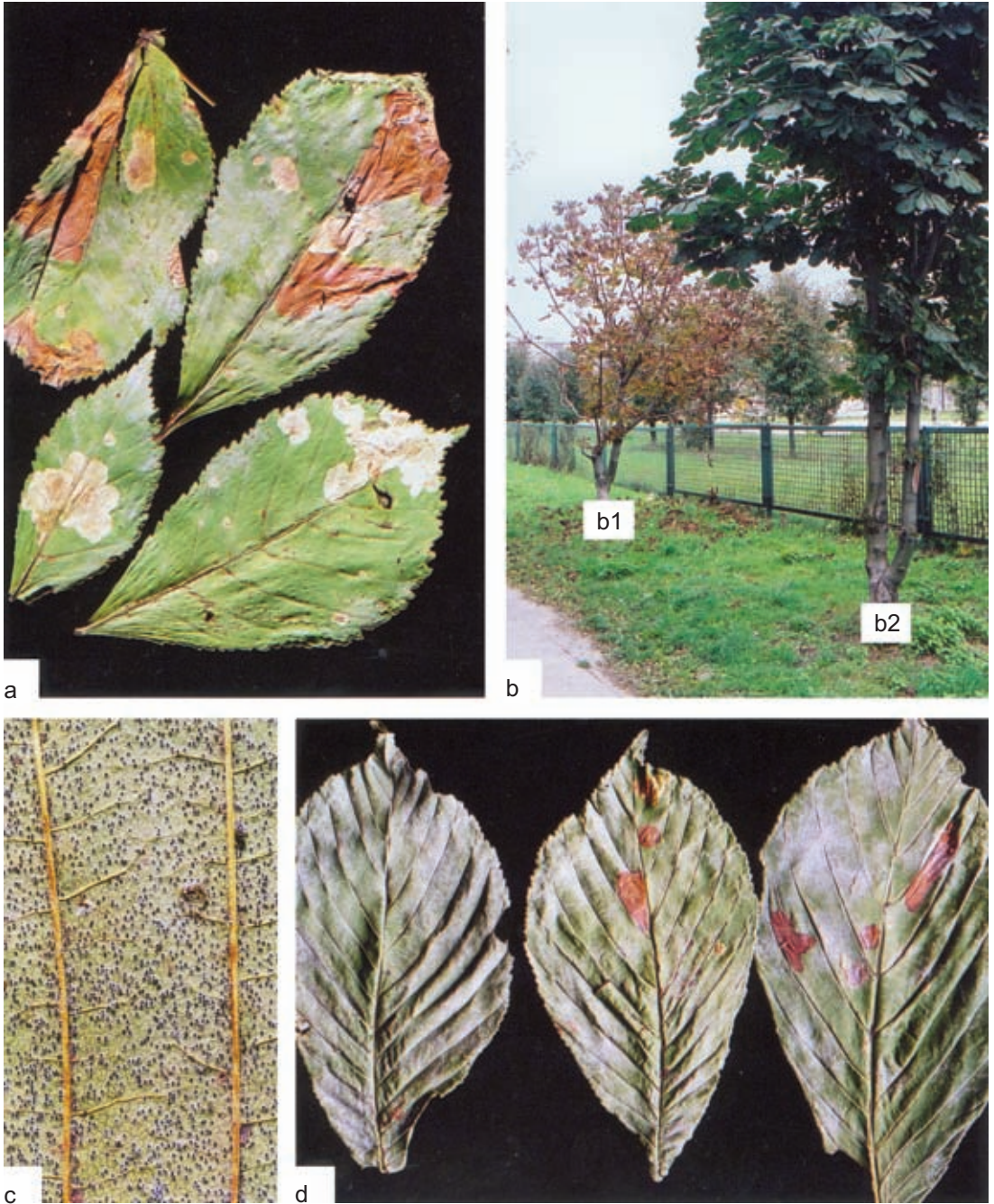


Fig. 3. a – Leaves of *Aesculus hippocastanum* L. damaged by the butterfly *Cameraria ohridella* Deschka & Dimic with weak infection of powdery mildew *Erysiphe flexuosa* (Peck) U. Braun & S. Takamatsu; b – horse chestnut tree heavily fed on by butterfly (b1) and heavily infected by *Erysiphe flexuosa* (b2); c – cleistothecia of *Erysiphe flexuosa* on adaxial side of leaf not fed on by the butterfly; d – leaves of tree infected by *Erysiphe flexuosa* with small traces of feeding by *Cameraria ohridella*.

ASC-7147, LBLM-ASC-7148); Lublin-Center, 28 Sept. 2002, *leg. A. Wołczańska* (LBLM ASC-7149); Lublin-LSM, 12 Sept. 2002, 7 Oct. 2002, *leg. M. Kozłowska* (LBLM ASC-7154, 7155); Lublin-Center, urban park, 12 July 2002, 25 Aug. 2002, *leg. K. Pilipów* (LBLM ASC-7151, 7150); 2 – On *Aesculus pavia* L.: WYŻYNA LUBELSKA UPLAND. Lublin-Botanical Garden, 30 Sept. 2002, *leg. W. Mułenko* (LBLM ASC-7153, 7152); 3 – On *Aesculus* × *carnea* Hayne: WYŻYNA LUBELSKA UPLAND. Lublin-Botanical Garden, 30 Sept. 2002, *leg. W. Mułenko* (LBLM ASC-7145, 7146); NIZINA MAZOWIECKA LOWLAND. Warsaw, roadside, 22 Aug. 2002, *leg. M. Ruszkiewicz-Michalska* (LOD 458 PF).

REMARKS. This fungus is widespread on different species of the genus *Aesculus* in North America (U.S.A., Canada). It was also noted in the Russian Far East (Braun 1987). In Europe it was collected in Germany, Switzerland (Ale-Agha *et al.* 2000), Great Britain (Ing & Spooner 2002), Austria, the Czech Republic, Croatia, France and Slovakia (Zimmermannová-Pastirčáková *et al.* 2002; Zimmermannová-Pastirčáková & Pastirčák 2002). In Poland it was noted at three localities in opposite regions: Szczecin city and Słowiński National Park (N and NW Poland) (Adamska 2002; Adamska *et al.* 2002; Zimmermannová-Pastirčáková *et al.* 2002) and Tarnów (SE Poland) (Piątek 2002). At present, numerous localities in eastern Poland indicate the rapid eastward spread of this parasite. The number of additional observations, more than those recorded in this paper, indicate that this fungus should be considered frequent or even common, at least in the eastern regions of Poland.

Another interesting phenomenon we observed regarded the occurrence (coexistence) of two different organisms representing different taxonomic groups of fungi and animals, on leaves of horse chestnut (*Aesculus hippocastanum*).

In 1985, a butterfly species (*Cameraria ohridella* Deschka & Dimic) was introduced into Europe and spread to many European countries (also Poland); now it is recognized as a danger to this tree (Łabanowski & Soika 2000). Larvae of this butterfly feed inside horse chestnut leaves, eating the assimilation tissue and causing them to dry and fall quickly (Hurej & Kukuła 2002). However, we have observed that if a tree is infected by

Erysiphe flexuosa the feeding sites of the insect are limited to small patches on the leaves, or it does not feed on them at all. Similarly, defoliation of the horse chestnut tree caused by the action of the insect is either considerably limited or does not take place.

No detailed observations of this phenomenon have been made this year, so substantive conclusions about the relations between the two organisms cannot be drawn. Relationships of this kind are known to occur and have frequently been studied (e.g., Hatcher 1995; Lappalainen *et al.* 1995; Reithinger *et al.* 1997). The present case is likely another example of spontaneous (natural) formation of relations in the plant-animal-parasitic fungus system, in which two organisms (fungus and butterfly) compete for food supplied by a third organism. It will take some time to examine the mechanism of these interactions; the results of such studies may be employed to limit the development of a noxious insect which is not yet controllable.

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