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FIRST RECORDS OF AN INVASIVE FUNGUS *PODOSPHAERA AMELANCHIERIS* (*ERYSIPHALES*) IN BELARUS AND UKRAINE

Heluta V.P., Hirylovich I.S. **First records of an invasive fungus *Podosphaera amelanchieris* (*Erysiphales*) in Belarus and Ukraine**. Ukr. Bot. J., 2016, **73**(1): 78–83.

Abstract. Information on the distribution of a new invasive powdery mildew, *Podosphaera amelanchieris* Maurizio, recorded on *Amelanchier alnifolia* Nutt. and *A. spicata* (Lam.) K. Koch (*Rosaceae*) in Belarus and Ukraine is provided. The fungus was first found in 2000 in Belarus (Minsk), then in Sofiyivsky Park (Cherkasy Region, Ukraine), and later again in Belarus (Gomel and Minsk Regions) and in Ukraine, in Kharkiv, Kyiv and Volhynian Region. The Belarusian and Ukrainian specimens appeared to be identical, their morphological characteristics corresponded to the European samples of *P. amelanchieris* described by U. Braun and R. Cook. Chasmothecia of *P. amelanchieris* ex *A. spicata* and *P. clandestina* (Wallr.) Lév. parasitizing *Crataegus* sp. and *Mespilus germanica* L. were compared. It was found that the former fungus has longer appendages with more compact apices.

Key words: Europe, invasion, powdery mildews, thicket shadbush, *Podosphaera clandestina*, *Amelanchier*, *Crataegus*, *Mespilus*

Introduction

The list of powdery mildews (*Ascomycota*, *Erysiphales*) of Europe is constantly updated with species originating from other regions, mainly from North America and East Asia. The North American species penetrate into Belarus and Ukraine mainly via Western Europe. Thus, for the past two decades, such species as *Erysiphe azaleae* (U. Braun) U. Braun & S. Takam., *E. elevata* (Burrill) U. Braun & S. Takam., *E. flexuosa* (Peck) U. Braun & S. Takam., *E. platani* (Howe) U. Braun & S. Takam., and *Golovinomyces greeneanus* (U. Braun) V.P. Heluta entered Ukraine and naturalized there (Heluta, Voytyuk, 2004; Heluta et al., 2004, 2009, 2013; Heluta, Korytnianska, 2011). Of these, *E. azaleae* and *E. flexuosa* are also widely distributed in Belarus (Hirylovich, Lemeza, 2008). This process continues, as it is evidenced by the powdery mildew on *Amelanchier alnifolia* Nutt. and *A. spicata* (Lam.) K. Koch (*Rosaceae*) (Fig. 1, *a–c*, *f*, *h*, *j–m*; Fig. 2) found in Belarus and Ukraine and identified as *Podosphaera amelanchieris* Maurizio. This brief article is devoted to the characterization of the fungus and its spread in the mentioned countries.

Materials and methods

Samples of powdery mildew infecting *A. alnifolia* and *A. spicata* were collected in Belarus in 2000–2014 and in Ukraine in 2012 and 2015. They are listed below, following the species characteristics. The specimens are deposited in the National Herbarium of M.G. Kholodny Institute of Botany of the National Academy of Sciences of Ukraine (*KW*) and in the Herbarium of the Belarusian State University (*MSKU*). The fungus was studied and photographed under a light microscope «Primo Star» (Carl Zeiss, Germany) using the camera «Canon A 300» and the software «AxioVision 4.7». Only herbarium specimens were used. The mycelium, conidiophores and conidia removed from the surface of infected leaves by a transparent adhesive tape. To restore shape and size, a piece of tape with these fungus structures was put in a droplet of 40 % lactic acid

solution on a microscope slide (sticky side up), covered with a cover glass, gently heated to boiling point, then examined under the light microscope. Chasmothecia were prepared and studied in a drop of distilled water. For scanning electron microscopy (SEM), small dried pieces of serviceberry leaves affected by the fungus were glued on to the metal stubs, then coated with gold and studied under the scanning microscope Jeol 6060LA (Japan). Digital data were treated statistically when n was ≥ 30 for each character.

Results and discussion

In Belarus and Ukraine, *Amelanchier alnifolia* and *A. spicata* are introduced plants. The species originate from North America and are widely cultivated as important ornamental plants and a rootstock material for undersized apples and pears (Kokhno et al., 1986). According to our observations, the seeds of *A. spicata* are spread by birds, therefore young serviceberry plants in the wild state are quite common in the pine forests around settlements. In the recent monograph by Braun and Cook (2012), only two powdery mildews are mentioned on the representatives of the genus *Amelanchier*, *Phyllactinia mali* (Duby) U. Braun and *Podosphaera amelanchieris*. In our report, the former species is not a subject of discussion, since it was not found on serviceberry in our countries. As for the latter one, the Belarusian and Ukrainian samples largely correspond to this species, especially to the European specimens that are discussed in detail in the aforementioned monograph by Braun and Cook. Below is an illustrated description of our materials.

Podosphaera amelanchieris **Maurizio, Zentralbl. Bakt. Parasitenk., Abt. 2, 72: 145. 1927 (Fig. 1, *a–c*, *f*, *h*, *j–m*; Fig. 2; Journal cover, Page 4)**

Mycelium foliicolous, amphigenous, effuse or in irregular confluent patches, evanescent to more or less persistent, greyish white. *Conidiophores* straight, 98–146 μm, *foot-cells* subcylindrical, usually slightly thickened toward the top, about 36–60 × 5.5–9.0 μm at the base and × 7.0–9.5 μm at the top, followed by 2–3(–4) shorter cells, forming catenescent conidia. *Conidia* ellipsoid to doliiform-subcylindrical, 23–31 × 11.5–15.5 μm. *Chasmothecia* scattered to gregarious, hemispherical, depressed below, (70–)75–92(–100) μm diam. *Peridium cells* not very distinct, irregularly polygonal, 11–20 μm diam. *Appendages* equatorially arising, frequently also erect from the upper half of the ascoma, rather stiff, straight to slightly arcuate, 6–16, unequal in length on the same chasmothecium, 1–3(–3.5) times as long as the chasmothecial diam., 95–250 μm, 8–10 μm wide at the base, mostly narrower towards the tip, stalk septate, with 3–5 septa, wall smooth to verruculose-rugose, simple, rarely forked near the middle of the stalk, about 75 % or even more of the stalk pigmented, brown below, paler towards the hyaline apex. *Apices* 3–5 times tightly dichotomously branched, sometimes primary branches elongated, branched part flat, up to 48.5 μm wide, tips more or less knob-like, wide, occasionally somewhat recurved. *Ascus* subglobose to broadly ovoid, (6–)8-spored, 75–82 × 65–73 μm, ascus wall 2–3 μm wide, terminal oculus 16.5–23.5 μm diam. *Ascospores* oblong-ovate, mostly slightly asymmetric, recurved, with 1–2(–3) oil drops, colourless, 22–30 × 12–15 μm.

Specimens examined

On *Amelanchier alnifolia* Nutt. (*Rosaceae*). **Ukraine**: Kyiv, Pivdenna Borshchahivka, Symyrenko Str., 23.10.2015, V.P. Heluta (*KW* 70093F).

On *Amelanchier spicata* (Lam.) K. Koch. **Belarus**: *Brest Region*: Brest, city square, 14.09.2001, I.S. Hirylovich (*MSKU* 4432); Drahichyn District, near the urban village Antopal', 06.09.2006, I.S. Hirylovich (anamorph; *MSKU* 4736). *Gomel Region*: Rahachov District, village Haradziec, park, 28.08.2005, I.S. Hirylovich (*MSKU* 4735); Žlobin District: village Chornaya Virnia, 26.08.2005, I.S. Hirylovich (*MSKU* 4737); near the village Maiskwye, 12.08.2013, I.S. Hirylovich (*KW* 60652F). *Minsk Region*: Barisaw District, Barisaw, city square, 10.09.2002, I.S. Hirylovich (anamorph; *MSKU* 4427); Dzyaržynsk District, near the village Byareža, 22.08.2008, I.S. Hirylovich (*MSKU* 5769); Minsk, city square, 15.09.2000, I.S. Hirylovich (*KW* 60653F); ibid, 16.08.2003, I.S. Hirylovich (*KW* 60661F); Minsk District, near the village Barauliany, forest park, 28.08.2014, I.S. Hirylovich (*MSKU* 6283); near the village Hliebkavichy, military training area, 10.08.2009, I.S. Hirylovich (*MSKU* 5770); Pukhavichy District, Pukhavichy, park, 06.09.2014, I.S. Hirylovich (*MSKU* 6282); Valozyn District, near the village Kaldyki, clearing in pine forest, 27.07.2013, I.S. Hirylovich (*KW* 60654F); near the village Sakaŭščyna, at the edge of pine forest, 18.07.2011, I.S. Hirylovich (*MSKU* 5766); village Žhamoid', 20.07.2003, mossy pine forest with *Frangula*, I.S. Hirylovich (*MSKU* 4431). *Mogilev Region*: near Asipovichy, in plantations along the railroad, 28.07.2003, I.S. Hirylovich (*MSKU* 4430). **Ukraine**: *Cherkasy Region*, Uman', Sophiivka arboretum, green ornamental plantings, 10.10.2012,

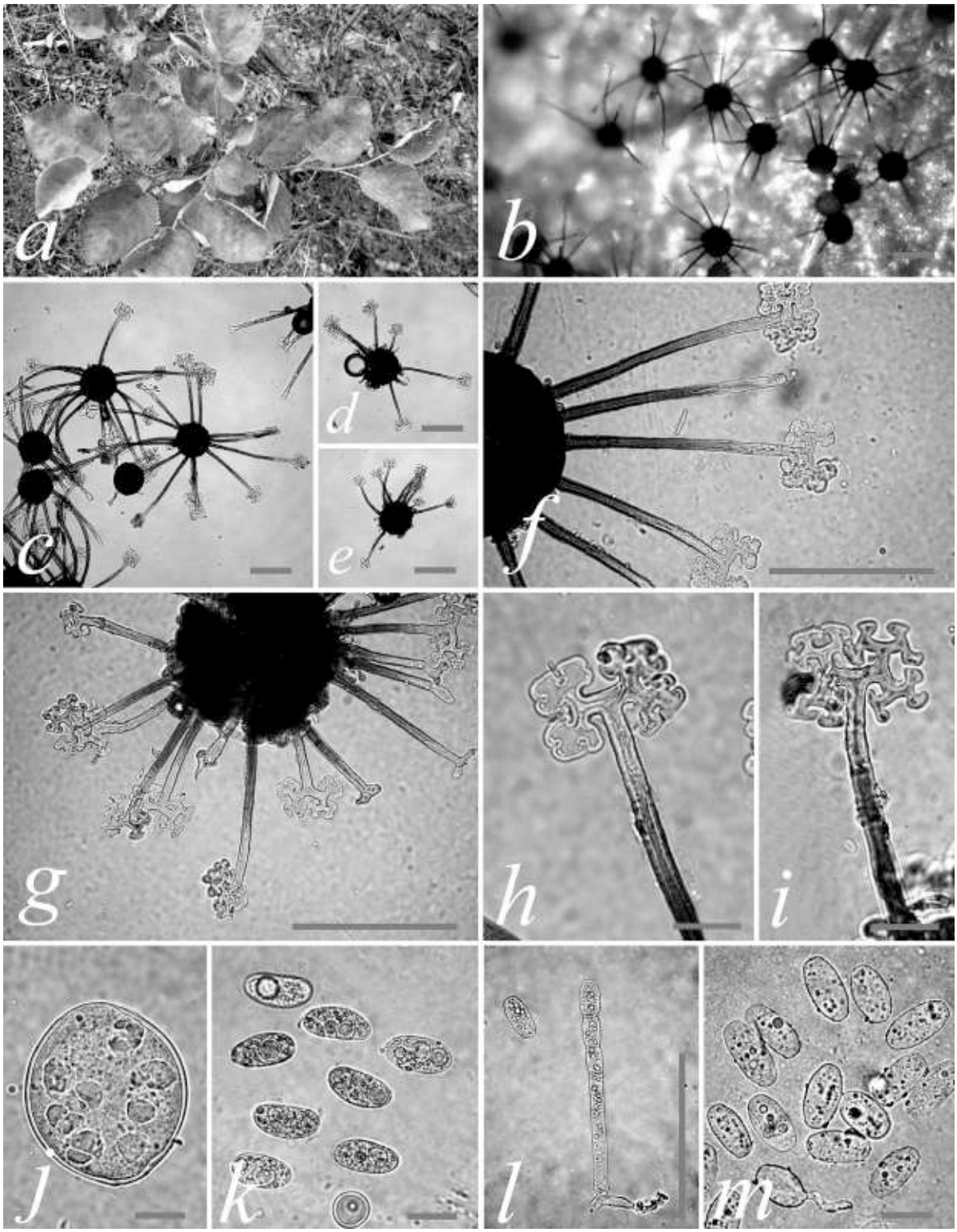

Fig. 1. *Podosphaera amelanchieris* on *Amelanchier spicata* (*a–c*, *f*, *h*, *j–m*) and *P. clandestina* on *Crataegus* sp. (*d, i*) and *Mespilus germanica* (*e*, *g*): *a* — infected young plant, *b–g* — chasmothecia, *h–i* — appendage apices, *j* — ascus, *k* — ascospores, *l* — conidiophore and conidium, *m* — conidia. Bars: *b–e* — 100 μm, *g–m* — 20 μm

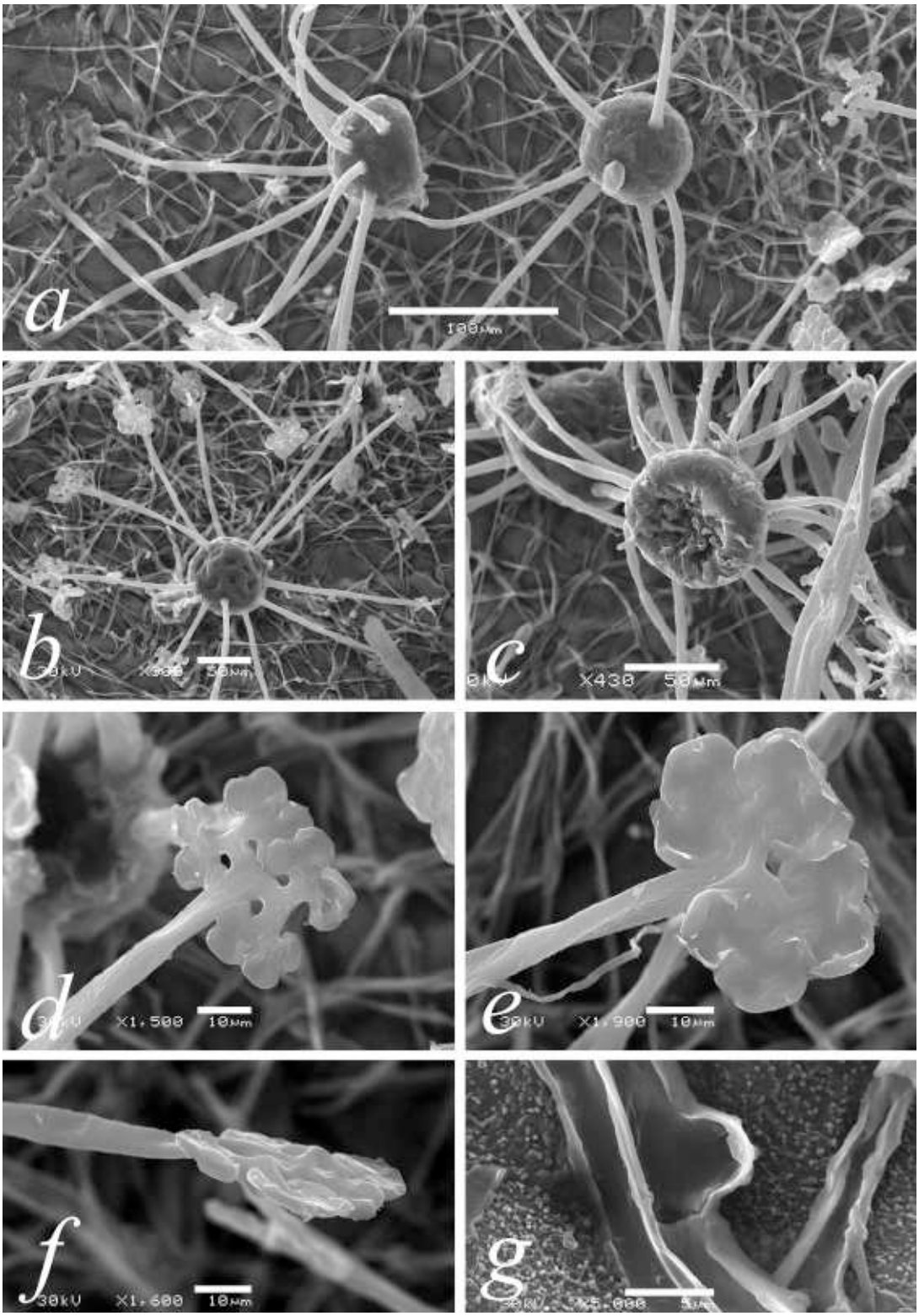

Fig. 2. *Podosphaera amelanchieris* on *Amelanchier spicata* (*KW* 60655F; SEM): *a–c* — chasmothecia (*c* — bottom view), *d–f* — dichotomously branched appendage apices, *g* — appressorium. Bars: *a* — 100 µm, *b–c* — 50 µm, *d–f* — 10 µm, *g* — 5 µm

V.P. Heluta (*KW* 60658F–60660F). *Kharkiv*, city square, 23.08.2015, N.B. Saidakhmedova (*KW* 60664F); ibid., 26.08.15, N.B. Saidakhmedova (*KW* 60691F, 60692F). *Kyiv*, Academician Palladin Avenue, 7, ornamental planting, 09.08.2015, V.P. Hayova (*KW* 60662F). *Volhynian Region*: Liubeshiv District, north-western neighborhood of the village Lyubyaz', forest road, 25.06.2015, V.P. Heluta (*KW* 60655F–60657F).

The species status of powdery mildew belonging to the genus *Podosphaera* Kunze and parasitizing *Amelanchier* representatives was discussed in detail in the monograph by Braun and Cook (2012, pp. 100 and 103). The authors have shown that this fungus is a separate American species morphologically close to other parasites of plants of the family *Rosaceae* such as *P. clandestina* (Wallr.) Lév. known on species of genera *Crataegus* L., *Cydonia* Mill., *Mespilus* L. and *Pyrus* L. (*Pyreae*), *Podosphaera prunicola* U. Braun (on species of the genus *Prunus* L., *Amygdaleae*) and *P. spiraeicola* U. Braun (on *Spiraea japonica* L.f., *Spiraeeae*). However, the fungus ex *Amelanchier* differs from the first one by more numerous (up to 30, except for European specimens) and longer appendages, from the second — by thin-walled asci, from the third — by more cleft and smaller apical parts of the appendages. Note, however, that the European samples of *P. amelanchieris* described by Braun and Cook (2012) have a relatively small number of appendages (6–15), i.e., on this basis, the fungus rather looks like *P. clandestina*. Judging by this description, our materials are similar to the European specimens.

In order to confirm identification of the fungus collected on *Amelanchier*, we conducted a morphological comparison of its fruiting bodies (Fig. 1, *b*, *c*, *f*) with chasmotecia of *P. clandestina* on *Crataegus* sp. (Fig. 1, *d*) and *Mespilus germanica* L. (Fig. 1, *e*, *g*). These are definitely closely related species, however they differ in some characters. Firstly, the appendages of the fungus ex *A. spicata* are much longer (cf. Figs 1, *c* and 1, *d*, *e*; 1, *f* and 1, *g*), up to three times of the chasmothecial diameter or even more (Fig. 2, *b*). Another difference is in the structure of the apical part of the appendage. Although this feature is quite variable, however, the apices of the fungus ex *Amelanchier* are mainly dense, with much enlarged, knob-like tips (Fig. 1, *f*, *h*; Fig 2, *d*, *e*). In *P. clandestina* ex *Crataegus* sp. and *M. germanica*, the tips are generally thinner, so that apices look relatively loose (Fig. 1, *g*, *i*). Therefore, we conclude that the specimens of powdery mildew collected on *Amelanchier* do not belong to *P. clandestina*. Thus, we subscribe to the view of Braun and Cook (2012) that the fungus found on serviceberry in Europe, including our countries, belongs to *P. amelanchieris*, the species introduced from North America.

Up to now, *P. amelanchieris* was unknown in Belarus and Ukraine. Distributed in North America (Canada, USA), it has been introduced in Europe and already reported from Germany, Lithuania, and Switzerland (Braun, 2012; Braun, Cook, 2012; Kruse, 2014). Furthermore, it is possible that *Oidium* sp., *P. clandestina* and *P. oxycanthae* (DC.) de Bary recorded on representatives of the genus *Amelanchier* in several European countries (Belarus, France, Great Britain, Lithuania, Norway, Switzerland) (Blumer, 1967; Amano, 1986; Grigaliūnaitė, 1990; Hirylovich, 2000; Bolay, 2005; Talgø et al., 2011) also belong to this species.

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Гелюта В.П.[1], Гирилович І.С.[2] **Перші знахідки в Білорусі та Україні інвазійного гриба *Podosphaera amelanchieris* (*Erysiphales*).** — Укр. ботан. журн. — 2016. — **73**(1): 78—83.

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Наводяться відомості про поширення на території Білорусі й України нового інвазійного борошнисторосяного гриба *Podosphaera amelanchieris* Maurizio, виявленого на *Amelanchier alnifolia* Nutt. та *A. spicata* (Lam.) K. Koch (*Rosaceae*). Уперше він знайдений 2000 р. у Білорусі (м. Мінськ), згодом — у дендропарку «Софіївка» (Черкаська обл., Україна), потім знову ж таки в Білорусі (Гомельська та Мінська області) й Україні, але вже у Волинській обл., у містах Києві та Харкові. Білоруські й українські зразки ідентичні, їхні морфологічні характеристики відповідають європейським зразкам, описаним У. Брауном і Р. Куком. Здійснено порівняння морфологічних ознак хазмотеціїв *P. amelanchieris* з *A. spicata* та *P. clandestina* (Wallr.) Lév. з *Crataegus* sp. і *Mespilus germanica* L. З'ясовано, що перший із цих грибів має довші придатки з компактнішими апікальними частинами.

Ключові слова: Європа, інвазія, борошнисторосяні гриби, ірга, *Podosphaera clandestina*, *Amelanchier*, *Crataegus*, *Mespilus.*

Гелюта В.П.[1], Гирилович И.С.[2] **Первые находки в Беларуси и Украине инвазионного гриба *Podosphaera amelanchieris* (*Erysiphales*).** — Укр. ботан. журн. — 2015. — **73**(1): 78—83.

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Приводятся сведения о распространении на территории Беларуси и Украины нового инвазионного мучнисторосяного гриба *Podosphaera amelanchieris* Maurizio, обнаруженного на *Amelanchier alnifolia* Nutt. и *A. spicata* (Lam.) K. Koch (*Rosaceae*). Впервые он найден в 2000 г. в Беларуси (г. Минск), затем — в дендропарке «Софиевка» (Черкасская обл., Украина), еще позже — опять в Беларуси (Гомельская и Минская области) и в Украине, но уже в Волынской обл., в городах Киеве и Харькове. Беларусские и украинские образцы идентичны, их морфологические характеристики соответствуют европейским образцам, описанным У. Брауном и Р. Куком. Проведено сравнение морфологических признаков хазмотециев *P. amelanchieris* с *A. spicata* и *P. clandestina* (Wallr.) Lév. с *Crataegus* sp. и *Mespilus germanica* L. Установлено, что первый из этих грибов имеет более длинные придатки с более компактными конечными частями.

Ключевые слова: Европа, инвазия, мучнисторосяные грибы, ирга, *Podosphaera clandestina*, *Amelanchier*, *Crataegus*, *Mespilus.*