V.P. HELUTA [1], O.O. DZYUNENKO [1,2],
R.T.A. COOK [3], V.P. ISIKOV [4]

[1] M.G. Kholodny Institute of Botany of the National Academy of Sciences of Ukraine
2 Tereshchenkivska St., Kiev, 01601, Ukraine
vheluta@botany.kiev.ua

[2] Botanical Garden of V.I. Vernadsky Taurida National University
4 Academician Vernadsky Avenue, Simpheropol, Autonomous Republic of Crimea, 95007, Ukraine

[3] European Mycological Network
30 Galtres Avenue, York, YO31 1JT, United Kingdom
rtacook@hotmail.com

[4] Nikita Botanical Garden — National Science Centre of UAAS
Nikita, Yalta, Autonomous Republic of Crimea, 98648, Ukraine

NEW RECORDS OF *ERYSIPHE* SPECIES ON *CATALPA BIGNONIOIDES* IN UKRAINE

Key words: Erysiphales, Microsphaera, *new records, peridial surface, Ukraine*

The number of powdery mildew species in Europe is continually increasing due to the invasion of new species from other regions. They spread rapidly and epiphytotically through the new territories parasitizing not only their introduced hosts, but often native plants as well. For example, over the last few decades such North American species as *Erysiphe* (*Microsphaera*) *azaleae* (U. Braun) U. Braun et S. Takam., *E.* (*Uncinula*) *flexuosa* (Peck) U. Braun et S. Takam., East Asian *E. arcuata* U. Braun, Heluta et S. Takam etc. became common species in Europe, including Ukraine. *Erysiphe* (*Microsphaera*) *elevata* (Burrill) U. Braun et S. Takam. is also an invasive species that was reported on *Catalpa* Scop. representatives in several European countries, e.g. in 2002 on *C. bignonioides* Walt. in Great Britain and Hungary (Ale-Agha et al., 2004; Cook et al., 2004, 2006; Vajna et al., 2004; Kiss, 2005), and later in Germany, Slovakia, Slovenia, France, Czech, and Switzerland (Ale-Agha et al., 2004; Millevoj, 2004; Pastirčáková et al., 2006). The fungus was also found on *C. ovata* in Switzerland, on *C.* × × *erubescens* Carr (*C. bignonioides* × *ovata*) in Germany (Ale-Agha et al., 2004), and on this hybrid and on *Chitalpa tashkentensis* (*Chilopsis linearis* × *Catalpa bignonioides*) in Great Britain (Cook et al., 2006). We now report that in 2007 *E. elevata* was found in the Autonomous Republic of Crimea (Ukraine).

Erysiphe elevata (Fig. 1) is a common North American species which up to the 21st century was known on *C. bignonioides* and *C. speciosa* only in Canada and USA (Amano, 1986; Braun, 1987; Farr et al., 1989). This fungus has an anamorph of the *Pseudoidium* type which was described in detail by Ale-Agha et al. (2004) and Cook et al. (2006). The teleomorph consists of hemispherical ascomata (chasmothecia) that are depressed on the underside. The chasmothecia possess rather long dichotomously branched (microsphaeroid) appendages. Thus, this species was formerly placed in

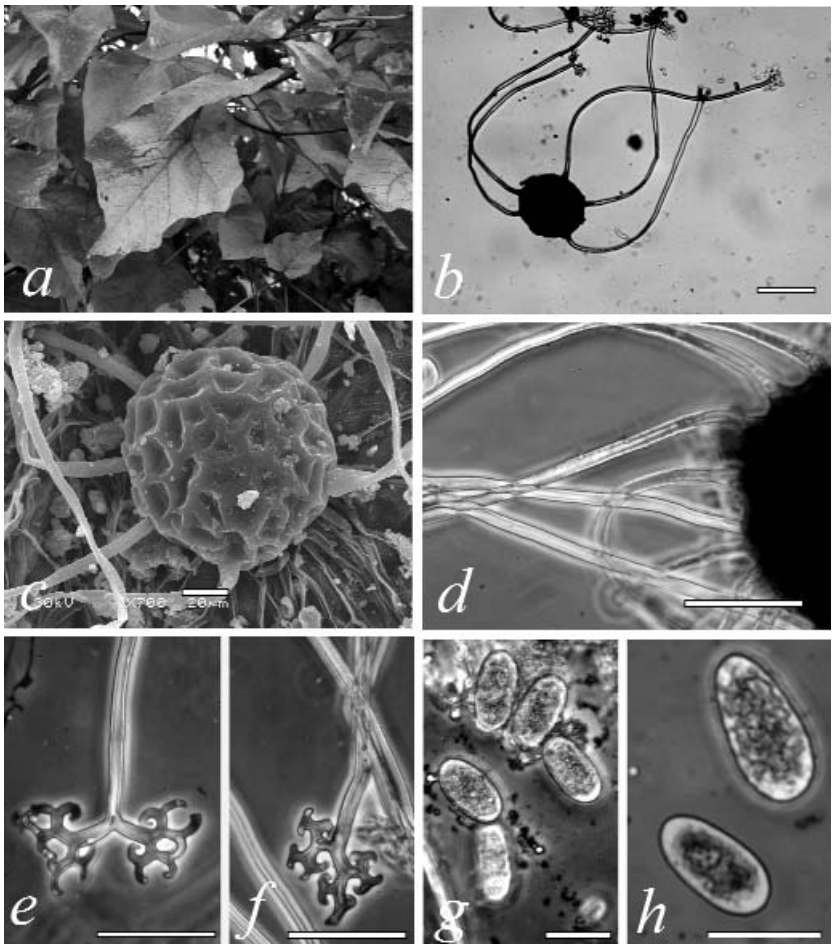

Fig. 1. *Erysiphe elevata* (Burrill) U. Braun et S. Takam. on *Catalpa bignonioides* Walt. as viewed by light microscopy apart from *c* which is viewed by a scanning electron microscope: *a* – the host plant affected by the fungus; *b–c* – fruit bodies; *d* – appendages, basal part; *e–f* – dichotomously branched apical parts of the appendages; *g–h* – ascospores (bars: *b* – 100 μm, *c, g, h* – 20 μm, and *d–f* – 50 μm)

Microsphaera Lév. In July 2007 the first finding by us of this fungus was in the Crimean town of Alushta in an ornamental plantation alongside the Simpheropol — Yalta highway. Almost at the same time the fungus was collected in Simpheropol, and shortly afterwards in three localities in Kiev. In the next year it was recorded by the authors in several localities in Simpheropol, in the town of Kerch (Crimea), and again in Kiev but only in one locality.

Another powdery mildew on *Catalpa*, *Erysiphe catalpae* Simonian (Fig. 2), was described on *C. bignonioides* based on the specimens collected in Armenia as far back as 1957 (Симонян, 1984). However, the same fungus was probably found in Ukraine as early as 1909. It was reported by Jaczewsky (Ячевский, 1910, 1927) from the Nikita Botanical Garden (Crimea) as *Oidium bignoniae* Jacz., i.e. the anamorph of *E. communis* f. *bignoniae* Jacz. (= *E. catalpae*). The teleomorph state of this fungus was

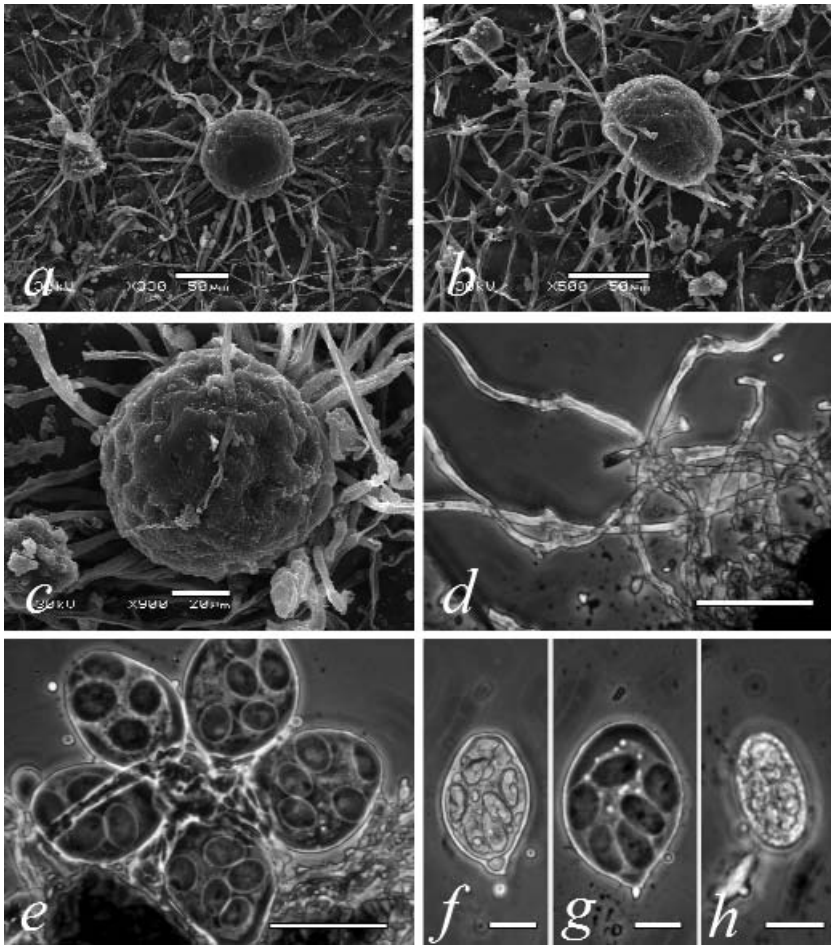

Fig. 2. *Erysiphe catalpae* Simonian on *Catalpa bignonioides* Walt.: *a–c* – as viewed by a scanning electron microscope, *d–h* – as viewed by light microscopy: *a–c* – chasmothecia; *d* – appendages; *e–g* – asci (*e, g* – very flattened by a microglass), *h* – ascospore (bars: *a, b, d, e* – 50 μm, *c, f, g* – 20 μm, and *h* – 10 μm)

found by Lavitska (Лавітська, 1955) in 1950 in the Sophiivka arboretum (town of Uman, Cherkasy region, Ukraine). Based on this information, Heluta (Гелюта, 1989) reported *E. catalpae* in his volume on powdery mildews in «Fungi Flora of Ukraine». This fungus was also recorded in other European countries and in Asia on *C. bignonioides, C. japonica* Dode, *C. ovata* G. Don fil., and *C. speciosa* (Warder ex Barney) Warder ex Engelm. (Blumer, 1967; Sandu-Ville, 1967; Бункина, 1978, 1991; Горленко, 1983; Sałata, 1985; Amano, 1986; Григалюнайте, 1990; Симонян, 1994; Ranković, 2002; Ale-Agha et al., 2004; Cook et al., 2006). In 2007 a microscope study of powdery mildews collected from *C. bignonioides* by O. Dzyunenko in the Botanical Garden of Taurida National University (Simpheropol) has revealed that only *E. catalpae* was present here.

It should be noted that the chasmothecia of *E. catalpae* have mycelioid appendages, whose apices are simple, not branched dichotomously. However, immature speci-

mens of *E. elevata* can also have unbranched appendages (Cook et al., 2006). Ale-Agha et al. (2004) carried out comparative analysis of features of these two fungi. As a result, the authors concluded that the chasmothecia of *E. catalpae* were not immature ones of *E. elevata* as previously thought. These fungi are separate species with a number of morphological differences. Thus, conidiophores of *E. catalpae* have a straight foot cell, wider conidia (14—20 μm), chasmothecia with short simple appendages and peridial cells irregularly shaped, whereas *E. elevata* has conidiophores with a curved foot cell, conidia 8—15 μm wide, chasmothecia with long apically dichotomously branched appendages and rounded or angular peridial cells. When distinguishing these species morphologically, Cook et al. (2006) emphasised the place of attachment of the appendage to the chasmothecium. *Erysiphe catalpae* has appendages attached to the base of the chasmothecium and they are more or less curved mycelioid, 1—2 septate, whereas those of *E. elevata* are mainly equatorial, well differentiated from the mycelium, stiff throughout most of their length, and aseptate or with only a single septum near the base.

We also did a similar comparative analysis of the Ukrainian specimens using the type specimen of *E. catalpae* from Armenia. It was clear that our results generally agreed with the conclusions of the above workers. However not previously observed was our finding that the chasmothecial peridia of *E. elevata* are very easily distinguished from those of *E. catalpae* as indicated by a comparison of the SEM images, Fig. 1, *c* and Fig. 2, *a*–*c*. Consequently in reflected light under the dissecting microscope chasmothecia of *E. elevata* have a rough surface (Fig. 3, *a*) whereas those of *E. catalpae* are smooth with highly reflective patches (Fig. 3, *b*). In addition, we observed that ascospores of *E. elevata* are more elongated, sometimes with unequal ends, i.e. oblong ovoid (Fig. 1, *g*—*h*), whereas ascospores of *E. catalpae* are almost always ellipsoidal, only occasionally being short and ovoid (Fig. 2, *e, g*—*h*). This agreed with previous findings regarding the differences in shape of ascospores, but not the supposed differences in ascospore size where those of *E. elevata* were notably narrower than those of *E. catalpae* (Ale-Agha et al., 2004; Braun, 1987, Cook et al., 2006). Similar differences in the relative sizes of conidia were not observed in our material. However, the width of conidia can be influenced by their degree of hydration (Cook, Braun, 2009).

Cook et al. (2006) carried out a molecular phylogenetic study on powdery mildews recorded on *Catalpa* species in Great Britain. These authors ascertained that the rDNA ITS sequences of *E. catalpae* are close to the *E. aquilegiae* DC. complex, whereas those of *E. elevata* are related to species of the section *Microsphaera* (Lév.) U. Braun et N. Shishkoff. Thus, these *Catalpa* powdery mildews are rather distant phylogenetically. The first author has previously observed that chasmothecia of many samples of *E. aquilegiae* had the shiny peridial surface very similar to that of *E. catalpae***.** So, it is not surprising that these two taxa are close phylogenetically.

Considering that *E. catalpae* is quite a rare species and its description (Гелюта, 1989) was based on specimens only from Armenia and not from Ukrainian material and *E. elevata* is a new invasive species in Ukraine we present here descriptions and illustrations of these species. It should be noted that in 2007 in the Botanical Garden

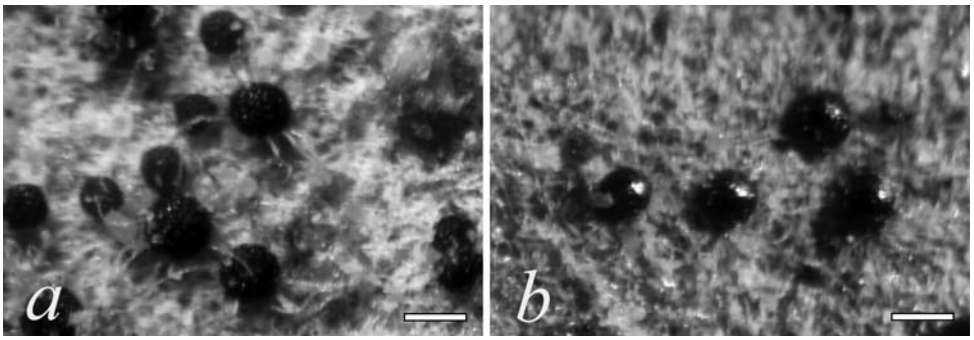

Fig. 3. Chasmothecia as viewed under the dissecting microscope in reflected light: *a* – the matt peridial surfaces of *Erysiphe elevata*; *b* – the shiny surfaces of E. catalpae (bars: *a, b* – 100 μm)

of Taurida National University only *E. catalpae* was collected, and all plants showed very severe infection, but in the next year *E. elevata* was also observed on certain trees. Therefore, it is likely that the native fungus may be supplanted in future by *E. elevata*, an invasive North American species. A similar phenomenon was observed in the 1970s in Europe when a local biotype of *E. trifolii* Grev. on *Caragana arborescens* Lam. was supplanted over a period of one year by *Erysiphe* (*Microsphaera*) *palczewskii* (Jacz.) U. Braun et S. Takam., an invasive Far Eastern species (Гелюта, Горленко, 1984).

Erysiphe elevata **(Burill) U. Braun et S. Takam., Schlechtendalia 4: 8 (2000) (Fig. 1)**

Mycelium white, only epiphyllous, forming rounded patches eventually merging and forming a white dense film. Anamorph *Pseudoidium*. Conidiophores 3—4-celled, foot cell curved, conidia ellipsoidal, 26.5—33.0 × 10.0—16.5 μm. Chasmothecia numerous, only on the upper side of the leaf, black or dark brown, hemispherical, depressed in the lower part, 92—110 μm in diam. Appendages mainly equatorial, few in number (4—8), length about 4—5 times the diameter of the chasmothecium, non-septate or with a single septum in the basal part, colourless, well differentiated from the mycelium, rising above the chasmothecia and loosely interlacing, 2—5 times dichotomously branched apices, tips of final branches curved. Peridial cells rounded or angular, 11—20 μm in diam., peridium matt in reflected light. Asci 4—7, sessile or on a short stalk, 41.5—59.0 × 33.5—40.0 μm, 3—5-spored. Ascospores ellipsoidal, sometimes oblong ovoid, 19—27 × 13–16 μm.

Specimens examined

On *Catalpa bignonioides* Walt.: Ukraine, Kiev, Pivdenna (South) Borshchahivka, Simyi Sosninykh St., 16.10.2007, 31.10.2008, V.P. Heluta; Centre, Taras Shevchenko Avenue, 15.09.2007, V.P. Heluta (anamorph); Centre, Shevchenko Park, 24.10.2007, V.P. Heluta; Autonomous Republic of Crimea, Alushta, near the bus station, 15.08.2007, V.P. Heluta (anamorph); Alushta, northern environs, before Velyka Kutuzovka, 02, 03.10.2007, V.P. Isikov[1]; Simpheropol, Bespalov St., 13.07.2007,

[1] This locality was registered through a trolleybus window 27.08.07 by V.P. Heluta in the first time.

05.09.2008, 14.10.2008, O.O. Dzyunenko; Myru St., 14.10.2008, O.O. Dzyunenko; Kievska St., 15.10.2008, O.O. Dzyunenko; Kerch, Komsomolsky Park, 26.08.2008, 17.10.2008, O.O. Dzyunenko; Botanical Garden of Taurida National University, 12.11.2008, O.O. Dzyunenko.

Erysiphe catalpae **Simonian, Микология и фитопатология 18(6): 463 (1984) (Fig. 2)**

Syn.: *Erysiphe communis* f. *bignoniae* Jacz., Карм. опред. грибов, вып. 2: 231 (1927); *Oidium bignoniae* Jacz., ibid.: 260.

Mycelium white, mainly epiphyllous, forming rounded patches eventually merging. Anamorph *Pseudoidium*. Conidiophores 2—3-celled, foot cell straight, conidia ellipsoidal, 23.0—29.5 × 13.0—16.5 μm. Chasmothecia numerous, only on the upper side of the leaf, black or dark brown, hemispherical, depressed in the lower part, (76) 96—142 μm in diam. Appendages attached to the base of the chasmothecium, 6—10, length about 1—4 times the diameter of the chasmothecium, with 1—2 septa, brownish in the basal part, mycelioid, mostly simple, without dichotomously branched apices. Peridial cells irregular in outline, 10—15 μm in diam., peridium shining in reflected light. Asci 5—6, ovoid, on a short stalk, 43—56 × 29.5—39.5 μm, 4—6-spored. Ascospores ellipsoidal, sometimes short ovoid, 16.5—23.0 × 10—13 μm.

Specimens examined

On *Catalpa bignonioides* Walt.: Autonomous Republic of Crimea, Simpheropol, Botanical Garden of Taurida National University, 11.10.2007, 06.11.2007, 15.11.2007, 05.09.2008, 14.10.2008, O.O. Dzyunenko.

Acknowledgments. Authors are grateful to the late Mr. D. Diomenko, for his help with scanning electron microscopy.

1. *Бункина И.А.* Мучнисто-росяные грибы (сем. *Erysiphaceae*) Дальнего Востока. — Владивосток: Дальневост. ун-т, 1978. — 150 с. (Рукопись деп. в ВИНИТИ 20 февр.1978 г., № 581-78 Деп.).
2. *Бункина И.А.* Порядок *Erysiphales* // Низшие растения, грибы и мохообразные советского Дальнего Востока. Грибы. Т. 2. Аскомицеты. Эризифальные, клавиципитальные, гелоциальные / Отв. ред. З.М. Азбукина. — Л.: Наука, 1991. — С. 11—142.
3. *Гелюта В.П.* Флора грибов Украины. Мучнисторосяные грибы. — Киев: Наук. думка, 1989. — 256 с.
4. *Гелюта В.П., Горленко М.В. Microsphaera palczewskii* Jacz. в СССР // Микол. и фитопатол. — 1984. — 18, вып. 3. — С. 177—182.
5. *Горленко М.В.* Мучнисторосяные грибы Московской области. Семейство *Erysiphaceae*. — М.: Изд-во Московского ун-та, 1983. — 73 с.
6. *Григалюнайте Б.* Мучнисторосяные грибы Литвы. — Вильнюс: Мокслас, 1990. — 88 с.
7. *Лавітська З.Г.* Нові для Правобережного Лісостепу знахідки борошнисто-росяних грибів (*Erysiphaceae*) // Наук. зап., Київ. ун-т. — 1955. — **13**, вип. 16. — С. 67—77.
8. *Симонян С.А.* Номенклатурные изменения в названиях некоторых мучнисторосяных грибов // Микол. и фитопатол. — 1984. — **18**, вып. 6. — С. 463—466.
9. *Симонян С.А.* Микофлора Армении. VII. Мучнисторосяные грибы Армении (пор. *Erysiphales*). — Ереван: Изд-во АН Армении, 1994. — 385 с.
10. *Ячевский А.А.* Ежегодник сведений о болезнях и повреждениях культурных и дикорастущих растений. 5-й год — 1909. — Спб., 1910. — 259 с.

11. *Ячевский А.А.* Карманный определитель грибов. Выпуск второй. Мучнисто-росяные грибы. — Л., 1927. — 626 с.
12. *Ale-Agha N., Bolay A., Braun U. et al. Erysiphe catalpae* and *Erysiphe elevata* in Europe // Mycological Progress. — 2004. — **3**, № 4. — P. 291—296.
13. *Amano K.* Host range and geographical distribution of the powdery mildew fungi. — Tokyo: Japan Scientific Societies Press, 1986. — 741 p.
14. *Blumer S.* Echte Mehltaupilze (Erysiphaceae). Ein Bestimmungsbuch für die in Europa vorkommenden Arten. — Jena: Gustav Fischer Verlag, 1967. — 436 S.
15. *Braun U.* A monograph of the Erysiphales (powdery mildews). — Berlin; Stuttgart: J. Cramer, 1987. — 700 p. [Beihefte zur Nova Hedwigia **89**: 1—700].
16. *Cook R.T.A., Braun U.* Conidial germination patterns in powdery mildews. Mycological Research. — 2009. — http://dx.doi.org/10.1016/j.mycres.2009.01.010.
17. *Cook R.T.A., Henricot B., Kiss L.* First record of *Erysiphe elevata* on *Catalpa bignonioides* in the UK // Plant Pathology. — 2004. — **53**. — P. 807.
18. *Cook R.T.A., Henricot B., Henrici A., Beales P.* Morphological and phylogenetic comparisons amongst powdery mildews on *Catalpa* in the UK // Mycological Research. — 2006. — **110**. — P. 672—685.
19. *Farr D.F., Bills F.G., Chamuris G.P., Rossman E.Y.* Fungi on plants and plant products in the United States. — St. Paul: APS Press, 1989. — 1252 p.
20. *Kiss L.* Powdery mildew as invasive plant pathogens: new epidemics caused by two North American species in Europe // Mycological Research. — 2005. — **109**, № 3. — P. 257—258.
21. *Millevoj L.* The occurence of some pests and diseases on horse chestnut, plane tree and Indian bean tree in urban areas of Slovenia // Acta agriculturae slovenica. — 2004. — **83**, № 2. — P. 297—300.
22. *Pastirčáková K., Pastirčák M., Juhásová G.* The *Catalpa* powdery mildew *Erysiphe elevata* in Slovakia // Cryptogamie, Mycologie. — 2006. — **27**, № 1. — P. 31—34.
23. *Ranković B.R.* Gljive reda Erysiphales i njihovi paraziti u Srbiji. — Kragujevac: Prirodno-matematičky fakultet, 2002. — 155 s.
24. *Sałata B.* Flora Polska. Grzyby (Mycota). Tom 15. Workowce (Ascomycetes). Maczniakowe (Erysiphales). — Warzsawa; Kraków: Panstwowe wydawnictwo naukowe, 1985. — 248 s.
25. *Sandu-Ville C.* Ciupercile Erysiphaceae din Romąnia. — Bucuresti: Editura Academiei Republicii Socialiste Romąnia, 1967. — 358 p.
26. *Vajna L., Fischl G., Kiss L. Erysiphe elevata* (syn. *Microsphaera elevata*), a new North American powdery mildew fungus in Europe infecting *Catalpa bignonioides* trees // Plant Pathology. — 2004. — **53**. — P. 244.

Recommended for publication by I.O. Dudka

Submitted 20.02.2009

В.П. Гелюта[1], О.О. Дзюненко[1,2], Р.Т.А. Кук[3], В.П. Ісіков[4]

[1] Інститут ботаніки ім. М.Г. Холодного НАН України, м. Київ
[2] Ботанічний сад Таврійського національного університету ім. В.І. Вернадського, м. Сімферополь
[3] Європейська мікологічна мережа, Йорк, Велика Британія
[4] Нікітський ботанічний сад — Національний науковий центр УААН, м. Ялта

НОВІ ЗНАХІДКИ ВИДІВ РОДУ *ERYSIPHE* НА *CATALPA BIGNONIOIDES* В УКРАЇНІ

Наводиться інформація про поширення в Україні та морфологічні особливості інвазійного північноамериканського виду борошнисторосяного гриба *Erysiphe elevata* (Burrill) U. Braun et S. Takam. та євразійського *E. catalpae* Simonian. Показано, що крім форми конідієносців і плодових тіл, форми і місця прикріплення придатків, ці види можуть розрізнятися за особливостями поверхні перидію та за формою аскоспор. Передбачається, що аборигенний вид *E. catalpae* з часом буде витіснений інвазійним видом *E. elevata*.

Ключові слова: Erysiphales, Microsphaera, *нові знахідки, поверхня перидію, Україна.*

В.П. Гелюта[1], Е.А. Дзюненко[1,2], Р.Т.А. Кук[3], В.П. Исиков[4]

[1] Институт ботаники им. Н.Г. Холодного НАН Украины, г. Киев
[2] Ботанический сад Таврического национального университета им. В.И. Вернадского, г. Симферополь
[3] Европейская микологическая сеть, Йорк, Великобритания
[4] Никитский ботанический сад — Национальный научный центр УААН, г. Ялта

НОВЫЕ НАХОДКИ ВИДОВ РОДА *ERYSIPHE* НА *CATALPA* BIGNONIOIDES В УКРАИНЕ

Приводится информация о распространении в Украине и морфологических особенностях инвазионного североамериканского вида мучнисторосяного гриба *Erysiphe elevata* (Burrill) U. Braun et S. Takam. и евразийского *E. catalpae* Simonian. Показано, что кроме формы конидиеносцев и плодовых тел, формы и места прикрепления придатков, эти виды могут различаться по особенностям поверхности перидия и по форме аскоспор. Высказано предположение, что аборигенный вид *E. catalpae* будет со временем вытеснен инвазионным видом *E. elevata*.

Ключевые слова: Erysiphales, Microsphaera, *новые находки, поверхность перидия, Украина.*

V.P. Heluta[1], O.O. Dzyunenko[1,2], R.T.A. Cook[3], V.P. Isikov[4]

[1] M.G. Kholodny Institute of Botany of the National Academy of Sciences of Ukraine, Kiev, Ukraine
[2] V.I. Vernadsky Taurida National University, Simpheropol, Ukraine
[3] European Mycological Network, York, United Kingdom
[4] Nikita Botanical Garden - National Science Centre, Yalta, Ukraine

NEW RECORDS OF *ERYSIPHE* SPECIES ON *CATALPA BIGNONIOIDES* IN UKRAINE

The distribution in Ukraine and morphological peculiarities of the North American invasive powdery mildew fungus *Erysiphe elevata* (Burrill) U. Braun et S. Takam. and Eurasian *E. catalpae* Simonian both pathogens of *Catalpa* Scop. are given. It was demonstrated that these species are distinguishable by features of the peridium surface in addition to the previously known differences in the characteristics of chasmothecia and their appendages, the shapes of ascospores, conidiophores and conidia. It is suggested that with time the native species, *E. catalpae*, will be supplanted by the invasive *E. elevata*.

Key words: Erysiphales, Microsphaera, *new records, peridial surface, Ukraine.*