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THE FIRST REPORT OF *PERONOSPORA VERBENAE*, A DOWNY MILDEW ON *VERBENA OFFICINALIS*, IN UKRAINE

Key words: Oomycota, Peronosporales, downy mildews, Peronospora, Verbena

Abstract

A rare downy mildew, *Peronospora verbenae* on *Verbena officinalis*, is newly reported from Ukraine. The species recently described from Germany and recorded in the UK and Czech Republic is unknown outside Europe. Using SEM, additional ultrastructural features of the ultimate branchlets and conidiospore surface were discovered. Original illustrations of the revealed morphological characters are provided.

In June 2012, several plants of *Verbena officinalis* L. (*Verbenaceae*) with typical symptoms of downy mildew on living leaves were observed in the Danube Biosphere Reserve (Odessa Region, Ukraine). The collected specimen was identified as *Peronospora verbenae* U. Braun, Jage, Udo Richt. et H.J. Zimm. (*Peronosporales*, *Peronosporomycetes*, *Chromista*).

The first specimens of *Peronospora* on *V. officinalis* were recorded in Germany in 2007–2008 and described as a new species (Braun et al., 2009). In May 2009, the same *Peronospora* infection was also reported from England (UK) (Anon., 2009). In August and September of the same year, *P. verbenae* was found in the Czech Republic (Choi et al., 2010). The present collection is therefore the forth record of the species in Europe.

So far all previously known specimens of *P. verbenae* have been studied under light microscopy (LM). Since

scanning electron microscopy (SEM) proved to be a useful tool in taxonomic studies of downy mildews (Thines, 2006), we examined our specimen using both LM and SEM. Some additional micromorphological characters of *P. verbenae* revealed under SEM are depicted below. The specimen is deposited in the Herbarium of the M.G. Kholodny Institute of Botany (KW).

Peronospora verbenae U. Braun, Jage, A.U. Richt. et H.J. Zimm. (Figs. 1–4).

Colonies as more or less dense tufts, hypophyllous, scattered, rarely confluent, usually on yellowish spots visible also on the upper leaf surface. *Down* whitish, dirty white to greyish. *Conidiosporophores* solitary, protruding through stomata, sometimes with inflated and/or truncate base, dendroid, 200–400(–450) µm long; *trunk* erect, 100–240 × 7–10 µm, subhyaline, smooth, monopodially branched, callose plugs absent; *branches* straight to slightly curved, in up to 5–6(–7) orders; *ultimate branchlets* almost straight to curved, the longer ones 12–20 µm long, the shorter ones 4–12 µm long, 2–4 µm wide at the base, occasionally slightly widening before ramification, tips obtuse, subtruncate, subacute or tubular. *Conidiospores* narrowly to broadly ellipsoidal, (20–)25–35(–39) × 15–20(–24) µm, length/width ratio 1.2–2.0, grey, greyish-violaceous

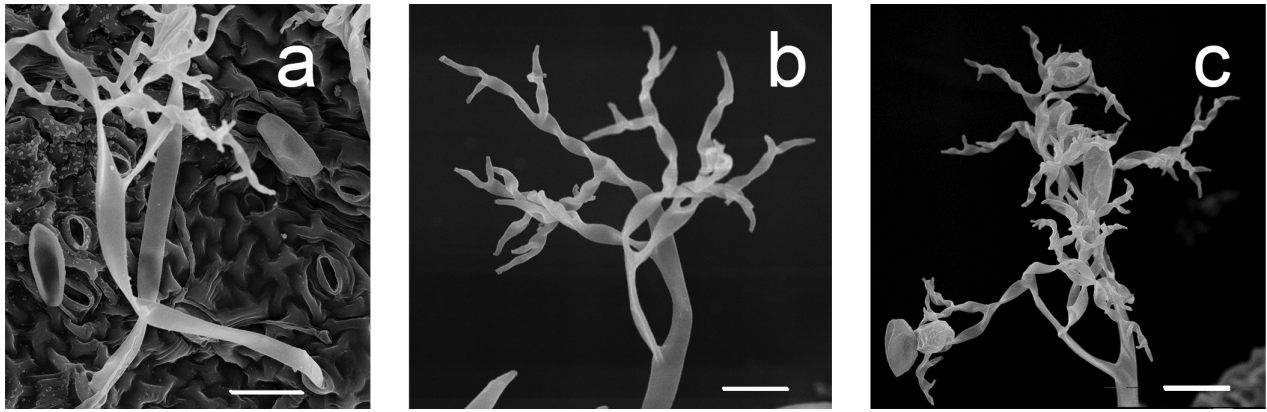


Fig. 1. Conidiosporophores of *Peronospora verbenae*: trunks arising through stomata (a); branches and ultimate branchlets (b, c); conidiospores (a, c). Scale bars: 20 μ m

to pale brown, content granular, surface from almost smooth to slightly verruculose, pedicel mostly absent, rarely scar conspicuous. *Oospores* not observed.

On leaves of *Verbena officinalis* L. — Ukraine, Odessa Region, Kiliya District, Danube Biosphere Reserve, Ermakov Island (45°25' N, 29°25' E), 30.06.2012, coll. V.G. Korytnianska.

This description is almost in full agreement with those already published (Braun et al., 2009; Choi et al., 2010). Some of the known morphological characters of *P. verbenae* revealed under LM are illustrated here on the SEM pictures. These are, for example, trunk bases of conidiosporophores which can be inflated or truncate just above the point they protrude through the stomata of the host plant (Fig. 2).

However, some ultrastructural features accessible in SEM were omitted before. We have paid special attention to those characters which are usually considered in the taxonomy of *Peronosporales* (Thines, 2006). They are the following: morphology of the last two ramifications, particularly of the ultimate branchlets, shape of

their apical ends, anatomy of the sporangium (or conidiospore) attachment site, ornamentation of the sporangium (or conidiospore) surface, etc.

According to our observations, ultimate branchlets in *P. verbenae* are not only straight or curved (Fig. 3, a, c, d) but also can be spirally twisted (Fig. 3, b); tips not only more or less conical to subacute and flat (Figs. 3, a—d) but also tubular with the covering wall caving in at the apical end (Fig. 3, c). Neither distinct annulus, nor distal widening were observed in SEM. Interestingly, some ultimate branches occasionally exhibit clear broadening towards ramification (Fig. 3, d), which is typical for *Paraperonospora* Constant., a genus separated

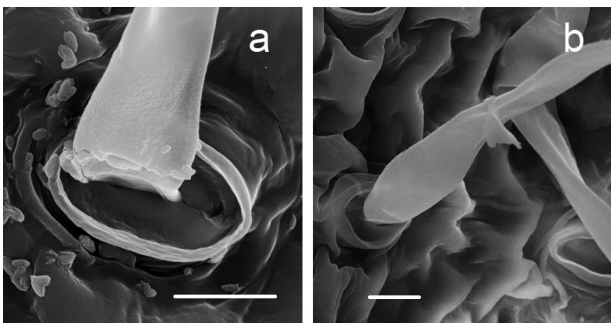


Fig. 2. Conidiosporophore trunk bases of *Peronospora verbenae*. Scale bars: 10 μ m

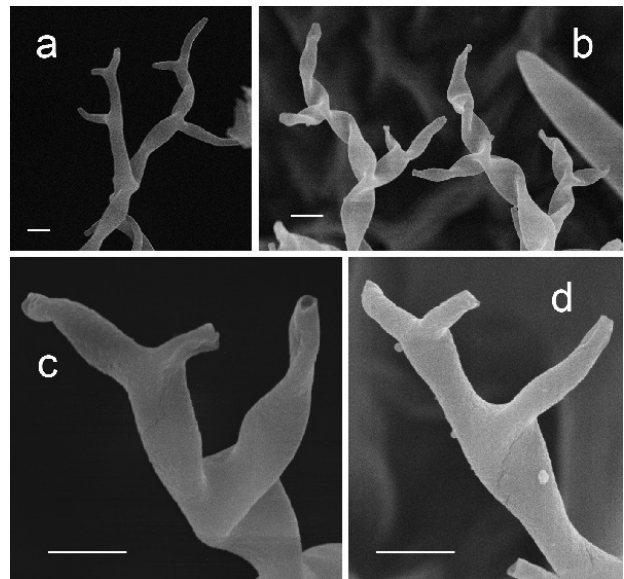


Fig. 3. Ultimate branchlets of *Peronospora verbenae*: straight and curved (a), spirally twisted (b), tubular (c), broadening before ramification (d). Scale bars: 5 μ m

from *Peronospora* Corda (Constantinescu, 1989), and a few other genera of downy mildews.

The conidiospore surface in *P. verbenae* varies from slightly verruculose (Fig. 4, *a, b, d*) to nearly smooth (Fig. 4, *c*). The surface ornamentation, if present, resembles small rounded warts. It can be suggested from our material that younger conidiospores, including those still remaining within the branches (Fig. 4, *a, b*), are apparently more ornamented than those lying freely on the leaf underside and probably discharged earlier. The ornamentation, if present, is more or less similar all over the conidiospore surface. No clear pedicel is usually present; however, occasionally a scar can be visible (Fig. 4, *c, d*). Correspondingly, a papilla at the opposite end is hardly conspicuous.

Hitherto, *P. verbenae* is the only downy mildew infection recorded on *Verbena* and *Verbenaceae* in general. A previously published report of *Plasmopara halstedii* (Farl.) Berl. et De Toni on *Verbena* sp. from New Mexico, USA (Farr et al., 1989), is doubtful since downy mildews are highly host specific and the *P. halstedii* complex is confined to *Asteraceae*.

Verbena officinalis is a perennial herb quite common in Europe. The plant can be used in traditional medicine and as a herbal tea. In Ukraine it occurs on forest edges, waste grounds, along waysides throughout the country.

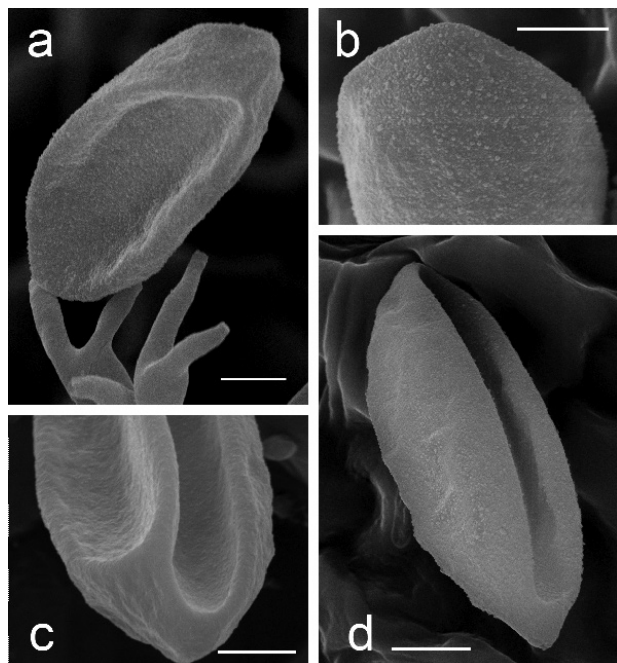


Fig. 4. Conidiospore surface of *Peronospora verbenae*: verruculose (*a, b, d*) or almost smooth (*c*). Scale bars: 5 μ m

Nevertheless, this downy mildew is so far registered in a single locality in the south-west of the country.

Although the host plant is believed to be native to Europe, it is widely naturalized outside its native range. However, *P. verbenae* apparently remains unknown elsewhere except for Europe. According to Braun et al. (2009), it is an indigenous species which might have been overlooked before. This is entirely possible as in our collection some of the infected live leaves appear almost symptomless while on dying leaves the unclear necrotic spots become less noticeable.

Since *P. verbenae* is the only oomycete representative on the *Verbenaceae*, its phylogenetic origin through a host jump could be traced in downy mildews parasitizing host plants presumably from closely related families within *Lamiales*. Comparison with the sequences available in the GenBank database has demonstrated that the ITS sequence shares 94 % similarity with *Peronospora flava* Gäum. (Choi et al., 2010). *P. flava* is known to occur on *Linaria vulgaris* (*Plantaginaceae* s.l.). However, so far it was the only sequence submitted for *P. verbenae* and used in molecular studies. More data is required for future comparison and conclusions on the origin of this species and its distribution.

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ПЕРША В УКРАЇНІ ЗНАХІДКА *PERONOSPORA VERBENAE* НА *VERBENA OFFICINALIS*

Повідомляється про першу в Україні знахідку рідкісного ооміцета *Peronospora verbenae* на *Verbena officinalis*. Цей вид, недавно описаний з Німеччини і наведений для Великої Британії та Чехії, невідомий за межами Європи. За допомогою СЕМ з'ясовані додаткові особливості ультраструктури кінцевих гілочок і поверхні конідіоспор. Представлені оригінальні ілюстрації виявлених морфологічних ознак.

Ключові слова: Oomycota, Peronosporales, несправжня борошниста роса, *Peronospora*, *Verbena*.

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ПЕРВАЯ В УКРАИНЕ НАХОДКА *PERONOSPORA VERBENAE* НА *VERBENA OFFICINALIS*

Сообщается о первой в Украине находке редкого оомицета *Peronospora verbenae* на *Verbena officinalis*. Этот вид, недавно описанный из Германии и приведенный для Великобритании и Чехии, неизвестен за пределами Европы. При помощи СЭМ выявлены дополнительные особенности ультраструктуры конечных веточек и поверхности конидиоспор. Представлены оригинальные иллюстрации обнаруженных морфологических признаков.

Ключевые слова: Oomycota, Peronosporales, ложная мучнистая роса, *Peronospora*, *Verbena*.

НОВІ ВИДАННЯ

Гродзинская А.А., Сырчин С.А., Кучма Н.Д., Вассер С.П. и др. Аккумулятивная активность макромицетов в условиях радионуклидного загрязнения территории Украины. — К.: Наук. думка, 2013. — 383 с.

У монографії наведено результати багаторічних досліджень мікобіоти, що зазнає впливу радіаційного стресу внаслідок Чорнобильської катастрофи. Вперше показані радіаційно індуквані реакції мікроміцетів: промислова меланізація, позитивний радіотропізм і їхня здатність до руйнування «гарячих» частинок. Узагальнено відомості щодо динаміки накопичення радіонуклідів макроміцетами в зоні відчуження та на прилеглих територіях. Для тривалого моніторингу запропоновані види-біоіндикатори (макро- і мікроміцети), адекватність яких підтверджена 20-річним терміном досліджень.

Книга буде корисною для мікологів, радіобіологів і екологів.