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NEW DATA ON THE OCCURRENCE AND BIOLOGY OF *PUCCINIA LILIACEARUM*

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Abstract

In 2000–2007, the biology of *Puccinia liliacearum* was investigated in Szczecin and its vicinity. In wet chambers and Petri dishes with potato dextrose agar, the fungi successively colonizing and decomposing leaves of *Ornithogalum umbellatum* parasitized by *P. liliacearum* were identified. Infectious experiments were performed in the years 2000–2004. The investigations conducted revealed a growing number of sites with *O. umbellatum* affected by *P. liliacearum*, a fungus recorded in the former Szczecin province since 1990.

Key words: *Ornithogalum umbellatum*, *Puccinia liliacearum*, occurrence, secondary fungi

Introduction

In the literature, ca. 10 species of the order Uredinales that affected different plant species of the genus *Ornithogalum* are listed (http://nt.ars-grin.gov/fungaldata-bases/fungushost/new_frameFungusHostReport.cfm). Gäumann (1959) listed five species of the collective group *Puccinia liliacearum* found to parasitize plants of the families Amarylidaceae and Liliaceae.

In 1830, De Bary was the first who described *P. liliacearum* from *O. umbellatum* (according to Gäumann 1959). Generally, *P. liliacearum* is considered a representative of the hypo-Uredinales. According to Schroeter (1889), aecia do not form at all or are produced sporadically. This parasite was reported from different species and cultivars of *Ornithogalum*, including, e.g., *O. umbellatum* (the type host), *O. nutans*, and *O. pyrenaicum*.

Farr et al. (1989) found *P. liliacearum* in two states of the USA, i.e., New York and Pennsylvania. The fungus has been also recorded in Asia, Africa, many countries of Europe, including Denmark, France, Germany, Sweden, Hungary, Ukraine,

and UK. In Poland, *P. liliacearum* was for the first time identified in Prusiec near Złotoryja (the former Prausnitz; Schroeter 1889), and later the fungus was found on *O. umbellatum* growing in Nakło and the botanical garden in Bydgoszcz (collections of A. Michalski; Majewski 1979). According to Saniewska and Jarecka (2005), *P. liliacearum* occurs in Poland for several years. However, up to 1990, the parasite was not found in the former Szczecin province.

The first studies of biology of *P. liliacearum* have been performed by Maire, Fischer and Bubák (Gäumann 1959).

The aim of this paper is to present the occurrence and biology of *P. liliacearum* in the former Szczecin province.

Materials and methods

The development of *P. liliacearum* was investigated in Szczecin in the years 2000–2007, in each year at the same sites and occasionally at sites located near Szczecin.

Dead and decaying leaves of *O. umbellatum* parasitized by *P. liliacearum* were incubated in humid chambers to reveal later colonizers of affected leaves. The appearing fungal colonies were transferred to Petri dishes with potato dextrose agar (PDA, Difco) and grown at room temperature. Then, one-species cultures of these fungi were established and identified under an Olympus CX21 compound microscope, and finally photographed using an Olympus BX51 microscope equipped with Nomarski differential interference contrast.

Infection experiments were performed in the years 2004–2006. Near plants of *O. umbellatum* severely affected by *P. liliacearum*, bulbs of *Allium moly*, *Muscaria botryoides*, *Scilla hispanica*, and *Tulipa gesneriana* were planted.

In the middle of September 2005, bulbs of *O. umbellatum* coming from severely affected plants by *P. liliacearum* were planted. Before the planting, the bulbs were disinfected with Kaptan zawiesinowy 50 WP (captan).

Results

Each year, the first disease symptoms appeared between the third decade of March and the first half of April, depending on the site and the weather conditions. In 2008, in one of the sites considered, the first symptoms appeared already in the last days of February. At the soil surface, the tops of developing leaves gradually became thick, spotted, pale green-yellowish and were covered with many spermogonia. After several to a dozen or so days, telia appeared between newly formed spermogonia. Before flowering, only not numerous telia developed and they occurred only on well coloured, green leaf parts. No hyphae of the parasite in non-green leaf parts, floral stems, calyx sepals or bulbs were found.

The hyphae of *P. liliacearum* colonized intercellularly the parenchymal leaf tissue, frequently from its lower surface. This resulted in the appearance of telia on both surfaces of spotted and deformed leaves.

Chlorotic and strongly deformed leaf initials with their upper surface covered with many, closely packed telia with numerous hyphae (teliophysis) were occasionally found not deeply under the soil surface.

Telia associated with slightly affected leaves incubated in wet chambers produced numerous new teliospores, which did not germinate either on PDA or in a drop of water.

Each year, plants of *O. umbellatum* were colonized by *P. liliacearum* to a similar degree. From year to year, the plants gradually deteriorated and bloomed poorly. No other symptoms were found.

The test plants, *A. moly*, *M. botryoides*, *S. hispanica*, and *T. gesneriana*, were not affected by *P. liliacearum* coming from *O. umbellatum*. Other plants of the genera *Convallaria*, *Galanthus*, *Hyacinthus*, *Lilium*, and *Narcissus* reacted similarly.

The plants grown from bulbs of *O. umbellatum*, derived from plants affected by *P. liliacearum*, but isolated spatially, were healthy and free of the pathogen.

The fungi more frequently isolated from decaying and necrotic leaves earlier parasitized by *P. liliacearum* were *Alternaria alternata*, *Aureobasidium pullulans*, *Cladosporium cladosporioides*, and yeast-like fungi forming cream and orange colonies on PDA. Rarely isolated microorganisms included *A. tenuissima*, *C. herbarum*, *C. macrocarpum*, *Epicoccum nigrum*, *Fusarium* spp., and hyaline and coloured non-sporulating mycelia.

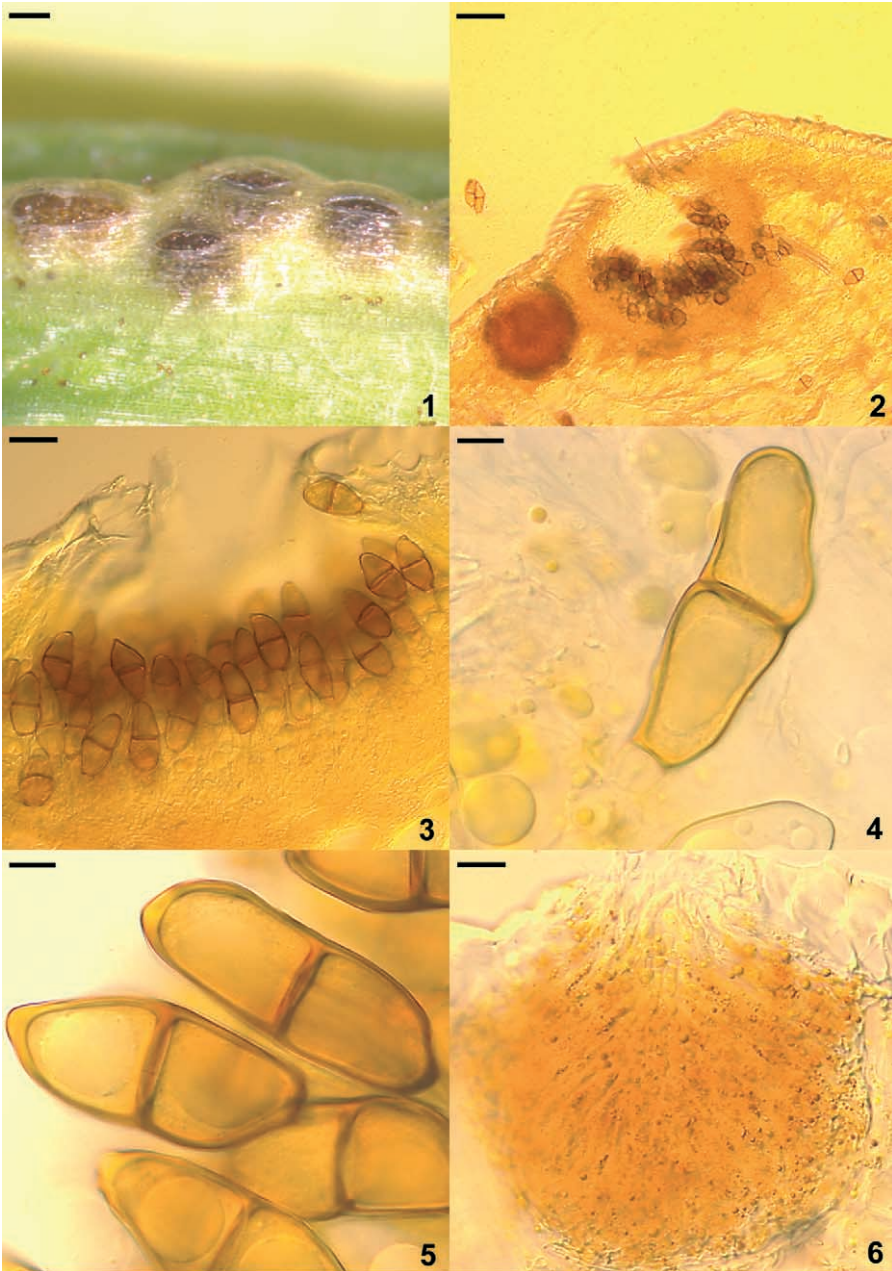
In wet chambers, fungi of the genus *Cladosporium* colonized decaying and dead leaves. They occasionally also colonized telia and spermatogonia, but did not grow into teliospores.

Discussion

The rust caused by *P. liliacearum* probably was not recorded in the former Szczecin province since 1990. At the sites considered, plants of *O. umbellatum* growing in the same places for two years were ill each year. The occurrence of *P. liliacearum* on *Ornithogalum* spp. probably was sporadic at the beginning, but increased with time and, thereby, became visible (Farr et al. 1989, Majewski 1979, Moore 1959).

The disease symptoms and morphological characters of *P. liliacearum* found generally fitted those given in the literature (Brandenburger 1985, Gäumann 1959, Majewski 1979), except for the rare presence of meiospores and the lack of three-four-celled teliospores. According to Gäumann (1959), a similar variability in the number of cells in teliospores occurred in *P. allii*.

The results obtained agree with the findings of Mairea and others (according to Gäumann 1959) that the only source of a primary infection of *Ornithogalum* spp. are teliospores overwintering on the soil surface in non-deteriorated leaf debris.



Phots. 1–6. *Puccinia liliacearum*. 1. A fragment of leaf of *Ornithogalum umbellatum* with telia. 2. A cross section of spermogonium and telium. 3. Mature telium seen in a cross section. 4 and 5. Teliospores. 6. Young spermogonium seen in a cross section.

Bars: 1 – 200 μm , 2 – 100 μm , 3 – 20 μm , 4 – 10 μm , 5 – 10 μm , 6 – 20 μm
(photo by J. Błaszowski)

The first leaves appearing over the soil surface, already fully green, were abundantly covered by spermogonia. In contrast, some leaves developed later were free of the parasite. The reason of it probably was lower air humidity at the later stages of plant growth that precluded their infection by the pathogen. It also explains the lack of infected flower organs. The investigations do not confirm those of Saniewska and Jarecka (2005), in which *P. liliacearum* was found to affect flower stems and calyx sepals as well.

Bubák (according to Gäumann 1959) concluded that *P. liliacearum* was specialized only to *Ornithogalum* spp.; results of our studies confirm it.

Maire (according to Gäumann 1959) reported of the palisade cells originated in young, developing telia on hyphae of mycelium somatogamically copulating with each other or with other cells of this mycelium. Similar palisade cells were observed in developing telia, but only on young, chlorotic leaves still being under the soil surface. The somatogamic process probably is a part of the biology of *P. liliacearum*.

Planting bulbs in a new, isolated place fully protected *Ornithogalum* from the disease and, thereby, may be recommended for protection of the plant against *P. liliacearum*.

The fungi isolated from decaying and necrotic leaves earlier affected by *P. liliacearum* were taxonomically identical to those recovered from dead organs of different other herbaceous plants. At high humidity, the fungi intensified leaf decaying, as the tests conducted in wet chambers indicated.

In the literature, no data on resistance of species and cultivars of *Ornithogalum* to *P. liliacearum* exist.

Streszczenie

NOWE DANE NA TEMAT WYSTĘPOWANIA I BIOLOGII *Puccinia liliacearum*

Biologię *Puccinia liliacearum* badano w latach 2000–2007 w Szczecinie i okolicy. W wilgotnych kamerach i na pożywce ziemniaczano-glukozowej określano grzyby następczo zasiedlające liście *Ornithogalum umbellatum* – martwe i obumierające wskutek pasożytowania *P. liliacearum*. Doświadczenie infekcyjne przeprowadzono w latach 2004–2006, wysadzając obok porażonych roślin *O. umbellatum* cebule różnych gatunków roślin z rodziny *Liliaceae*.

Pierwsze symptomy choroby obserwowano na *O. umbellatum* między trzecią dekadą marca a pierwszą połową kwietnia, w 2008 roku już w trzeciej dekadzie lutego. Nie stwierdzono sporulacji pasożyta ani obecności jego grzybni w niezielonych, dolnych fragmentach liści, łodygach kwiatostanowych i działkach okwiatu ani w cebulach. Sporadycznie znajdowano chlorotyczne, silnie zniekształcone liście tuż pod powierzchnią gleby, pokryte licznymi spermogoniami. Corocznie egzemplarze *O. umbellatum*, wegetujące latami w tych samych miejscach, nie przesadzone, były

porażane przez *P. liliacearum*, marniały, ich kwitnienie zaś ilościowo i jakościowo było zredukowane. Testowane rośliny rodzajów *Allium*, *Convallaria*, *Galanthus*, *Hyacinthus*, *Lilium*, *Muscari*, *Narcissus*, *Scilla* i *Tulipa* wykazały się pełną odpornością na *P. liliacearum* z *O. umbellatum*, co przemawia za wąską specjalizacją pasożyta, ograniczoną do *Ornithogalum* spp. Z cebul *O. umbellatum*, pochodzących z egzemplarzy porażonych przez *P. liliacearum* – zachowując izolację przestrzenną – uzyskano rośliny zdrowe. Jedynym źródłem infekcji pierwotnej były teliospory, które przetrwały na powierzchni gleby bądź w nie całkowicie jeszcze rozłożonych resztkach. Proces chorobowy w badanych ogniskach jest chroniczny. Wyizolowane grzyby, następczo kolonizujące martwe i zamierające liście, były taksonomicznie identyczne z izolowanymi z innych roślin, głównie rodzajów *Aureobasidium*, *Alternaria* i *Cladosporium*. Obserwacje prowadzone w Szczecinie i okolicy wykazują wzrost liczby i zagęszczanie się ognisk *P. liliacearum* na *O. umbellatum*, rdzy nierejestrowanej w tym obszarze do końca lat dziewięćdziesiątych ubiegłego wieku.

Literature

- Brandenburger W., 1985: Parasitische Pilze an Gefäßpflanzen in Europa. Fischer, Stuttgart.
- Farr D.F., Bills G.F., Chamuris G.P., Rossman A.Y., 1989: Fungi in plants and plant products in the United States. APS Press, St. Paul, Minnesota.
- Gäumann E., 1959: Die Rostpilze Mitteleuropas mit besonderer Berücksichtigung der Schweiz. Beitr. Kryptogamenflora Schweiz 12.
- Majewski T., 1979: Flora polska. Rośliny zarodnikowe Polski i ziem ościennych. T. 11. Grzyby (Mycota). Podstawczaki (*Basidiomycetes*) Rdzawnikowe (*Uredinales*). PWN, Warszawa.
- Moore W.C., 1959: British parasitic fungi. Cambridge University Press, Cambridge.
- Saniewska A., Jarecka A., 2005: Pochodne strobiluryiny w ograniczaniu rozwoju *Puccinia liliacearum* Duby, patogena *Ornithogalum umbellatum* L. Progr. Plant Prot./Post. Ochr. Rośl. 45, 2: 1058–1060.
- Schroeter J., 1889: Die Pilze Schlesiens, I. Kryptogamenflora, Uredinei. Bibl. Mycol. 34a: 291–381.

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