МИКОЛОГИЯ И ФИТОПАТОЛОГИЯ, 2020, том 54, № 6, с. 460–464

КРАТКИЕ СООБЩЕНИЯ

УДК 582.284.1 (481.922-1)

# MICROMYCETES ROSSICAE: CHOROLOGICAL AND TAXONOMICAL NOTES. 3. *EXOBASIDIUM SUNDSTROEMII* (*EXOBASIDIALES*, *BASIDIOMYCOTA*) – NEW FIND FOR LENINGRAD REGION

**© 2020 V. A. Dudka[1,*] and I. V. Zmitrovich[1,**]**

[1] *Komarov Botanical Institute of the Russian Academy of Sciences, 197376 St. Petersburg, Russia*

**e-mail: dudkavasiliy.a@gmail.com*

***e-mail: iv_zmitrovich@mail.ru*

Received March 1, 2020; revised May 1, 2020; accepted May 11, 2020

*Exobasidium* representatives cause various deformations of the aerial part of ericaceous, theaceous, and lauraceous plants. In the course of the present research carried out on the territory of the oceanic sector of the European middle taiga subzone in the vicinity of the Vaskelovo settlement (Leningrad Region), we found rather little-known species, *Exobasidium sundstroemii*. The morphological features of this species and symptoms demonstrated by infected plants are considered and compared with those of widespread species *E. karstenii*, more frequent on *Andromeda polifolia* leaves.

*Keywords: Andromeda*, ericaceous plants, *Exobasidium*, micromycetes, systemic parasites

**DOI:** 10.31857/S0026364820060069

The present notice continues a series devoted to rare and interesting species of micromycetes of various regions of Russia that cause rust and other leaf spots (Zmitrovich et al., 2020a, 2020b).

The *Exobasidium* species (*Basidiomycota*, *Ustilaginomycotina*, *Exobasidiomycetes*, *Exobasidiales*) compose a specific parasitic group which provokes the plant to over-production of growth hormones and causes hypertrophy of the affected areas of host tissues. At the current moment, there are about 120 species of the genus found in various climatic zones. The genus representatives affect predominantly the members of the *Ericaceae* family, but were found also on the members of *Theaceae*, *Lauraceae*, and a number of other families. The main symptoms of damage caused by *Exobasidium* spp., are localized in different parts of the plant, for example, the pathogen forms local spots on host leaves, sometimes causes its thickening, colonizes a young shoot (which leads to the formation of "witch's brooms"), buds, fruits or form systemic damage, when the leaves of the plant increase in size (hypertrophy and hyperplasia), and sometimes the entire plant becomes entirely red (Nannfeldt, 1981; Karatygin, 2002; Klenke, Scholler, 2015).

The genus *Exobasidium* is fairly well studied in the European part of the temperate zone. However, despite this, a number of species remain (*E. arescens* Nannf., *E. ledi* P. Karst., *E. oxycocci* Rostr. ex Shear, *E. sundstroemii* Nannf.) which are rare in the European part of Russia or have a dubious taxonomic status. For example, Döring (2003), using molecular methods, could not confirm the distinction between *E. juelianum* Nannf. and *E. vaccinii* (Fuckel) Woronin.

In the present notice, we would like to report about the first record of *E. sundstroemii* in the Leningrad Region as well as consider its morphological differences from another species, *E. karstenii* Sacc. et Trotter, more usual on *Andromeda polifolia* (*Ericaceae*).

The exobasidiaceous parasite on *Andromeda polifolia* causing a systemic disease called "rose blossom" for a long time was considered as *Exobasidium andromeda*e Peck. Studying this species in detail, i.e. using morphological, cultural, and physiological approaches, Sundström (1964) came to the conclusion that this species is not homogeneous, however this researcher not complete this important work. This research was continued by another Norwegian researcher Nannfeldt (1981), who divided *E. andromedae* into two species, *E. karstenii* and *E. sundstroemii*. These works convincingly confirmed the independent status of both species. In recent works, devoted to the phylogeny of the genus *Exobasidium*, where molecular methods were used, the phylogenetic trees were shown, generated on the basis of nr5.8S, nrSSU, and nrSSU data. These results show that *E. sundstroemii* and *E. karstenii* place different position in molecular phylograms (Begerow et al., 2002; Döring, 2003; Piątek et al., 2012; Brewer et al., 2014),


**Fig. 1.** *Exobasidium sundstroemii* locality (E): Russia, Leningrad Region, Vsevolozhsky district, Vaskelovo settlement vicinity, Oxycocco-Sphagnetum, 60°23′27″N, 30°23′40″E.

therefore, two rather distant *Exobasidium* phylospecies were adapted to parasitizing the same *Andromeda* host.

During mycological studies within swamp forests and raised bogs in July 2019, in the vicinity of the Vaskelovo settlement (Leningrad Region), we found *E. sundstroemii* (Fig. 1). Earlier for Russia, this species was already noted by Gomzhina and Tobias (2015) on Sredniy Isle of the Kretsk Archipelago. The GBIF website also contains a record on *E. sundstroemii* by Filippova from the Khanty-Mansi Autonomous Okrug of the Tyumen Region (Filippova, 2020). In the present notice, a detailed diagnosis of this species is given and the differentiating features of *E. sundstroemii* and *E. karstenii* are analyzed.

Leaves herborization was carried out according to a standard recommendation (Geltman, 1995). Dried shoots and leaves were examined using an MBS-3 binocular stereoscopic microscope. Micromorphological analysis of the affected parts of the plant was carried out using an Axio Scope A1 light microscope in the Laboratory of Systematics and Geography of Fungi of the Komarov Botanical Institute of the Russian Academy of Sciences. The material was prepared manually by thin cutting of the blade. To study the general morphology of microstructures, hyphae were prepared using 5% KOH and Cotton Blue reagent. The collected material kept in the Mycological Herbarium of Komarov Botanical Institute (LE F).

*Exobasidium sundstroemii* Nannf., Symb. bot. Upsal. 23(no. 2): 59, 1981.

Systemic parasite of *Andromeda polifolia*. Whole shoot or its parts can be infested. Affected shoots may be crowded. Leaves increase slightly or retain the same size. The edge of the affected leaf is slightly wrapped, the color is pink, red (does not darken over time, as is the case with *Exobasidium karstenii*), or more often the leaf has a mosaic structure with green patches (Fig. 2, a). A dense white hymenium forms on the leaf abaxial side (Fig. 2d). Basidia cylindrical, usually with 4 (rarely 5) sterigmata (Fig. 2, i). Basidiospores 8.4–14.3 × 1.5–3.7 μm, with a thin wall, hyaline, musiform or ellipsoid, sometimes straightly elongated; there is a distinct chilar appendage. Basidiospores aseptate or with 1 (rarely 3) septa (Fig. 2, g). Basidiospore germination with a seedling tube formation (Fig. 2, h). Conidia 6.7–11 × 0.8–2.0 μm, fusiform, rod-shaped (Fig. 2, j).

Material examined: *Exobasidium sundstroemii*, Russia, Leningrad Region, Vsevolozhsky district, Vaskelovo settlement vicinity, Oxycocco-Sphagnetum, 60°23′27″N, 30°23′40″E, on *Andromeda polifolia* (LE 330119).

General distribution. Russia: Republic of Karelia, Leningrad Region, Tyumen Region (Khanty-Mansi Autonomous Okrug). Europe: Denmark, Estonia, Finland, Germany, Norway, Sweden.

*Exobasidium sundstroemii* is one of the most hidden and difficult to identify European *Exobasidium* species. The fact is that it has a rather mild manifestation of lesion symptoms, which often overlap with *E. karstenii*. As a consequence, this species is often overlooked in field research. Both of these species parasitize the circumpolar *Andromeda polifolia*. They are characterized by damage to a part of the plant with reddening of the leaves. Moreover, *Exobasidium karstenii* is characterized by a dark red or almost violet spots production (Fig. 2, c, f). Isolation of the mosaic leaf structure for *E. sundstroemii* lesions is not confirmed because we found specimens affected by *E. karstenii* which also caused mosaic damage (Fig. 2, b, e). The number of sterigmata and septa also overlap in both species, therefore, are rather inconstant. These depend on the microclimatic conditions, as pointed out in his work by Gäumann (1922) on the example of closely related genus *Kordyana* (*Exobasidiales*). *E. sundstroemii* (Fig. 2, g, h) is characterized by slightly smaller basidiospores and conidia (Fig. 2, j). *E. karstenii*, has larger basidiospores (Fig. 2, k), and their conidia are larger and cylindrical (Fig. 2, l).

In our opinion, it is worth paying special attention to two characters when separating these two species, namely, the structure of the mesophyll of affected leaf and the nature of the germination of basidiospores. These characters were identified by Sundström and Nannfeldt to distinguish between *E. sundstroemii* and *E. karstenii*, but for some reason, a number of other researchers (Klenke, Scholler, 2015) omitted these characters from the keys for identification and anamnesis, perhaps to simplify the definition. Table 1 summarizes

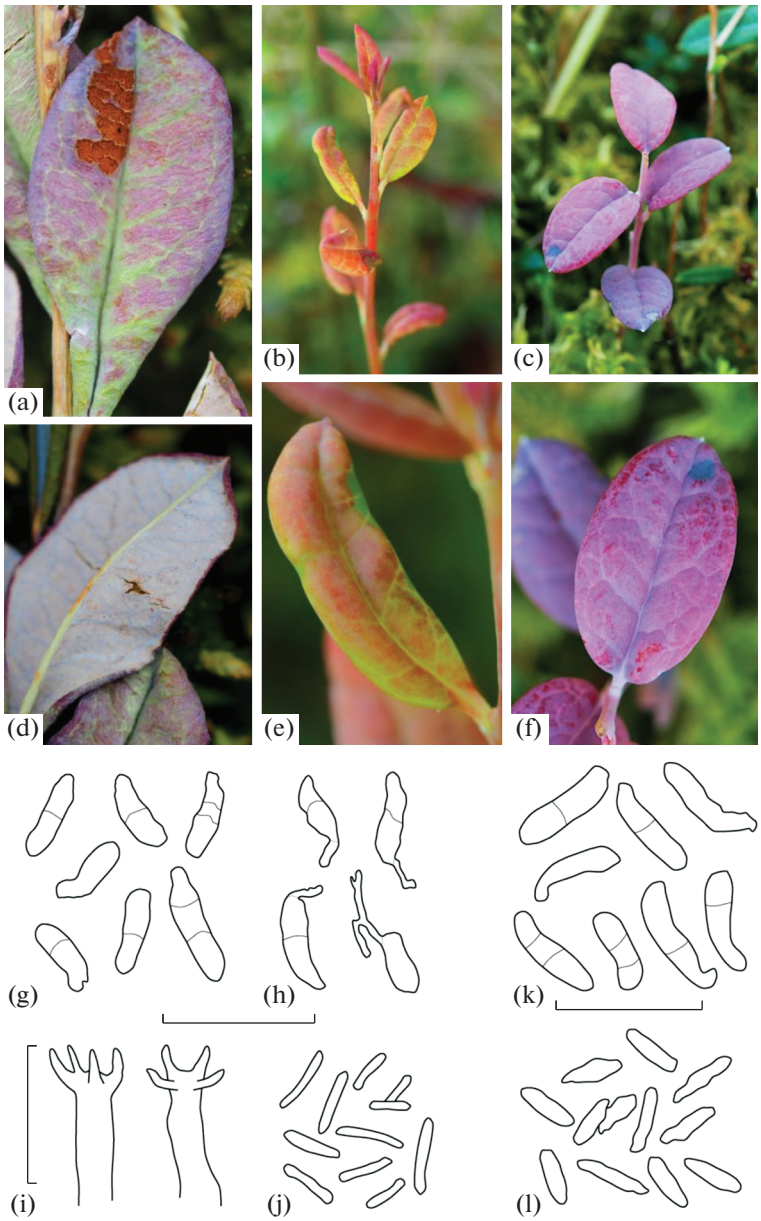


**Fig. 2.** Symptoms of damage and microstructures of *Exobasidium sundstroemii* and *E. karstenii*: a – leaf affected by *E. sundstroemii*; b, c – plant affected by *E. karstenii*; d – hymenium of *E. sundstroemii* on the abaxial side of the leaf; e, f – appearance of diseased leaves of *E. karstenii*; g – basidiospores of *E. sundstroemii*; h – germination of *E. sundstroemii* basidiospores; i – basidia of *E. sundstroemii*; j – conidia of *E. sundstroemii*; k – basidiospores of *E. karstenii*; l – conidia of *E. karstenii*. Scale bar – 20 μm.

all the main features of both species with an emphasis on the differential ones.

Taking into account such ambiguous morphological differences, each affected plant should be carefully examined during parasites identification and all available characters should be recorded. Also, if the identification is difficult, some additional methods can be involved, e.g., molecular data and isolation of the fungus into a pure culture. The mentioned approach is often practiced by Japanese mycologists when studying *Exobasidium* species on *Rhododendron* hosts.

The work was carried out using technique of the Center "Cellular and Molecular Technologies for Studying Plants and Fungi" at Komarov Botanical Institute of the Russian Academy of Sciences. Laboratory work was supported by the State Research Task "Herbarium funds of the BIN RAS" (AAAA-A18-

**Table 1.** Differential characteristics of *Exobasidium sundstroemii* и *E. karstenii*

| Character | *E. sundstroemii* | *E. karstenii* |
|---|---|---|
| Shoots growth | crowded | scattered or less often crowded |
| The nature of shoot affection | partial | systemic, rarely partial |
| Shoots defeat coverage | rarely sprouts from the underground part | often sprouts from underground |
| The nature of the leaf lesion | moderately widened, of normal thickness | greatly enlarged, thin and soft |
| The nature of the defeat of the mesophyll | with typical spongy mesophyll | with undifferentiated mesophyll |
| Leaves color | light purple-red (pink) above, often with green spots | above dark bluish (often almost blackish) purple |
| Hymenium | white on the underside | white on the underside |
| Number of sterigmata | 4–5 | 2–4 |
| Basidiospore sizes | 8.4–14.3 × 1.5–3.7 μm | 11.4–20.0 × 2.0–5.5 μm |
| Basidiospore quotient (Q) | 4.13 | 4.42 |
| Basidiospore shape | musiform, almost straight or moderately geniculate near the hilar appendage | narrowly musiform, moderately allantoid |
| Number of septa in mature basidiospore | 1 (rarely 3) | 1–3 |
| Basidiospore germination | germination by germ-tubes | germination by conidium |
| Conidia | 6.7–11 × 0.8–2.0 μm | 7.4–13.0 × 0.8–2 μm |
| Conidia quotient (Q) | 7.41 | 8.6 |
| Conidia shape | rod-shaped | rod-shaped |
| Frequency | rare | widespread |

Note. Reliably differentiating characters are underlined.

118022090078-2) and by the RFBR grant (N 19-04-00024 A).

## REFERENCES

*Begerow D., Bauer R., Oberwinkler F.* The *Exobasidiales*: an evolutionary hypothesis. Mycol. Progress. 2002. V. 1. P. 187–199.

*Brewer M.T., Turner A.N., Brannen P.M. et al. Exobasidium maculosum*, a new species causing leaf and fruit spots on blueberry in the southeastern USA and its relationship with other *Exobasidium* spp. Parasitic to blueberry and cranberry. Mycologia. 2014. V. 106 (3). P. 415–423. https://doi.org/10.3852/13-202

*Döring H.* Molekularsystematische Untersuchungen an Vertretern der pflanzenparasitischen Gattung *Exobasidium* (*Basidiomycota*). Phd Thesis. Bayreuth, 2003.

*Filippova N.* The fungarium of Yugra State University reference collection. Version 1.8. Yugra State University Biological Collection (YSU BC). 2020.

*Gäumann E.* Über die gattung *Kordyana* Rac. Ann. Mycol. 1922. V. 20. P. 257–271.

*Geltman D.V.* (ed.). The Herbarium handbook. Kew, 1995 (in Russ.).

*Gomzhina M.M., Tobias A.V.* Species of *Exobasidium* Woronin on some islands of Keret Archipelago (White Sea). Vestnik Sankt-Peterburgskogo universiteta. Ser. 3. Biologiya. 2015. N 2. P. 23–31 (in Russ.).

*Karatygin I.V.* Definitorium fungorum Rossiae. Ordines *Taphrinales, Protomycetales, Exobasidiales, Microstromatiales*. Nauka, Petropolis, 2002 (in Russ.).

*Klenke F., Scholler M.* Pflanzenparasitische Kleinpilze. Springer, Berlin, Heidelberg, 2015. https://doi.org/10.1007/978-3-662-46162-4

*Nannfeldt J.A. Exobasidium*, a taxonomic reassessment applied to the European species. Symb. Bot. Upsal. 1981. V. 23. N 2. P. 1–72.

*Piątek M., Lutz M., Welton P. Exobasidium darwinii*, a new Hawaiian species infecting endemic *Vaccinium reticulatum* in Haleakala National Park. Mycol. Progress. 2012. V. 11. P. 361–371. https://doi.org/10.1007/s11557-011-0751-4

*Sundström K.R.* Studies of the physiology, morphology and serology of *Exobasidium*. Symb. Bot. Upsal. 1964. V. 18, N 3. P. 1–89.

*Zmitrovich I.V., Dudka V.A., Shevchuk S.V.* Micromycetes Rossicae: Chorological and taxonomical notes. 1. *Chrysomyxa succinea* (*Pucciniales, Basidiomycota*) – new find for Saint Petersburg, European Russia. Mikologiya i fitopatologiya. 2020. V. 54 (4). P. 305–308. https://doi.org/10.31857/S0026364820040133

*Zmitrovich I.V., Dudka V.A.* Micromycetes Rossicae: Chorological and Taxonomical notes. 2. *Melampsora arctica* (*Pucciniales, Basidiomycota*) – urediniospore variability in specimens from European and Siberian Arctic. Mikologiya i fitopatologiya. 2020. V. 54 (5). P. 384–388. https://doi.org/10.31857/S0026364820050128

*Гельтман Д.В.* (Geltman) (ред.) Гербарное дело. Справочное руководство. Русское издание. Кью: Королевские ботанические сады, 1995. 342 с.

*Гомжина М.М., Тобиас А.В.* (Gomzhina, Tobias) Виды рода Exobasidium Woronin на некоторых островах Керетского архипелага (Белое море) // Вестник Санкт-Петербургского университета. Серия 3. Биология. 2015. № 2. С. 23–31.

*Каратыгин И.В.* (Karatygin) Определитель грибов России. Порядки тафриновые, протомициевые, экзобазидиевые, микростромациевые. СПб.: Наука, 2002. 137 с.

# Микромицеты России: географические и таксономические заметки. 3. *Exobasidium sundstroemii* (*Exobasidiales*, *Basidiomycota*) – новая находка на территории Ленинградской области

**В. А. Дудка[a,#], И. В. Змитрович[a,##]**

[a] *Ботанический институт им. В.Л. Комарова РАН, Санкт-Петербург, Россия*

[#]*e-mail: dudkavasiliy.a@gmail.com*

[##]*e-mail: iv_zmitrovich@mail.ru*

Представители рода *Exobasidium* вызывают различные деформации надземной вегетативной части растений семейств *Ericaceae*, *Theaceae*, *Lauraceae*. В ходе исследований на территории приокеанического сектора среднетаежной подзоны в окрестностях Васкелово (Ленинградская обл.) нами был обнаружен малоизвестный вид *Exobasidium sundstroemii*. Рассмотрены морфологические особенности данного вида и проведено его сравнение с широко распространенным видом *E. karstenii*, который встречается на *Andromeda polifolia* чаще, чем *Exobasidium sundstroemii*.

*Ключевые слова:* вересковые, микромицеты, системные паразиты, *Andromeda*, *Exobasidium*