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PARASITIC MICROMYCETES ON TREES AND SHRUBS INTRODUCED TO THE TALLINN BOTANICAL GARDEN FROM THE RUSSIAN FAR EAST

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Abstract. The Tallinn Botanical Garden has introduced 173 species of trees and shrubs with areas of distribution in the Russian Far East. Of these 26 species have been found to be infected with 19 species of parasitic micromycetes from the orders *Erysiphales*, *Uredinales* and *Melanconiales*. The primary mycoflora of the introduced plants forms slowly, mainly by spreading from native plant species to introduced ones, and it consists of species with a wide distribution area.

Key words: pathogenic micromycetes, introduction, trees, shrubs, the Russian Far East, Estonia.

The Far East Floristic Region is an import area for the introduction of the plants, especially trees and shrubs, to Estonia.

In the process of introduction of plant species the establishing of their resistance to pathogenic fungi, among other necessary characteristics, is of great importance. The species composition of the pathogenic fungi (mycoflora) on introduced plants forms from two sources: parasites introduced together with plants from the previous habitats, and parasitic fungi that occur in new habitats which may infect plant species to be introduced. Consequently, bearing in mind successful plant introduction, basic information about the distribution of pathogenic fungi and the formation of the mycoflora on the plant species to be introduced is urgently needed.

There are 173 species of trees and shrubs in the collections of the Tallinn Botanical Garden (TBG) coming from areas of their distribution in the Far East. Of these 160 species belong to the phylum *Angiospermae*; up to the present, 26 species of them have been found to be infected with 19 species of parasitic micromycetes.

Data on the distribution of parasitic micromycetes on these plants in the Far East and in the TBG are summarized in Table 1. Available data on the distribution of pathogenic fungi in the Far East are based on papers published by Ablakatova (Аблакатова, 1965), Azbukina (Азбукина, 1974), Bunkina (Бункина, 1991), Gelyuta (Гелюта, 1990), Koval (Коваль, 1960, 1969, 1972), Nelen (Нелен, 1972), Tomilin (Томилин, 1962), and Vasilevski & Karakulin (Василевский, Каракулин, 1937, 1950). Previous data on the distribution of parasitic fungi in the TBG were published by Karis (1969, 1972, 1987), Karis, Rumberg (1966), Karis, Normet (1986), and Normet (Нормет, 1991). Unpublished materials collected and determined by T. Normet are provided with the dates of collecting.

Table 1

The distribution of pathogenic fungi on the trees and shrubs descended from the Russian Far East

Host and parasite	
In the Tallinn Botanical Garden	In the Russian Far East
1	2
On **Acanthopanax sessiliflorus** (Rupr. et Maxim.) Seem.	
Colletotrichum yaquense Pet. et Cif., 28. 08. 1981.	*Phyllactinia guttata* (Wallr.: Fr.) Lév., *Phyllosticta axanthopanaxis* Syd.
On **Acer ginnala** Maxim.	
Sawadaea tulasnei (Fuck.) Homma)	*Phyllosticta aceris* Sacc., *Rhytisma acerinum* (Pers.) Fr., *R. punctatum* Rehm., *Sawadaea bicornis* (Wallr.: Fr.) Miyabe
On **Acer tegmentosum** Maxim.	
Oidium spec.	*Rhytisma punctatum*, *Sawadaea bicornis*
On **Berberis amurensis** Rupr.	
Puccinia graminis Pers.	*Microsphaera berberidis* (DC.) Lév., *Phyllactinia guttata*, *Phyllosticta berberidis* Rabh., *Puccinia graminis*, *P. pygmaea* Eriks.
On **Betula davurica** Pall.	
Melampsoridium betulinum (Fr.) Kleb.	*Gloeosporium betulinum* West., *Melampsoridium betulinum*, *Microsphaera ornata* U. Braun, *Phyllactinia guttata*, *Phyllosticta betulina* Sacc., *Uncinula betulae* Homma
On **Betula divaricata** Ledeb.	
Melampsoridium betulinum, 07. 09. 1984.	*Melampsoridium betulinum*, *Phyllactinia guttata*
On **Betula ermanii** Cham.	
Microsphaera ornata	*Microsphaera ornata*, *Phyllactinia guttata*, *Uncinula betulae*
On **Betula platyphylla** Sukacz.	
Melampsoridium betulinum	*Melampsoridium betulinum*, *Phyllactinia guttata*
On **Corylus mandshurica** Maxim.	
Gloeosporium coryli (Desm.) Sacc., 23. 09. 1982.	*Mamiania coryli* Ces. et de Not, *Microsphaera hommae* U. Braun,
Phyllactinia guttata, 21. 10. 1983	*Phyllactinia guttata*, *Phyllosticta corylaria* Sacc., *Pucciniastrum coryli* Kom.

1	2
	On **Crataegus chlorosarca** Maxim.
Podosphaera clandestina (Wallr.; Fr.) Lév.	*Gymnosporangium clavariiforme* (Pers.) DC., *Podosphaera clandestina*
	On **Lonicera ruprehctiana** Regel
Microsphaera lonicerae (DC.) Wint.	*Microsphaera erlangshanensis* Yu, *Microsphaera lonicerae*, *Puccinia festucae* Plowr.
	On **Maackia amurensis** Rupr. et Maxim.
Oidium sp.	*Cercospora cladrastidis* Jacz., *Microsphaera cladrastidis* Jacz., *Phyllosticta sophorae* Ell. et Ev., *Uromyces amurensis* Kom.
	On **Padus asiatica** Kom.
Podosphaera tridactyla (Wallr.) de Bary	*Cylindrosporium padi* (Lib.) Karst., *Gloeosporium prunicola* Ell. et Ev., *Leucotelium padi* Tranz., *Podosphaera tridactyla*, *Polystigma ochraceum* (Fr.) Sacc., *Thecopsora areolata* (Fr.) Magn.
	On **Padus ssiori** Fr. Schmidt
Podosphaera tridactyla	*Podosphaera tridactyla*, *Thecopsora areolata*
	On **Quercus crispula** Blume
Microsphaera alphitoides Griff. et Maubl.	*Microsphaera alphitoides*
	On **Quercus dentata** Thunb.
Microsphaera alphitoides	*Microsphaera alphitoides*
	On **Quercus mongolica** Fisch. et Ledeb.
Microsphaera alphitoides	*Cronartium quercuum* (Berk.) Miy. ex Shirai, *Gloeosporium quercinum* West., *Microsphaera alphitoides*, *Phyllactinia roboris* (Gachet) Blumer, *Phyllosticta quercina* Thuem., *Typhulochaeta japonica* Ito et Hara
	On **Rhamnus davurica** Pall.
Microsphaera friesii Lév., 10. 09. 1990.,	*Microsphaera friesii*, *Phyllosticta cathartica* Sacc.,
Puccinia coronifera Kleb.	*Puccinia coronifera*, *P. hierochloae* Ito, *P. melicae* (Eriks.) Syd., *P. poae-pratensis* Miura
	On **Ribes mandshuricum** (Maxim.) Kom.
Cronartium ribicola J. C. Fisch. et Rabh., 02. 10. 1985.	*Cronartium ribicola*, *Puccinia caricina* DC.

1	2
On **Rosa amblyotis** C. A. Mey.	
Sphaerotheca pannosa (Wallr. : Fr.) Lév.	*Medusosphaera rosae* Golov. et Gamal., *Phragmidium kamtschatkae* (F. W. Anderss.) Arth. et Cumm., *Ph. montivagum* Arth., *Ph. yezoense* Kasai, *Sphaerotheca pannosa*
On **Rosa davurica** Pall.	
Sphaerotheca pannosa, 08. 08. 1969.	*Phragmidium kamtschatkae*, *Ph. montivagum*, *Ph. tuberculatum* J. Muell., *Ph. yezoense*, *Phyllosticta rosae* Desm., *Sphaerotheca pannosa*
On **Rosa maximowicziana** Regel	
Marssonina rosae (Lib.) Died., 02. 10. 1985., *Sphaerotheca pannosa*	*Phragmidium rosae-multiflorae* Diet., *Sphaerotheca pannosa*
On **Rosa rugosa** Thunb.	
Sphaerotheca pannosa	*Phragmidium kamtschatkae*, *Ph. montivagum*, *Ph. rosae-rugosae Kasai*, *Ph. tuberculatum*, *Phyllosticta rosae*, *Septoria rosae* Desm., *Sphaerotheca pannosa*
On **Syringa wolfii** Schneid.	
Oidium sp.	*Microsphaera syringae-japonicae* U. Braun, *Phyllosticta syringae* West.
On **Tilia amurensis** Rupr.	
Gloeosporium tiliae Oud.	*Cercospora microsora* Sacc., *Pucciniastrum tiliae* Miyabe ex Hirat, *Uncinula oleosa* Zheng et Chen
On **Viburnum sargentii** Koehne	
Microsphaera sparsa Howe	*Aecidium viburni* P. Henn. et Shirai, *Cercospora opuli* Sacc., *Microsphaera miranda* Hel., *M. sparsa*, *Phyllactinia guttata*, *Phyllosticta opuli* (Fuck.) Hoehn., *Septoria viburni* West.

According to the data in Table 1, plant species studied are susceptible to many pathogenic fungi in the areas of distribution of these plants but resistant in the TBG. Could the resistance of the plants to the parasitic micromycetes be changed in the course of their introduction?

To clarify this, it is necessary to know the areas of the distribution of the pathogenic fungi discussed.

According to Braun (1987), the following powdery mildew fungi mentioned in Table 1 have been known in Eastern Asia only: *Medusosphaera rosae, Microsphaera cladrastidis, M. erlangshanensis, M. hommae, M. syringae-japonicae, Typhulochaeta japonica, Uncinula betulae* and *U. oleosa.*

In addition to these, *Microsphaera miranda* is known only from the type collection in the Far East (Гелюта, 1990).

According to Azbukina (Азбукина, 1974), the following rusts have been recorded in Eastern Asia only: *Aecidium viburni, Phragmidium rosae-multiflorae, Ph. rosae-rugosae, Ph. yezoense, Puccinia hierochloae, P. poae-pratensis, Pucciniastrum coryli, P. tiliae* and *Uromyces amurensis.*

Phragmidium montivagum is distributed also in North America, but *Leucotelium padi* as an endemic has a narrow area of distribution in Ussuriland.

From the leaf spot causing fungi the East Asian species are: *Cercospora cladrastidis, Gloeosporium prunicola, Phyllosticta acanthopanaxis* and *Ph. sophorae* (Василевский, Каракулин, 1937, 1950).

The invasion of above-mentioned parasites of Europe could take place only with the introduction of their host species. Up to now these parasitic micromycetes have not been found in the TBG.

Most of the pathogenic fungi distributed both in the Far East and in the TBG on the trees and shrubs introduced from the Far East, have nearly circumglobal areas of distribution, or else they are widely distributed in Eurasia.

Some widely-distributed pathogenic fungi have been known on several host species in various geographic areas. For example, *Cylindrosporium padi, Polystigma ochraceum* and *Thecopsora areolata* parasitizing on *Padus asiatica* in the Far East have been found on the native bird-cherry (*Padus avium* Mill.) in Estonia. Pathogenic fungi *Phragmidium kamtschatkae, Ph. tuberculatum, Phyllosticta rosae* and *Septoria rosae* parasitizing on *Rosa amblyotis, R. davurica* and *R. rugosa* in the Far East have been known on *Rosa canina* L., *R. majalis* Herrm, and other *Rosa* species native to Estonia. In the Far East leaf spot causing fungi on *Betula davurica, Gloeosporium betulinum* and *Phyllosticta betulina* are common on native *Betula pendula* Roth and on other birches native to Estonia.

Consequently, numerous phytopathogenic fungi on native host plants are able to attack susceptible introduced plant species.

Many pathogenic fungi found on introduced trees and shrubs in the TBG (*Microsphaera alphitoides, M. ornata, Phyllactinia guttata, Cronartium ribicola, Melampsoridium betulinum, Puccinia coronifera, P. graminis* and others) are widely distributed on the plant species native to Estonia.

Gloeosporium coryli, G. tiliae, Marssonina rosae, Microsphaera lonicerae and *Sawadaea tulasnei* not known in the Far East on the plant species discussed here, but found in the TBG, are distributed on plant species native to Estonia.

In the Far East, on *Acer ginnala*, a powdery mildew fungus *Sawadaea bicornis* has been found, which is common in Eurasia (including Estonia) on species of *Acer. Sawadaea tulasnei* occurring on *Acer ginnala* in the TBG and not found in the Far East at all, is a common powdery mildew species on *Acer platanoides* L. which is native in Estonia. Probably, the anamorph (*Oidium* sp.) of powdery mildews on *Acer tegmentosum* determined in the TBG belongs to *Sawadaea tulasnei.*

On the other hand, on several plant species distributed in Europe and introduced to the Far East, Eastern Asian species of the powdery mildew fungi have been recorded that do not occur in the areas of the native distribution of the same plants. For example, East Asian species of

Table 2

The formation of the mycoflora on the trees and shrubs introduced from the Russian Far East to the Tallinn Botanical Garden

Plant species	Year of the introduction to the TBG		Parasite	First time found in the TBG
	by seeds	by plants		
Acanthopanax sessiliflorus	1961		*Colletotrichum yaquense*	1981
Acer ginnala	1961		*Sawadaea tulasnei*	1965
A. tegmentosum	1961	1975	*Oidium* spec.	1990
Berberis amurensis	1957		*Puccinia graminis*	1963
Betula davurica	1961	1982	*Melampsoridium betulinum*	1981
B. divaricata		1975	*M. betulinum*	1984
B. ermanii	1961	1976	*Microsphaera ornata*	1968
B. platyphylla	1959	1976	*Melampsoridium betulinum*	1981
Corylus mandshurica	1966	1961	*Gloeosporium coryli*	1982
			Phyllactinia guttata	1983
Crataegus chlorosarca		1961	*Podosphaera clandestina*	1965
Lonicera ruprechtiana	1957		*Microsphaera lonicerae*	1963
Maackia amurensis	1961	1977	*Oidium* spec.	1966
Padus asiatica	1961		*Podosphaera tridactyla*	1966
P. ssiori	1961		*P. tridactyla*	1968
Quercus crispula	1961	1981	*Microsphaera alphitoides*	1964
Q. dentata	1961		*M. alphitoides*	1965
Q. mongolica	1961	1975	*M. alphitoides*	1964
Rhamnus davurica		1975	*Puccinia coronifera*	1985
			Microsphaera friesii	1990
Ribes mandshuricum		1981	*Cronartium ribicola*	1985
Rosa amblyotis	1961		*Sphaerotheca pannosa*	1965
R. davurica	1957	1975	*S. pannosa*	1969
R. maximowicziana	1980		*Marssonina rosae*	1985
R. rugosa	1957		*Sphaerotheca pannosa*	1965
Syringa wolfii	1957	1961	*Oidium* spec.	1968
Tilia amurensis	1961	1961	*Gloeosporium tiliae*	1982
Viburnum sargentii	1961	1977	*Microsphaera sparsa*	1978

powdery mildew fungi *Uncinula fraxini* Miyabe and *U. miyabei* (Salmon) Sacc. et Syd. on the *Fraxinus excelsior* L. and *Alnus glutinosa* (L.) Gaertn., respectively, introduced from Europe have been, according to Bunkina (Бункина, 1991), found in the Vladivostok Botanical Garden.

The formation of parasitic mycoflora on trees and shrubs introduced from the Far East to the Tallinn Botanical Garden is proceeding rather slowly. In Table 2, the data on it are given from the manuscript by J. Elliku and A. Paivel "The trees and shrubs from the Far East in the Tallinn Botanical Garden and in the other places of Estonia".

First parasitic fungi, mainly powdery mildews and rusts, were identified not before 3—5 years after the introduction of their host plants to the TBG (Table 2). Some pathogenic fungi, mainly species of the order *Melanconiales*, have been found a decade after the introduction of their new hosts. Up to the present, 134 species of trees and shrubs introduced from the Far East have been resistant to parasitic micromycetes in the TBG.

All parasitic micromycetes on the trees and shrubs introduced from the Far East to the TBG, have come from the local mycoflora of native plant species. The formation of the mycoflora on the introduced plants seems to be a long-lasting process, and the introduced trees and shrubs are free from phytopathogenic fungi during a long period of time.

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PARASIITSED MIKROSEENED KAUG-IDAST TALLINNA BOTAANIKAAEDA INTRODUTSEERITUD PUUDEL JA PÕÕSASTEL

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Kuni käesoleva ajani on Tallinna Botaanikaaeda Kaug-Idast introdutseeritud 173 liiki puittaimi, neist 26 on siin osutunud vastuvõtlikuks 19 liigile parasiitsetele pisiseentele peamiselt seltsidest *Erysiphales*, *Uredinales* ja *Melanconiales*. Introdutseeritud taimede mükofloora kujuneb aeglaselt, levides kohalikelt taimedelt sissetoodutele. Esmased parasiidid on kõik laia areaaliga liigid.

ПАРАЗИТНЫЕ МИКРОМИЦЕТЫ НА ДЕРЕВЬЯХ И КУСТАРНИКАХ, ИНТРОДУЦИРОВАННЫХ В ТАЛЛИННСКИЙ БОТАНИЧЕСКИЙ САД С ДАЛЬНЕГО ВОСТОКА

Тхэа НОРМЕТ, Харри КАРИС

До сих пор с Дальнего Востока в Таллиннский ботанический сад интродуцировано 173 вида древесных растений. Из них 26 видов заразились здесь 19 видами паразитных микромицетов из порядков *Erysiphales, Uredinales* и *Melanconiales*.

Микрофлора интродуцентов образуется медленно, паразиты распространяются преимущественно с местных растений на новые. Первыми на интродуцированных деревьях и кустарниках появляются виды с широким ареалом.