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Powdery mildews fungi of trees of Karaganda, Balkhash and Temirtau cities

Karaganda region is a major industrial center of our country. In such cities of the region as Karaganda, Temirtau and Balkhash there are large enterprises of ferrous metallurgy, construction, chemical JSC "ArcelorMittal Temirtau", JSC "Temirtau Electrometallurgical Combine", LLP "Ecominerals", JSC "CentralAsia Cement", "Agat-Service" LLP, JSC "Kazakhstan Invest Comir", LLP "Kazakhmys Corporation", LLP "MMC Kazpolymetal", Metal-Kit Karaganda, LLP "Mining and Metallurgical Combine", Non-ferrous metals processing plant, etc. All technogenic factors lead to a decrease in plant productivity and often to their death. The dynamics of seasonal development of phytopathogenic fungi depends on meteorological conditions. Changes in the dynamics of factors corresponding to the season of the year occur in the habitat of the species. Phytopathogenic fungi also directly depend on their own host-plants, the conditions of their development and the growing season. The article presents information about the types of powdery fungi affecting various types of trees growing in parks and squares of the cities of Karaganda, Balkhash, Temirtau. 4 species of trees affected by powdery mildew were analyzed. And during the study, the following types of phytopathogenic fungi were identified at various stages of development: *Uncinula aceris* Sacc., *Microsphaera betulae* Magnus, *Microsphaera penicillata* (Wallroth.) Leveille, *Uncinula salicis* Winter f. *populorum* Rabenhorst. Phytopathogenic fungi of trees growing in parks and squares of the industrial cities of Temirtau and Balkhash were studied for the first time.

Keywords: tree plantings, herbarium, phytopathogenic fungi, host-plant, powdery mildews fungi, seasonal dynamics, appendages, chasmothecia.

Introduction

Plants in the city parks and squares are often exposed to various diseases and need to be protected. This requires regular phytopathological studies. The main pathogens of tree diseases in the city are fungi that settle not only on living plants, but also on plant residues. More often, fungal diseases are focal in character, but sometimes they acquire the character of epiphytotics. Phytopathological researches are necessary to assess the infestation of plants with fungal diseases, to identify the lesions of the disease and the causes of their occurrence.

Studies of garden and park plantings in cities and countrysides of Kazakhstan were carried out in different years by various scientists. The study of the species composition and distribution of phytopathogenic fungi of plants in large cities of Central Kazakhstan was carried out by A.D. Spanbaev and S.A. Abiev. These scientists noted the significant harmfulness of a number of diseases caused by fungi for trees in the urban environment [1].

In the cities of the Karaganda region, trees are affected by various fungal diseases. Only some pathogens causing leaf diseases are attributed to the types of fungi that develop on hardwoods.

Powdery mildews are a class of fungi of the Ascomycetes order, in which about 500 of their species are known, they have specialized forms confined to certain plant species. These are obligate parasites of plants that cause the disease – powdery mildew. Their mycelium grows on the surface of leaves, stems, and fruits in the form of a white plaque. Later, fruit bodies of dark brown color appear on the plaque – chasmotecia. The source of infection is plant residues on which chasmotecia overwinter, as well as mycelium. The development of powdery mildew is promoted by hot and dry weather. The pathogen develops a superficial mycelium, on which is formed the conidial stage. During the growing season, new conidia are infected plants, which form several generations over the summer. They get on the leaves or other organs of susceptible plants, germinate and cause their infection. On the surface of infected organs develops a mycelium, and on it – conidiophores with conidia arranged in chains. At the end of the growing season, the marsupial stage of closed spherical fruit bodies (chasmotecia) with a diameter of up to 1.5 mm with appendages develops. After overwintering on fallen leaves, the spores in the ascocospores of chasmotecia ripen and provide primary in-

fection of plants. Overwintering with mycelium is possible when it penetrates into dormant buds. In the spring, the shell is ruptured and asci with ascospores are poured out, which infect plants [2].

Experimental

The objects of research are parks and squares of the cities of Karaganda, Temirtau and Balkhash. The collection of research materials from parks and squares was carried out in the summer and autumn periods of 2020–2022. The study was provided by the route method. When choosing a route, the occurrence of plants with signs of diseases in some areas, the presence of the most noticeable foci of diseases was taken into account. The material for the study was live leaves with raids, pustules, spots, with signs of drying and the presence of fungal structures, fruit bodies of macromycetes.

The collected samples were herbarized, and the determination was carried out using the method of light microscopy and standard determinants:

1. The key for determining the types of powdery fungi of Kazakhstan by families and genera of feeding plants (2013). It is based on the system of U. Braun (1987), where the characteristics of the fruit bodies of powdery fungi are decisive: the number of bags in the chasmotecia, the number of ascospores in the asci and the type of appendages of the chasmotecia [3, 4];

2. Reference-guide "Flora of spore plants of Kazakhstan", Volume 3 "Powdery mildews fungi". The determination of the species of powdery mildewsfungi in this key is based on the systematic position of the host-plant, the symptoms of the affected plants and microscopic signs of fungi pathogens [5];

3. Determinants of other authors G.B. Cummins, Y. Hiratsuka, H.L. Barnett, B.B. Hunter, T.L. Nikolaeva, A.A. Yachevsky, S.R. Shvartsman, D.N. Teterevnikova-Babayan were used to study phytopathogenic fungi.

The collection of samples of plants affected by powdery mildew was carried out during the growing season, starting in May, in various ecological situations of the city: in alley plantings, in squares and parks, in green spaces in courtyards. For microscopic identification of the species of powdery mildew fungi, herbarium samples of leaves of various plants with sporulation were collected (during the growing season – depending on the formation of chasmotecia).

The determination of phytopathogenic fungi by fruit bodies, appendages, asci and spores was carried out according to the method of I.I. Zhuravlev (1979). The method consists in examining the sporulation of pathogens or affected plant tissues under a microscope [6].

The degree of lesion of woody plants by phytopathogenic fungi was determined by a 6-point scale of Yu.V. Sinadskii:

1 – there is no disease lesion;
2 – single spots, up to 5 % of the plant surface is affected;
3 – up to 25 % of the plant surface is affected;
4 – up to 50 % is affected, the fructification of the fungus is clearly visible;
5 – more than 50 % of the plant surface is affected;
6 – more than 70 % of the plant's surface is affected, the leaves are crumbling [7].

Results and discussion

In the cities of the Karaganda region, trees are affected by various fungal diseases: *Uncinula aceris* Sacc., *Microsphaera betulae* Magnus, *Microsphaera penicillata* (Wallroth.) Leveille, *Uncinula salicis* Winter *f. Populorum* Rabenhorst.

1. ***Species:*** *Uncinula aceris* Sacc. ***Host-plant:*** found on the leaves of *Acer negundo* L. ***Located in Kazakhstan:*** Karaganda c., the square on Nazarbayev Avenue, GPS-coordinates: N 49.81364; E 73.08816; Ethnopark named after 10th anniversary of Independence of Kazakhstan, GPS-coordinates: N 49.776648; E 73.125413. ***Date of location:*** 10.07.–13.07.2021.

Mycelium on the surfaces of leaves, cobwebbed. Chasmotecia are scattered or crowded, spherical, 139–145 μm in diameter. The cells of the chasmotecia shell are unclear, about 10 μm in diameter, multifaceted. Appendages are multiple, located along the equator or in the upper part of the chasmotecia, short, colorless, smooth, with a thick shell, fork-branched once or twice at the apex, with curved ends in the form of a hook or spirally. Asci with a number of 6–10 in chasmotecia, spherical, on a short leg, with a thickened shell, 65.2–83.7×46.5–65 μm. Spores number 6–8, ellipsoidal or improperly ovoid, 21.5–24.8×9–12 μm (Fig. 1).

A B

A — leaves of *Acernegundo* L., affected by pathogenic fungi;
B — *Uncinula aceris* Sacc. under the microscope — 20× (asci, ascospores, appendages, chasmotecia)

Figure 1. *Uncinula aceris* Sacc

2. ***Species:*** *Microsphaera betulae* Magnus. ***Host-plant:*** found on the leaves of *Betula pendula* Roth. ***Located in Kazakhstan:*** Karaganda c., Central park, GPS-coordinates: N 49.801128; E 73.077488; E.A. Buketov Square, GPS-coordinates: N 49.770708; E 73.124901; Temirtau c., City Park of culture and recreation "Vostok", Square on the Avenue of Stroiteley, GPS-coordinates: N 50.057263; E 72.996888. ***Date of location:*** 20.09.–25.09.2020.

Mycelium and conidial sporulation on both sides of the leaf in the form of a cobwebby plaque, usually in the form of spots mainly on the upper side of the leaf. Chasmotecia in groups or scattered on both surfaces of leaves, several, 80–95 μm in diameter.Appendages 6–15, located radially and raised upwards, colorless, 80.5–94.5 μm long, 3–4-fold fork-branched, with short, barely bent terminal branches. Asci are 4–5, ellipsoidal or wide-ellipsoidal, 47–60×33.7–50.2 μm, without a leg. The number of ascospores is 7–8, ellipsoidal, 19–21.5×12,9–16,2 μm (Fig. 2).

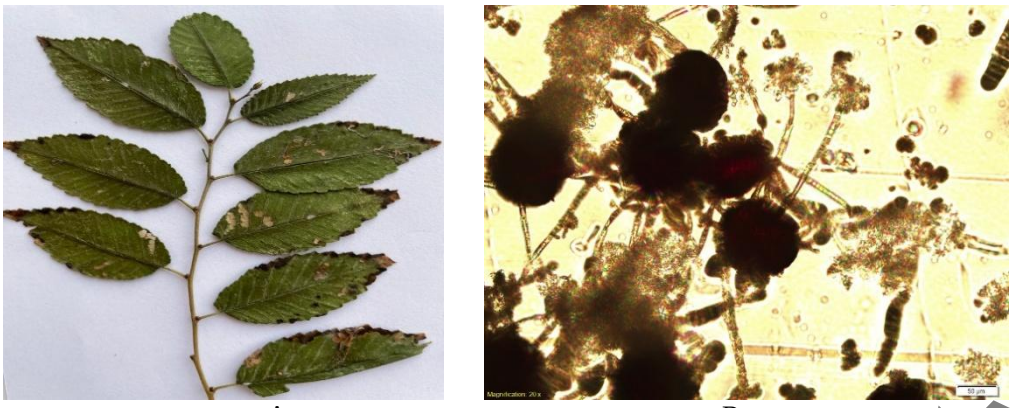
A B

A — leaves of *Betula pendula* Roth., affected by pathogenic fungi;
B — *Microsphaera betulae* Magnusunder the microscope — 40× (asci, appendages, chasmotecia)

Figure 2. *Microsphaera betulae* Magnus

3. ***Species:*** *Microsphaera penicillata* (Wallroth.) Leveille. ***Host-plant:*** found on the leaves of *Ulmus pumila* L. ***Located in Kazakhstan:*** Balkhash c., Central square, Youth park, Park at the Eternal Flame Memorial. GPS-coordinates: N 46.839326; E 74.983356. ***Date of location:*** 21.09.–26.09.2021.

Surgical dark spots can be seen on both surfaces of the leaf. Chasmotecia are scattered on the sides, the size is 80 μm. The number of appendages is 4. The number of spores is 4–8; size is 19.2–20.2×12.8–16 μm (Fig. 3).



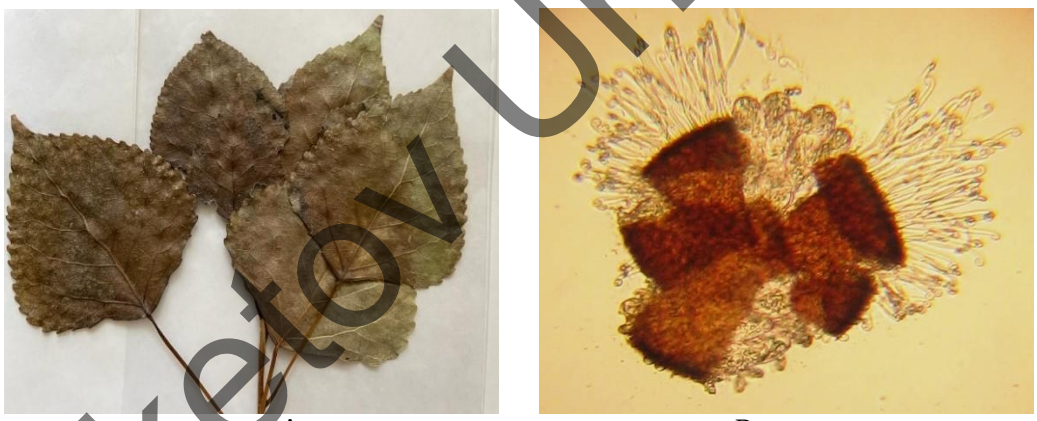
A B

A — leaves of *Ulmus pumila* L., affected by pathogenic fungi; *B* — *Microsphaera penicillata* (Wallroth.) Leveille. under the microscope — 20× (asci, ascospores, appendages, chasmotecia)

Figure 3. *Microsphaera penicillata* (Wallroth.) Leveille

4. ***Species:*** *Uncinula salicis* Winter *f. populorum* Rabenhorst. ***Host-plant:*** found on the leaves of *Populus nigra* L. ***Located in Kazakhstan:*** Temirtau c., Park of Labor Glory, GPS-coordinates: N 50.056381; E 73.009632; Karaganda c., Park Pobedy, GPS-coordinates: N 49.784412; E 73.136772; Square on the Avenue of Stroiteley, GPS-coordinates: N 49.776274; E 73.13603.

There are cobwebbed and black dot spots on the surface of the leaf. Chasmotecia are scattered everywhere, measuring 100–110 μm. Appendages are various, long, with a hook-shaped bend, measuring 140–38.5 μm. Number of spores is 4–5, size is 13–15; 2×7–13 μm (Fig. 4).



A B

A — leaves of *Populus nigra* L., affected by pathogenic fungi; *B* — *Uncinula salicis* Winter *f. populorum* Rabenhorst. under the microscope — 20× (asci, appendages, chasmotecia)

Figure 4. *Uncinula salicis* Winter *f. populorum* Rabenhorst

Researches conducted in the cities of Karaganda, Temirtau, Balkhash in 2020–2022 showed that the development of pathogens of phytopathogenic fungi directly depends on such factors: temperature, humidity, amount of precipitation.

Seasonal dynamics of powdery mildew fungi development in the cities is observed in June-July with the beginning of the conidial period and the maturation of chasmotecia in August-September. At Karaganda in August-September 2020, the average air temperature is +19 °C, and in 2021 is +18 °C. In Temirtau in August-September 2020, the average air temperature is +20 °C, and in 2021 is +19 °C. And at Balkhash in August-September 2020, the average air temperature is +22 °C, and in 2021 is +21 °C. During this period, it forms fruit bodies of various shapes adapted to wintering, overwintering in plant residues, bursting in spring, and spores from them come out. In three cities, in 2020–2022, an average high air temperature was observed, in 2020 and 2021, low humidity (on average – 56 %), and in 2021 and 2022 – this had a positive effect on

spore germination, on the reproduction of powdery mildew, created ideal conditions for the development of powdery mildew fungi (Fig. 5).

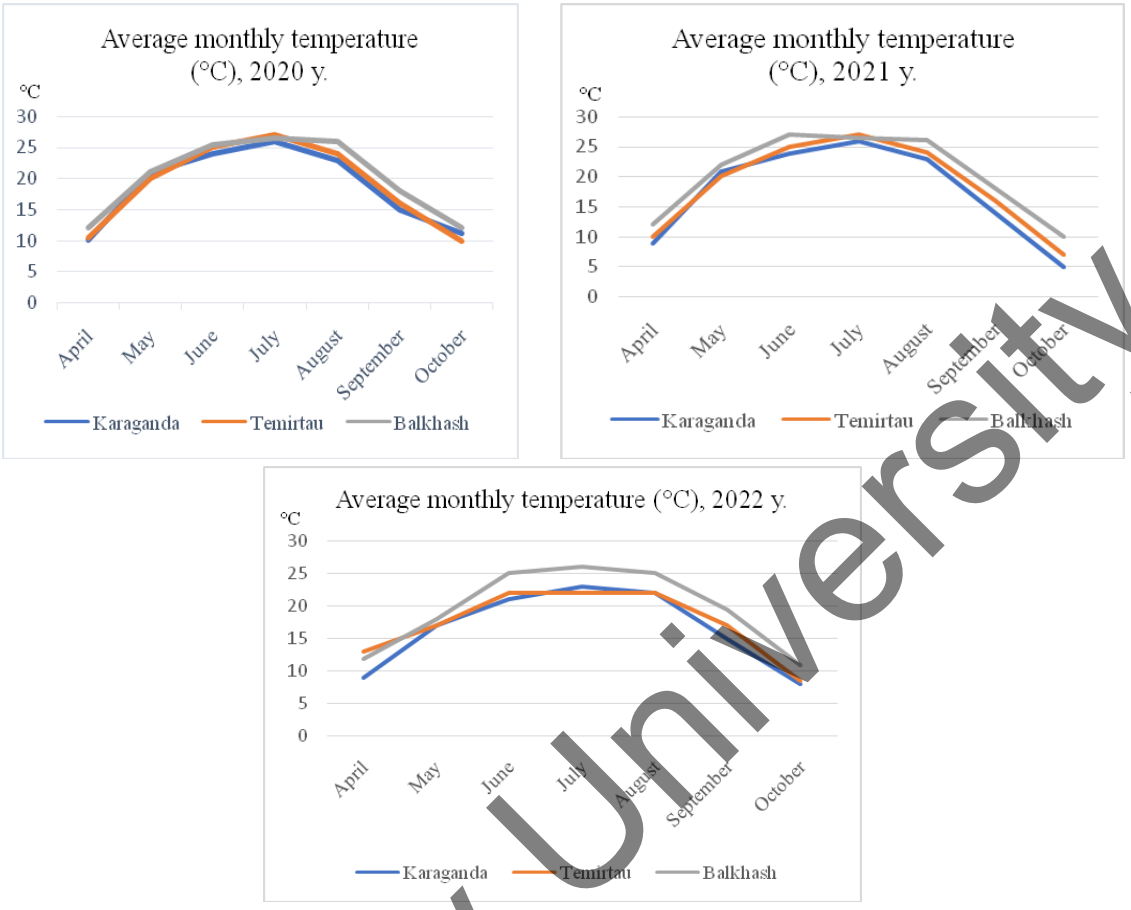


Figure 5. Seasonal dynamics of the development of powdery mildew fungi depending on the air temperature

For the research, data on atmospheric air temperature, humidity and precipitation were taken from the Karaganda Hydrometeorology Center from autumn 2020 to autumn 2022.

Conclusions

As a result of the studies of trees, 1 genus of Erysiphe and 4 species of powdery mildew fungi were discovered and studied: *Uncinula aceris* Sacc. at *Acer negundo* L., *Microsphaera betulae* Magnus at *Betula pendula* Roth., *Microsphaera penicillata* (Wallroth.) Leveille at *Ulmus pumila* L., *Uncinula salicis* Winter *f. populorum* Rabenhorst at *Populus nigra* L.

When analyzing the dynamics of seasonal development of phytopathogenic fungi identified in the trees vegetation of the cities of Karaganda, Temirtau, Balkhash, we came to the following conclusions:

Seasonal dynamics of powdery mildew fungi development in the studied cities is observed in June-July with the beginning of the conidium period and the maturation of chasmotecia in August, September. Fruit bodies of various shapes, adapted to wintering, overwinter on the remnants of growth. In spring, the fruit bodies burst, and the spores on them come out. The most favorable conditions for spore germination and reproduction were created by the high air temperature in June-July 2020–2022 and high humidity.

The study found that the dynamics of the development of powdery mildew fungi is similar in three cities. They damage many trees of the city. As a consequence of the disease, the growth and development of the damaged plant slows down, their decorative properties deteriorate.

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Қарағанды, Балқаш, Теміртау қалаларының ағаштарының ақұнтақ саңырауқұлақтары

Қарағанды облысы еліміздің ірі өнеркәсіптік орталығы. Қарағанды, Теміртау және Балқаш сияқты облыстың ірі қалаларында қара металлургияның ірі кәсіпорындары, құрылыс, химия өнеркәсібі, атап айтсақ: «АрселорМиттал Теміртау» АҚ, «Теміртау электрометаллургиялық зауыты» АҚ, «Экоминералс» ЖШС, «Централазия Цемент» АҚ, «Agat-Service» ЖШС, «Қазақстан Инвест Көмір» АҚ, «Қазақмыс корпорациясы» ЖШС, ТМК «Қазполиметалл» ЖШС, «Металл-Комплект Қарағанды», «Тау-кен металлургия комбинаты» ЖШС, Түсті металдарды өңдеу зауыты және т.б. орналасқан. Барлық техногендік факторлар өсімдіктердің өнімділігінің төмендеуіне және көбінесе олардың бүлінуіне әкеледі. Фитопатогенді саңырауқұлақтардың маусымдық даму динамикасы метеорологиялық жағдайларға байланысты. Түрдің тіршілік ету ортасында жыл мезгіліне сәйкес факторлардың динамикасында өзгерістер болады. Фитопатогенді саңырауқұлақтар сонымен қатар өздерінің иелік-өсімдіктеріне, олардың даму жағдайларына және вегетациялық кезеңіне тікелей байланысты. Мақалада Қарағанды, Балқаш, Теміртау қалаларының саябақтары мен сквелерінде өсетін әртүрлі ағаш түрлеріне әсер ететін ақұнтақ саңырауқұлақтары түрлері туралы ақпарат берілген. Ақұнтақтан зардап шеккен ағаштардың 4 түрі зерттелді. Зерттеу барысында дамудың әртүрлі кезеңдерінде фитопатогенді саңырауқұлақтардың келесі түрлері анықталды: *Uncinula aceris* Sacc., *Microsphaera betulae* Magnus, *Microsphaera penicillata* (Wallroth.) Leveille, *Uncinula salicis* Winter *f. populorum* Rabenhorst. Алғаш рет Теміртау және Балқаш қалаларының саябақтары мен сквелерінде өсетін ағаштардың фитопатогенді саңырауқұлақтары зерттелді.

Кілт сөздер: ағаш көшеттері, гербарий, фитопатогенді саңырауқұлақтар, иелік-өсімдік, ақұнтақ саңырауқұлақтары, маусымдық динамика, өсінділер, клейстотеций.

А.Ж. Бейсембай, А.К. Оспанова, А. Кали

Мучнисто-росяные грибы деревьев городов Караганды, Балхаша, Темиртау

Карагандинская область является крупным промышленным центром нашей страны. В таких городах области, как Караганда, Темиртау и Балхаш расположены крупные предприятия черной металлургии, строительные, химические: АО «АрселорМиттал Темиртау», АО «Темиртауский электрометаллургический комбинат», ТОО «Экоминералс», АО «ЦентралАзия Цемент», ТОО «Agat-Service», АО «Казахстан Инвест Көмір», ТОО «Корпорация Казахмыс», ТОО «ГМК Казполиметалл», Металл-

Комплект Караганда, ТОО «Горно-металлургический комбинат», Завод обработки цветных металлов и др. Все техногенные факторы приводят к снижению продуктивности растений и зачастую к их гибели. Динамика сезонного развития фитопатогенных грибов зависит от метеорологических условий. В месте обитания вида происходят изменения динамики факторов, соответствующих сезону года. Фитопатогенные грибы также напрямую зависят от собственных растений-хозяинов, условий их развития и срока вегетации. В статье представлена информация о видах мучнисто-росяных грибов, поражающих различные виды деревьев, произрастающих в парках и скверах городов Караганды, Балхаша и Темиртау. Было исследовано 4 вида деревьев, пораженных мучнистой росой. И в ходе исследования были выявлены следующие виды фитопатогенных грибов на различных стадиях развития: *Uncinula aceris* Sacc., *Microsphaera betulae* Magnus, *Microsphaera penicillata* (Wallroth.) Leveille, *Uncinula salicis* Winter *f. populorum* Rabenhorst. Впервые исследованы фитопатогенные грибы деревьев, произрастающих в парках и скверах промышленных городов Темиртау и Балхаша.

Ключевые слова: древесные насаждения, гербарий, фитопатогенные грибы, растение-хозяин, мучнисто-росяные грибы, сезонная динамика, придатки, клейстотеции.

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