



## Distribution of species of the genus *Gymnosporangium* (*Pucciniales*) in Uzbekistan

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**Abstract.** In this study, we analyzed distribution of species of the genus *Gymnosporangium* in the mountain regions of Uzbekistan, including the Western Tien Shan and Pamir-Alay. Four species of *Gymnosporangium* (*G. confusum*, *G. sabinae*, *G. fusisporum*, and *G. turkestanicum*) are reported for Uzbekistan. The telial hosts of these rust fungi are species of the genus *Juniperus*, while aecial hosts in Uzbekistan are representatives of the genera *Cotoneaster*, *Crataegus*, *Sorbus*, and *Pyrus* (all *Rosaceae*). It has been found that the distribution patterns of species of *Gymnosporangium* within mountain areas of Uzbekistan depend largely on distribution of juniper woodlands because representatives of the genus *Juniperus* as telial hosts play a major role in the life cycle of these fungi. In that regard, *Gymnosporangium* species have not yet been recorded in the Nuratau Nature Reserve despite other favorable conditions for these rust fungi in this territory.

**Keywords:** aecia, *Juniperus*, life cycle, *Pucciniales*, host plant, rust fungi, telia

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### Introduction

The rust fungi (*Pucciniales*) is a cosmopolitan and taxonomically challenging group of plant pathogenic fungi comprising approximately 8000 species worldwide (Aime, 2006). Usually, rust fungi are heteroecious and require two independent specific host plants to complete their life cycle (Toome, 2010). As biotrophs, rust fungi completely depend on the nutrients provided by the host plant. Simultaneously, they secrete effector proteins into host tissues through haustoria during infection (Dodds et al., 2009). The rust fungi are one of the most important pathogens of various crops (Dodge, 1915; Helfer, 2005). More than half (54%) of *Rosaceae* species are highly susceptible to rust fungi, including fruit trees and ornamentals (Helfer, 2005).

Species of the genus *Gymnosporangium* R.Hedw. ex DC. are widespread in temperate zone of the Northern Hemisphere (Fernández, 2016). They are obligate parasites of vascular plants, with a complex life cycle that includes several stages with different spore types (Guyot, Malençon, 1957). *Gymnosporangium* is a unique genus in rust fungi; telial stages of its species occur only on gymnosperms of the family *Cupressaceae*, particularly junipers (*Juniperus* L.), while aecial stages may develop on hawthorn, apple trees and other representatives of the family *Rosaceae*, mainly subfamily *Amygdaloideae* (Aime, 2006). The most common worldwide diseases caused by *Gymnosporangium* species are cedar-apple rust, Japanese pear rust, and European pear rust (Cummins, Hiratsuka, 2003; Kellerhals et al., 2012).

The first study of rust fungi in Uzbekistan has been conducted by Zaprometov (1928). During the second half of the 20<sup>th</sup> century, 261 species of rust fungi were reported on 511 species of host plants belonging to 43 families of the flora of Uzbekistan (Ramazonova et al., 1986). Of them, 54 species were found to have a full life cycle while the rest have a short life cycle.

After publication of the *Flora of the Fungi of Uzbekistan* (Ramazonova et al., 1986), new data on the species diversity, biology, ecology, and biogeography of rust fungi in Uzbekistan have been published (Gafforov et al., 2016; Mustafaev, Iminova, 2018; Mustafaev et al., 2018, 2019; Liu et al., 2019). However, knowledge on the distribution of *Gymnosporangium* species in the mountain regions of Uzbekistan still remains insufficient. This study is devoted to analysis of all available data about host plants and geographical distribution of *Gymnosporangium* species in Uzbekistan.

## Materials and Methods

### Sampling and morphological study

This study is based on the results of field mycological research conducted in different mountain regions of Uzbekistan, as well as the revision of herbarium specimens at the Mycological Herbarium (TASM) of the Institute of Botany, Academy of Sciences of the Republic of Uzbekistan. Field surveys were performed in Ugam-Chatkal National Park in the Uzbek part of the Western Tien Shan in 2014–2016, in Zaamin National Park on the northern slope of the Turkestan Range in 2018–2019, in the Boysun Mountains in 2015–2017, and in the Nuratau Nature Reserve on the northern slope of the Nuratau Range in 2010–2018 (Fig. 4). Pictures were taken in the field with a Canon EOS 750D digital camera. Herbarium specimens of vascular plants affected by rust fungi were collected using standard technique; the coordinates of collection sites were recorded using a GPS navigation device. Dried specimens were examined with a light microscope, and photomicrographs were taken with the Moticam N-300M. The species of the rust fungi were identified using the relevant literature (Kuprevich, Ulyanishchev, 1975; Rakhimova et al., 2015); host plants were identified using *Conspectus Florae Asiae Mediae* (Russian title "Определитель растений Средней Азии. Критический конспект флоры", 10 volumes, 1968–1993) and the *Flora of Uzbekistan* (Russian title "Флора Узбекистана", alternative Latin title "Flora Uzbekistanica", 6 volumes, 1941–1962).

The nomenclature of fungi follows the *Index Fungorum* database (<http://www.indexfungorum.org/>); accepted names of the host plants are given mainly according to the *World Flora Online* taxonomic database (<http://www.worldfloraonline.org/>).

Names of collectors are designated by the following abbreviations: RT – Rotkevich, SR – Saviya Ramazonova, P – Panfilova, ShK – Shuhrat Kamilov, YS – Yoqut Soliyeva, KhN – Khamro Nuraliyev, YG – Yusuf Gafforov, MI – Malika Iminova, IM – Ilyor Mustafaev, ZI – Zoir Islomiddinov, IO – Islom Ortiqov. All collected specimens are deposited at the Mycological Herbarium (TASM) in Tashkent.

### GIS-based mapping

A distribution map of *Gymnosporangium* species was compiled using ArcGIS 10 Desktop software. The Google Earth software was used for georeferencing of collection sites of herbarium specimens from TASM. The Geographic Coordinate System 1984 (WGS 84) has been used as a reference datum. The information on each studied specimen (including the species of *Gymnosporangium*, collection date, locality, latitude and longitude, elevation, and host plants) was entered into the Microsoft Excel table, imported into ArcGIS 10, and transformed to a point map layer.

## Results

As a result of this study, four species of *Gymnosporangium* have been recorded from different regions of Uzbekistan. Information about their distribution in Uzbekistan and about their host plants is presented below.

### *Gymnosporangium confusum* Plowr.

Spermogonia epiphyllous, punctate and aggregated, 160–190 µm in diameter, pale yellow to black. Aecia mainly hypophyllous, roestelioid, 1–3 mm long, peridium losing tubular form, soon becoming lacerate nearly to base, peridial cells rhomboid, 48–101 × 10–24 µm, inner wall and side wall moderately rugose, outer wall smooth. Aeciospores globoid, yellowish brown or cinnamon brown, 16–24 × 13–22 µm, wall 0.5–2.0 µm, large coronate, with more than 5 germ pores, scattered.

### Distribution and specimens examined

On *Juniperus excelsa* M.Bieb.: Tashkent Region, Parkent District, Chotqol Nature Reserve, 15 August 1953, RT (41°10'41.93" N 69°44'42.46" E).

On *Crataegus turkestanica* Pojark.: Surkhandarya Region, Sherabad District, Kuxitang mountain, 09 July



Fig. 1. *Gymnosporangium confusum* on *Crataegus turkestanica*. A: damaged fruits. B: damaged leaves

1985, YS (38°16'47.64" N 67°8'32.40" E); Tashkent Region, Tashkent Botanical Garden, 08 May 1985, ShK (41°20'43.49" N 69°19'2.79" E); Namangan Region, Yangikurgan District, Koksaroy, 29 April 2001, YG (41°2'38.20" N 71°39'24.62" E); Bostanliq District, Ugam-Chatkal National Park, 08 June 2015, IM (41°50'58.66" N 70°18'33.43" E); Surkhandarya Region, Boysun District, Machay, 10 August 2015, IM (38°15'26.47" N 67°11'16.80" E); Boysun District, South-East Hissar mountains, 13 May 2016, IM (38°20'18.25" N 67°21'26.60" E); Jizzakh Region, Zaamin National Park, Teraklisoy, 31 July 2018, ZI (39°38'53.86" N 68°30'45.84" E); Oriklisoy, 28 May 2018, IM, MI (39°41'49.11" N 68°27'45.43" E); Usmonlisoy, 30 May 2019, ZI, IO (39°42'32.61" N 68°31'38.79" E) (Fig. 1, A, B).

On *Crataegus songarica* K.Koch: Tashkent Botanical Garden, 05 May 1985, ShK (41°20'32.42" N 69°18'55.84" E).

On *Crataegus pontica* K.Koch: Tashkent Botanical Garden, 17 June 1983, ShK (41°20'46.25" N 69°18'55.71" E); Bostanliq District, Ugam-Chatkal National Park, 26 June 2015, IM (41°53'22.66" N 70°21'45.72" E); Bostanliq District, Nanai village, 10 June 2015, IM (41°42'36.25" N 70°7'11.52" E); Jizzakh Region, Zaamin National Park, Yettikechuv village, 13 July 2019, ZI (39°41'17.63" N 68°24'58.12" E); Oriklisoy,

28 May 2019, ZI (39°41'26.11" N 68°28'41.99" E); Takasoy, 30 August 2018, IM, MI (39°38'10.44" N 68°32'7.78" E).

On *Cotoneaster multiflorus* Bunge: Jizzakh Region, Zaamin National Park, near Waterfall, 30 July 2018, IM, MI (39°37'36.86" N 68°29'25.90" E).

#### *Gymnosporangium fusisporum* Ed.Fisch.

Spermogonia epiphyllous, aggregated in groups, pale yellow to black. Aecia hypophyllous or fructicolous, roestelioid, 2–6 mm long, peridium cylindrical, soon rupturing at apex and becoming lacinate to base, peridial cells rhomboidal, 42–129 × 11–27 μm, inner wall small papillate, side wall moderately rugose, outer wall smooth. Aeciospores globoid, yellowish brown, 21–31 × 17–25 μm, 1–3 μm thick, minutely coronate, more than 5 germ pores, scattered. Telia caulicolous or foliicolous, conic or irregularly pulvinate, blackish brown, causing fusiform swellings. Teliospores 2-celled, fusiform, narrowed above and below, slightly or not constricted at septum, surface smooth, yellowish brown, 47–109 × 15–22 μm, wall 0.5–2 μm thick, with 1 pore (rarely 2) near septum, pedicel colorless, very long.

Field studies showed that galls appear on the branches of junipers infected by the *Gymnosporangium* fungi; after a certain period, the infected branches completely dry out (Fig. 2, A, B).

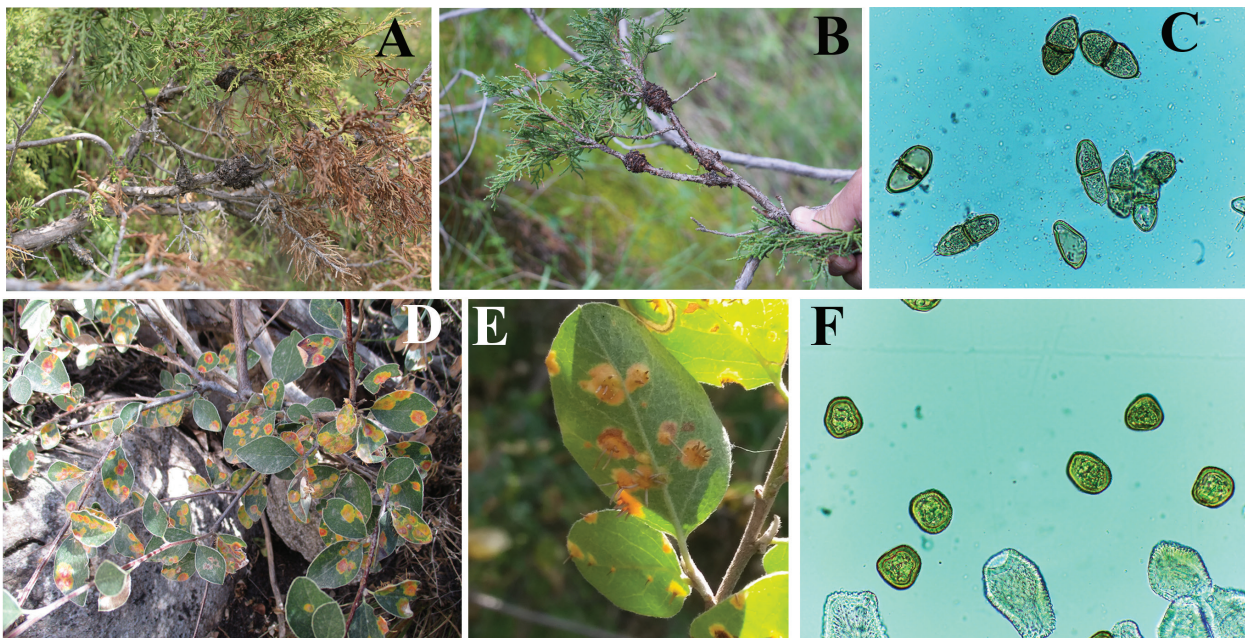


Fig. 2. A, B: infected branches of *Juniperus seravschanica*. C: teliospores of *Gymnosporangium fusisporum*. D, E: infected branches of *Cotoneaster* sp. F: aeciospores of *Gymnosporangium fusisporum*

### Distribution and specimens examined

On *Cotoneaster racemiflorus* (Desf.) K.Koch: Jizzakh Region, Zaamin Nature Reserve, Kolsoy, 27 June 1956, RT (39°36'20.93" N 68°22'2.76" E).

On *Crataegus turkestanica* Pojark.: Surkhandarya Region, Sariosiyo District, Machitli mountain, Shargunsoy, 16 July 1987, YS (38°33'18.28" N 67°59'4.86" E); Tashkent Region, Bostanliq District, Ugam-Chatkal National Park, 15 June 2015, IM (41°51'17.08" N 70°19'9.70" E).

On *Cotoneaster oliganthus* Pojark. (closely related to or probably conspecific with *C. nummularius* Fisch. & C.A.Mey.): Namangan Region, Pop District, Nanay, 30 June 2001, YG (41°29'58.48" N 71°41'58.51" E).

On *Cotoneaster nummularius* Fisch. & C.A.Mey.: Kashkadarya Region, Kitob Nature Reserve, 10 June 1995, XN (39°12'51.63" N 67°22'0.49" E); Surkhandarya Region, Boysun District, Machay, 10 May 2015, IM (38°23'45.96" N 67°8'39.62" E); Kizilnour village, 13 June 2016, IM (38°16'48.65" N 67°17'48.70" E); Tashkent Region, Bostanliq District, Ugam-Chatkal National Park, 01 August 2015, IM (41°52'47.65" N 70°20'57.70" E).

On *Cotoneaster* sp.: Jizzakh Region, Zaamin Nature Reserve, Dashti-Qazi, 05 June 1956, P, SR (39°36'8.53" N 68°20'32.42" E); Chandirsoy, 01 August 2019, MI, IM

(39°35'20.10" N 68°24'3.38" E); Zaamin National Nature Park, near Waterfall, 29 July 2018, MI, IM; ibid., 13 July 2019, ZI (39°37'53.95" N 68°29'25.22" E).

On *Juniperus semiglobosa* Regel: Jizzakh Region, Zaamin Nature Reserve, 17 July 1956, RT (39°35'8.67" N 68°20'55.78" E); Kolsoy, 31 July 2019, IM, ZI (39°36'32.88" N 68°22'17.02" E); Zaamin National Park, near Waterfall, 31 May 2019, MI, IM (39°37'47.15" N 68°29'22.92" E).

On *Juniperus seravschanica* Kom.: Jizzakh Region, Zaamin National Park, Usmonlisoy, 30 May 2019 (39°42'47.32" N 68°31'2.98" E); ibid., near Waterfall, 12 July 2019, MI, IM (39°37'58.44" N 68°29'23.51" E).

### *Gymnosporangium sabinae* (Dicks.) G.Winter (Fig. 3)

Aeciospores 25–29 (–33) × 21–23 μm, subglobose, ellipsoid or somewhat irregular, with 6–8 germ pores. Teliospores 42–52 (–60) × 16–23 μm, ellipsoid, rounded at both ends or somewhat attenuate, slightly constricted at the septum, with walls 1 μm thick, hyaline or tinted. Some spores obovoid with brown walls, up to 3 μm thick near the septum. Walls smooth, with two germ pores in each cell near the septum. Pedicels long, thin-walled and hyaline.

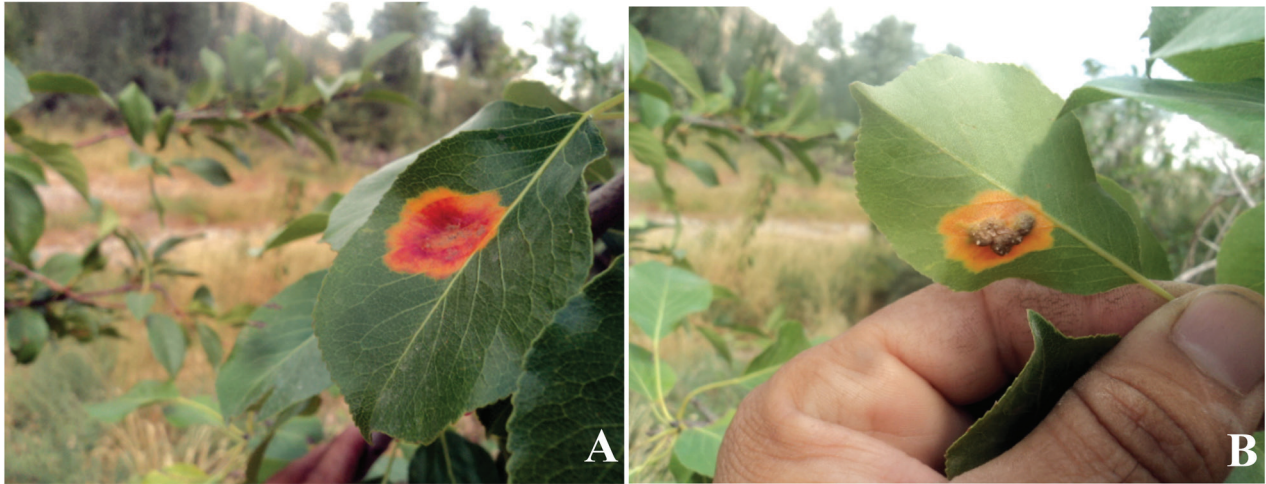


Fig. 3. *Gymnosporangium sabiniae* on *Pyrus communis*. A: adaxial leaf surface. B: abaxial leaf surface

#### Distribution and specimens examined

On *Pyrus korshinskyi* Litv.: Kashkadarya Region, Kitob Nature Reserve, 10 June 1996, XN (39°12'38.25" N 67°19'49.95" E); Surkhandarya Region, Boysun District, South-East Hissar mountains, 13 May 2016 (38°35'36.24" N 67°43'49.95" E); Machay village, 24 August 2016, IM (38°28'29.10" N 67°13'15.95" E).

On *Pyrus communis* L.: Surkhandarya Region, Boysun District, Machay village, 26 August 2016, IM (38°19'27.27" N 67°3'56.96" E).

#### *Gymnosporangium turkestanicum* Tranzschel

Spermogonia epiphyllous, aggregated in groups, pale yellow to black. Aecia hypophyllous, rarely caulicolous and fructicolous, roestelioid, 1–3 mm long, peridium becoming rupturing or lacerate to base, peridial cells

rhomboid, 50–100 × 15–30 μm, inner wall small papillate, side wall densely verrucose, outer wall smooth. Aeciospores globoid, yellowish brown, 25–36 × 19–34 μm, wall 1–3.5 μm, small coronate, with more than 5 pores, scattered.

#### Distribution and specimens examined

On *Sorbus tianschanica* Rupr.: Jizzakh Region, Zaamin National Park, near Waterfall, 12 July 2019, IM (39°37'40.37" N 68°29'28.62" E).

On *Sorbus persica* Hedl. (= *Hedlundia persica* (Hedl.) Mezhenkyj): Jizzakh Region, Zaamin Nature Reserve, Kolsoy, 31 July 2019 MI, IM (39°36'23.99" N 68°22'8.32" E).

Table 1. Telial and aecial host plants of *Gymnosporangium* species

Species	Telial hosts	Aecial hosts
<i>Gymnosporangium confusum</i>	<i>Juniperus excelsa</i>	<i>Cotoneaster multiflorus</i> <i>Crataegus pontica</i> <i>Crataegus songarica</i> <i>Crataegus turkestanica</i>
<i>Gymnosporangium fuscum</i>	<i>Juniperus seravschanica</i>	<i>Pyrus communis</i> <i>Pyrus korshinskyi</i>
<i>Gymnosporangium fusisporum</i>	<i>Juniperus semiglobosa</i> <i>Juniperus seravschanica</i>	<i>Cotoneaster nummularius</i> <i>Cotoneaster oliganthus</i> <i>Cotoneaster racemiflorus</i> <i>Cotoneaster</i> sp. <i>Crataegus turkestanica</i>
<i>Gymnosporangium turkestanicum</i>	<i>Juniperus seravschanica</i>	<i>Sorbus persica</i> <i>Sorbus tianschanica</i>

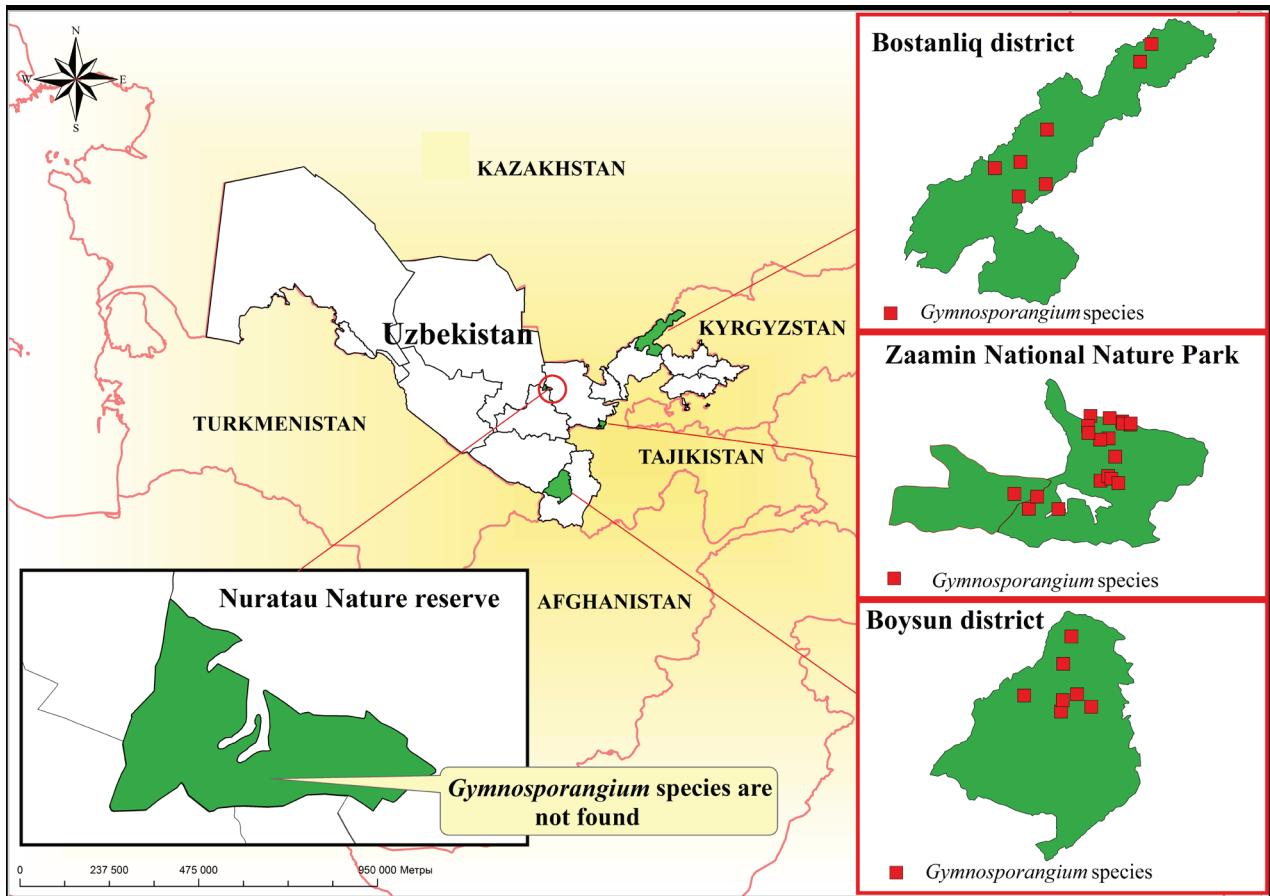


Fig. 4. Distribution of *Gymnosporangium* species within the studied areas in Uzbekistan

On *Juniperus seravschanica* Kom.: Jizzakh Region, Zaamin National Park, Usmonlisoy, 30 May 2019, MI, IM (39°43'25.16" N 68°28'29.00" E).

In total, *Gymnosporangium* species in Uzbekistan infect 19 species of host vascular plants belonging to six genera and three families; representatives of the genus *Juniperus* as telial hosts play the main role in the life cycle of these fungi (Table 1).

It has been found that the distribution of species of *Gymnosporangium* within mountain areas of Uzbekistan depends largely on the distribution of juniper woodlands.

While the aecial hosts, species of *Crataegus* and *Cotoneaster*, are common in all studied areas, the telial hosts, *Juniperus* species, are dominant in mountain forests in Ugam-Chatkal and Zaamin National Parks as well as in the Boysun Mountains, but extremely rare in the Nuratau Range. Respectively, *Gymnosporangium* species are widespread in all studied areas with the exception of the Nuratau Range, where representatives of this genus have not been found despite the long-term surveys (Table 2, Fig. 4).

Table 2. Distribution of *Gymnosporangium* species and their hosts in the studied areas

Territories	Aecial hosts	Telial hosts	<i>Gymnosporangium</i> species
Zaamin National Park (Turkestan Range, northern Pamir-Alay)	<i>Crataegus</i> spp., <i>Cotoneaster</i> spp. – widespread, often dominant or subdominant species; <i>Pyrus</i> spp., <i>Sorbus</i> spp. – rather rare, occur sporadically	<i>Juniperus seravschanica</i> , <i>J. semiglobosa</i> – widespread dominant or subdominant species	Widespread
Boysun Mountains (south-western Pamir-Alay)			Widespread
Bostanliq District (Western)			Widespread
Nuratau Nature Reserve (Nuratau Range, north-western Pamir-Alay)		<i>Juniperus seravschanica</i> – extremely rare	Not found

## Discussion

The Nuratau Nature Reserve, total area of 17552 hectares, is located 200 km to the west of Zaamin National Park where *Gymnosporangium* is one of the most widespread genera of rust fungi. The climate of the Nuratau Nature Reserve is rather arid in comparison with that of Zaamin National Park. Although the aecial hosts of *Gymnosporangium*, representatives of the genera *Cotoneaster* and *Crataegus*, are common and widespread within the reserve, *Juniperus* is extremely rare there (Tojibaev et al., 2017). In our opinion, no records of *Gymnosporangium* in the Nuratau Nature Reserve area can be explained by the lack or rarity of its telial host. This fact indicates that species of *Juniperus* play the main role in the life cycle of species of *Gymnosporangium*. Aeciospores of *Gymnosporangium* species spread over long distances by the wind (Cummins, Hiratsuka, 2003). At the same time, it has been found that these aeciospores infect only junipers (Cummins, Hiratsuka, 2003; Deacon, 2006, Kellerhals et al., 2012). Our studies conducted in the Boysun District, as well as the research performed in Europe (Lāce, 2017), showed that the greatest damage of pear trees was observed in the plantations located close to juniper forests. Thus, *Gymnosporangium sabinae* can be considered as the main pest of pear trees not only in European countries (Gjaerum et al., 2008), but in Uzbekistan as well. Since junipers as host plants are important for the development of *Gymnosporangium* species, it is necessary to pay attention to occurrence of rust fungi on junipers in order to control rust infection of *Cotoneaster*, *Crataegus*, *Pyrus* (sensu stricto), and *Sorbus* (sensu lato).

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## References

- Aime M.C. 2006. Toward resolving family-level relationships in rust fungi (*Uredinales*). *Mycoscience*, 47(3): 112–122. <https://doi.org/10.1007/s10267-006-0281-0>
- Cummins G.B., Hiratsuka Y. 2003. *Illustrated Genera of Rust Fungi*. St. Paul, MN: American Phytopathological Society, 240 pp.
- Deacon J.W. 2006. *Fungal Biology*. 4<sup>th</sup> ed. Malden, MA: Wiley-Blackwell Publishing, 371 pp.
- Dodge B.O. 1915. The effect of the host on the morphology of certain species of *Gymnosporangium*. *Bulletin of the Torrey Botanical Club*, 42: 519–544. <https://www.jstor.org/stable/pdf/2479727.pdf>
- Dodds P.N., Rafiqi M., Gan P.H.P., Hardham A.R., Jones D.A., Ellis J.G. 2009. Effectors of biotrophic fungi and oomycetes: pathogenicity factors and triggers of host resistance. *New Phytologist*, 183: 993–1000. <https://doi.org/10.1111/j.1469-8137.2009.02922.x>
- Fernández J.L., Llorens I., Alvarado P. 2016. Evidence for *Gymnosporangium atlanticum* in Europe. *Mycotaxon*, 131(2): 357–366. <https://doi.org/10.5248/131.357>
- Gafforov Yu.S., Abdurazzoqov A., Yarasheva M., Ono Y. 2016. Rust fungi from the Fergana Valley, Chatkal and Kurama Mountain Ranges in Uzbekistan. *Stapfia*, 105: 161–175.
- Gjaerum H.B., Gauslaa Y., Talg V. 2008. *Gymnosporangium sabinae* found in Norway. *Plant Pathology*, 57: 376. <https://doi.org/10.1111/j.1365-3059.2007.01730.x>
- Guyot A.L., Malençon G. 1957. Uredinées du Maroc. *Travaux de l'Institut Scientifique Chérifien: Série Botanique*, 11: 1–184.
- Helfer S. 2005. Overview of the rust fungi (*Uredinales*) occurring on *Rosaceae* in Europe. *Nova Hedwigia*, 81(3–4): 325–370. <https://doi.org/10.1127/0029-5035/2005/0081-0325>
- Kellerhals M., Szalatnay D., Hunziker K., Duffy B., Nybom H., Ahmadi-Afzadi M., Höfer M., Richter K., Lateur M. 2012. European pome fruit genetic resources evaluated for disease resistance. *Trees*, 26: 179–189. <https://doi.org/10.1007/s00468-011-0660-9>
- Kuprevich V.F., Ulyanishchev V.I. 1975. *Opredelitel rzhavchinykh gribov SSSR. Chast 1. Sem. Melampsoraceae i nekotorye rody sem. Pucciniaceae*. Minsk: Nauka i tekhnika, 336 pp. [Купревич В.Ф., Ульянищев В.И. 1975. *Определитель ржавчинных грибов СССР. Часть 1. Сем. Melampsoraceae и некоторые роды сем. Pucciniaceae*. Минск: Наука и техника, 1975, 336 с.]
- Lāce B. 2017. *Gymnosporangium* species – an important issue of plant protection. *Proceedings of the Latvian Academy of Sciences, Section B. Natural, Exact, and Applied Sciences*, 71(3): 95–102. <https://doi.org/10.1515/prolas-2017-0017>
- Liu Y., Gafforov Y., Liang Y.M. 2019. Taxonomy and phylogenetic position of *Phragmidium altaicum*, a newly described rust fungus on *Rosa* species. *Phytotaxa*, 423(3): 187–194. <https://doi.org/10.11646/phytotaxa.423.3.7>
- Mustafaev I.M., Iminova M.M. 2018. *Puccinia rhamni* Kupr. – novyi rzhavchinnyi grib mikobioty Uzbekistana. *Universum: khimiya i biologiya*, 11(53): 11–12. [Мустафаев И.М., Иминова М.М. 2018. *Puccinia rhamni* Kupr. – новый ржавчинный гриб микобиоты Узбекистана. *Universum: химия и биология*, 11(53): 11–12].

- Mustafaev I.M., Iminova M.M., Sherkulova J.P., Xolmurodova T.N., Teshaboeva Sh.A. 2018. New records of rust fungi of trees and shrubs from Uzbekistan. *European Science Review*, 7(8): 19–21.
- Mustafaev I.M., Islomiddinov Z.Sh., Iminova M.M. 2019. Distribution of rust fungus *Phragmidium tuberculatum* Jul. in Uzbekistan. *Scientific Bulletin of Namangan State University*, 1(6): 160–165. <https://uzjournals.edu.uz/namdu/vol1/iss6/25>
- Ramazanov S.S., Faizieva F.Kh., Sagdullaeva M.Sh., Kirgizbaeva Kh.M., Gaponenko N.I. 1986. *Flora of the Fungi of Uzbekistan*, vol. 3. *Rzhavchinnye griby*. Tashkent: Fan, 232 pp. [Рамазанова С.С., Файзиева Ф.Х., Сагдуллаева М.Ш., Киргизбаева Х.М., Гапоненко Н.И. 1986. *Флора грибов Узбекистана*, т. 3. *Ржавчинные грибы*. Ташкент: Фан, 232 с.]
- Rakhimova E.B., Nam G.A., Yermekova B.D., Abiyev S.A., Djetigenova U.K., Esengulova B.J. 2015. Key to the rust fungi of Kazakhstan. *Turczaninowia*, 18(3): 5–65. [Рахимова Е.В., Нам Г.А., Еркекова Б.Д., Абиев С.А., Джетиженова У.К., Есенгулова Б.Ж. 2015. Ключ для определения ржавчинных грибов Казахстана. *Turczaninowia*, 18(3): 5–65]. <https://doi.org/10.14258/turczaninowia.18.3.1>
- Tojibaev K.Sh., Beshko N.Yu., Popov V.A., Jang C.G., Chang K.S. 2017. *Botanical geography of Uzbekistan*. Pocheon, Republic of Korea: Korea National Arboretum, 250 pp.
- Toome M. 2010. *Leaf rust (Melampsora) on willows: ecological and plant response studies*. Ph.D. thesis. Tartu: Estonian University of Life Sciences, 123 pp. <https://dspace.emu.ee/xmlui/handle/10492/130>
- Zaprometov N.G. 1928. *Materialy po mikoflore Sredney Azii*, вып. 2. Tashkent, 71 pp. [Запрометов Н.Г. 1928. *Материалы по микофлоре Средней Азии*, вып. 2. Ташкент, 71 с.]
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Мустафаев І.М., Ісломіддінов З.Ш., Імінова М.М., Ортіков І.З. 2021. **Поширення видів роду *Gymnosporangium* (*Pucciniales*) в Узбекистані.** *Український ботанічний журнал*, 78(1): 39–46 [In English].

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**Реферат.** У статті проаналізовано поширення іржастих грибів роду *Gymnosporangium* у гірських районах Узбекистану, включаючи Західний Тянь-Шань та Паміро-Алай. Повідомляється про чотири види роду *Gymnosporangium* (*G. confusum*, *G. sabinae*, *G. fusisporum* і *G. turkestanicum*). Теліальні господарі цих іржастих грибів належать до роду *Juniperus*, тоді як еціальними господарями є представники родів *Cotoneaster*, *Crataegus*, *Sorbus* і *Pyrus*. Встановлено, що поширення видів роду *Gymnosporangium* у гірських районах Узбекистану значною мірою залежить від поширення ялівцевих лісів, оскільки представники роду *Juniperus* як теліальні господарі відіграють важливу роль у циклі розвитку цих грибів. У зв'язку з цим, види роду *Gymnosporangium* не були зареєстровані на території природного заповідника Нуратау, незважаючи на інші сприятливі умови для розвитку цих іржастих грибів.

**Ключові слова:** *Juniperus*, *Pucciniales*, еції, іржасті гриби, рослина-господар, телії, цикл розвитку