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Rust fungi on woody plants of the ile alatau mountain ridge (Kazakhstan)

Abstract: Establishing the species composition of rust fungi associated with trees and shrubs, their distribution in the altitude zones and gorges of the Ile Alatau is of scientific and practical importance. The presented work is devoted to the study of the diversity of rust fungi affecting all woody plants on the territory of the Ile Alatau. The material for the article was both the authors' own collections from the research area and the Institute's herbarium data. Preparation of specimens was carried out according to standard methods; they were studied using a Polyvar photomicroscope with Nomarsky interference optics. According to the long-term research results, 35 species of rust fungi were recorded on woody plants in the Ile Alatau, among them 5 species were registered by us for the first time. The most numerous genera are *Phragmidium* and *Puccinia*, which are presented by 10 species each.

The highest number of species (23) of rust fungi on trees and shrubs was recorded in the Turgen gorge of Ile Alatau. However, all identified species belonged only to four genera: *Melampsora, Gymnosporangium, Phragmidium,* and *Puccinia*. The high numbers of rust fungi species on woody plants were found in the Big and Small Almaty gorges: 22 and 19, respectively. The minimal number of species (6) was recorded in the Akterek gorge of the Zhetyzhol ridge, which is the western tip of the Ile Alatau. 56 vascular plants, including 22 species of trees, 30 species of shrubs, and 4 species of woody vines, were recorded as hosts for rust fungi. Almost 45% of species of rust fungi were found on representatives of the family Rosaceae. For the first time, 7 new host plants were registered.

The highest species diversity of rusts is recorded for the levels 1300–1900 m a. s. l. The value of the study and its practical importance lies in obtaining new data on the distribution of rust infections of various trees and shrubs in the territory of Ile Alatau.

Key words: altitudinal zonation, host plant, mycobiota, plant pathogenic fungi, Pucciniales, Tian Shan

Introduction

Ile Alatau is the most Northern range of the Tian Shan. Range is almost 380 km long, 30-40 km wide. The Northern slope of Ile Alatau consists of lateral spurs in the form of smaller ridges (Talgar, Novy, Kumbel, etc.) and is dissected by many gorges. The large rivers – Uzyn-Kargaly, Chemolgan, Aksay, Kaskelen, Big and Small Almaty, Issyk, Turgen – flow down from the Northern slope. The Southern slope of the ridge Ile Alatau is very steep and short, dissected by short valleys of shallow rivers [1].

The climate in the Ile Alatau is diverse and differentiated by high-altitude climatic zones. Summers are warm; winters are mild due to the pronounced inversion of air temperature. The average January temperature is in the foothills of –7.4°C, in the highlands –11.3°C. The average July temperature is +23°C and +7°C, respectively. Rainfall increases from 560 mm in the foothills to 800–1300 mm in the highlands. The number of days with snow cover at different altitudes varies from 111 to 236 [1].

Vegetation of Ile Alatau is characterized with specific spectrum of altitudinal belts. There is no continuous belt of coniferous forests and alpine tundra belt. A distinctive feature of Ile Alatau ridge is the wide spread of all subtypes of mountain steppes. Ile Alatau belongs to the Dzungar-Northern Tian Shan group of zonation types, including subnival vegetation (3300-3600 m a.s.l.), cryophytic (alpinotypic) meadows and meadows with *Kobresia* spp. (2800-3300 m a.s.l.), subalpinotype meadows and dwarf forests (2300-2800 m a.s.l.), dark coniferous forests and meadows (1700–2300 m a.s.l.), small-leaved

forests (1400–1700 m a.s.l.), steppes (800–1400 m a.s.l.), and foothill deserts (700–800 m a.s.l.) [1].

The mycobiota of Ile Alatau, including plant-parasitic rust fungi, has been studied by several mycologist of Soviet Union since 1950's. The three main monographs were published until today [2–4]. The first monography (Flora of spore plants in Kazakhstan. Rust fungi. by G.S. Nevodovsky) provided a detailed description of rust fungi of Kazakhstan at 1956, including the species in the Ile Alatau [2]. However, this information is outdated now, especially the used taxonomy. The second monography (Mycological flora of Ile Alatau (Northern Tian Shan) by B.K. Kalymbetov) provided information about 249 rust fungi species in Ile Alatau at 1969 [3]. However, this publication also included the data on rust fungi species of the adjacent mountain ridges of Northern Tian Shan (such as Ketmen, Kungei and others) as the data for Ile Alatau. The third monograph (Rust fungi of cereals of Kazakhstan by S.A. Abiev) provided the checklist and species descriptions of rust fungi on cereals (Poaceae) in Kazakhstan at 2002 [4]. Some recorded cereal-paraziting rust fungi have trees and shrubs as their second hosts.

The aim of our research was to revise the diversity of rust fungi on all woody plants (trees, shrubs and woody lianas) in Ile Alatau, and reveal patterns of species distribution in the relation of host plant distributions, geographical location and local altitude.

Materials and methods

The collecting of fungal specimens – rust fungi on plant leaves and other aerial parts of woody plants – has been performed during field trips in the Ile Alatau ridge in the southeastern region of Kazakhstan (Almaty region) for several years: 2010, 2012−2019. The location of each site was recorded using a digital GPS navigator "Garmin eTrex 10".

Spores of rust fungi at different stages of development were stripped off the plant surface, placed in a drop of distilled water on a microscopic slide, and examined using a photomicroscope "Polyvar" with Nomarski interference contrast optics (Reichert, Austria). Specimens were identified using several special keybooks and keys for rust fungi [2, 5–12].

Collected dried specimens are stored in the herbarium of the Institute of Botany and Phytointroduction, Almaty, Kazakhstan (AA).

The taxonomy of recorded Pucciniales species is given acorrding to Kirk et al. [13]. Specimens of rust fungi stored in the herbarium of the Institute of Botany and Phytointroduction are also included in the checklist. The names of the host plants are given in accordance with the Catalogue of Life database [14], while the names of fungal taxa and the names of taxon authors in accordance with the database Index Fungorum [15].

The similarity level of the species composition of rust fungi on all woody plants in Ile Alatau and adjacent territories was determined with the Jaccard (Kj) similarity coefficients [16].

Results and discussion

According to the long-term research results, 35 species of rust fungi were recorded on woody plants in the Ile Alatau, among them 5 species were registered by us for the first time (*Melampsora epitea* on *Salix* sp., *Phragmidium kamtschatkae* on *Rosa platyacantha* and *Rosa* sp., *Gymnosporangium juniperi* on *Sorbus tianschanica, Puccinia atragenicola* on *Clematis sibirica, Puccinia coronata* on *Rhamnus cathartica*, *Uromyces caraganae* on *Caragana* sp.). The most numerous genera are *Phragmidium* and *Puccinia*, which are presented by 10 species each (Table 1), which may be due to the wide distribution of their host plants.

Table 1– The families and genera of recorded rust fungi on woody plants

Families	Genera	Species
Coleosporiaceae	*Chrysomyxa*	2
Melampsoraceae	*Melampsora*	4
Phragmidiaceae	*Phragmidium*	10
Pucciniaceae	*Gymnosporangium*	5
	Puccinia	10
	Uromyces	1
Pucciniastraceae	*Melampsoridium*	1
	Pucciniastrum	1
Uropyxidaceae	*Tranzschelia*	1
Total	**9**	**35**

A checklist of rust fungi on woody plants in the Ile Alatau mountain ridge

The abbreviations are accepted in the proposed list: ibid. – ibidem, m a.s.l. – meters above sea level, SAG – Small Almaty gorge, BAG – Big Almaty gorge, IG – Issyk gorge, TG – Turgen gorge, PG – Prokhodnoye gorge. The most part of the specimens was collected by Yelena V. Rakhimova (abbreviated in the list as YVR), other collectors: MNK – MN Kuznetsova, LAK – LA Kyzmetova, GSN – GS Nevodovsky, UKJ – UK Jetigenova. The morphological types of fruiting bodies in the life cycle of rust fungi are traditionally marked by Roman numerals: 0 – spermogonia or pycnidia, I – aecia, II – uredinia, III – telia.

Pucciniomycetes R. Bauer, Begerow, J.P. Samp., M. Weiss & Oberw.

Pucciniales Clem. & Shear

Coleosporiaceae Dietel

Chrysomyxa deformans (Dietel) Jacz. (III) – on *Picea schrenkiana* Fisch. & C.A. Mey., SAG, Medeo, 07.1924, AA Yachevsky, ibid., 20.05.1938, MNK; Talgar gorge, 25.05.1952, SR Shvartsman; BAG, below the peak Young geologist, the upper boundary of spruce forests, 2513 m a.s.l., 43º06′87.9″N, 76º59′19.0″E, 18.07.2012, YVR; PG, spruce forest, 1871 m a.s.l., 43°04′47.4″N, 76°54′28.5″E, 14.07.2019, AM Assylbek.

Chrysomyxa weirii H.S. Jacks. (III) – on *Picea schrenkiana*, BAG, 14–27.05.1916, RN Abolin; Middle Talgar gorge, 06.06.1936; GSN; SAG, spruce forest, 26.05.1954, SR Shvartsman; PG, above the sanatorium Alma-Arasan, 2195 m a.s.l., 43º04′65.5″N, 76º54′27.5″E, 28.01.2012, YVR.

Melampsoraceae Dietel

Melampsora confluens (Pers.) H.S. Jacks. (II) – on *Ribes meyeri* Maxim., Talgar gorge, 06.06.1936, GSN.

Melampsora epitea Thüm. (II) – on *Salix* sp., Ayusai gorge, mixed forest, 1877 m a.s.l., 43°05′26.0″N, 76°56′51.9″E, 28.08.2018, LAK; BAG, 1950 m a.s.l., 43°06′18.6″N, 76°57′07.3″E, 04.06.2015, YVR; ibid., spruce forest, 1571 m a.s.l., 43°05′59.2″N, 76°55′51.1″E, 23.05.2019, LAK; ibid., border of spruce forest, 1579 m a.s.l., 43°06′00.5″N, 76°56′52.0″E, 23.05.2019, YVR; IG, the forest above the lake, 1761 m a.s.l., 43°14′43.1″N, 77°28′35.7″E, 14.07.2015, YVR; TG, at the confluence of the tributary with the Bear waterfall, 1427 m a.s.l., 43°16′28.9″N, 77°42′59.2″E, 27.07.2017, YVR; ibid., above the village Batan, floodplain forest, 2143 m a.s.l., 43°13′46.0″N, 77°49′07.1″E, 16.08.2019, YVR; ibid., path to the Bear waterfall, floodplain forest, 1942 m a.s.l., 43°16′37.5″N, 77°42′55.3″E, 12.07.2019, LAK, ibid., path to Kairak waterfall, floodplain forest, 1737 m a.s.l., 43°13′55.8″N, 77°45′27.2″E, 12.07.2019, UKJ; PG, pine forest border, 1994 m a.s.l., 43°04′37.0″N, 76°54′28.6″E, 15.07.2019, LAK; Kastek range, Kastek gorge, 2036 m a.s.l., 42º59′08.0″N, 78º50′04.9″E, 08.09.2015, YVR; Zhetyzhol range, Akterek gorge, 1297 m a.s.l., 43º13′42.6″N, 75º22′11.0″E, 16.11.2014, YVR.

Melampsora populnea (Pers.) P. Karst. (II) – on *Populus alba* L., foothills, 900 m a.s.l., 18.06.1941, MNK; TG, above the village Batan, 2362 m a.s.l., 43°13′44.7″N, 77°49′06.6″E, 02.08.2016, YVR; on *P. laurifolia* Ledeb., TG, at the confluence of the tributary with the Bear waterfall, 1427 m a.s.l., 43°16′28.9″N, 77°42′59.2″E, 27.07.2017, YVR; on *P. tremula* L., Kamenskaya fissure, 08.08.1946, MNK; Ayusai gorge, spruce forest, 1831 m a.s.l., 43°05′43.4″N, 76°56′44.9″E, 27.08.2018, AM Assylbek, ibid., birch forest, 1556 m a.s.l., 43°06′31.4″N, 76°54′43.8″E, 29.08.2018, LAK; on *Populus* sp., entrance to the canyon Aksai, 10.06.2011, YVR.

Melampsora salicina Desm. (II) (complex of species) – on *Salix arbuscula* L., Small Kemin gorge, 2300 m a.s.l., 04.09.1957, BK Kalymbetov; on *S. cinerea* L., SAG, the slope of Shaggy Hill, 03.07.1946, GSN; on *S. starkeana* Willd., SAG, spruce forests on the Kazachka river, 20.06.1945, MNK; on *Salix* sp., SAG, 2300 m a.s.l., 23.08.1945, MNK; Monk fissure, 03.06.1935, GSN; ibid., 1641 m a.s.l., 43º13′39.8″N, 77º15′34.6″E, 07.09.2012, YVR; PG, above the sanatorium Alma-Arasan, spruce forest, 2103 m a.s.l., 43º04′10.6″N, 76º54′43.9″E, 27.07.2012, YVR; Aksai gorge, 15.08.2009, YVR; Ayusai gorge, 1754 m a.s.l., 43º05′61.5″N, 76º56′38.1″E, 14.07.2011, YVR; BAG, 1662 m a.s.l., 43º06′10.3″N, 76º56′61.8″E, 14.07.2011, YVR; SAG, Mynzhylki, 01.08.2015, RD Rakhimov; IG, near the lake, 1744 m a.s.l., 43º15′35.7″N, 77º29′10.1″E, 23.06.2011, YVR; TG, above the village Batan, right bank, 2362 m a.s.l., 43°13′44.7″N, 77°49′06.6″E, 02.08.2016, YVR; Kastek range, Kastek gorge, 1434 m a.s.l., 43º01′53.9″N, 75º57′98.2″E, 17.09.2011, YVR; Zhetyzhol range, Akterek gorge, 1129 m a.s.l., 43º15′14.2″N, 75º24′19.6″E, 27.06.2014, UKJ.

Phragmidiaceae Corda

Phragmidium andersonii Shear (III) – on *Dasiphora fruticosa* (L.) Rydb., SAG, Aman-Dzhailau valley, 2600 m a.s.l., 14.08.1936, GSN; ibid., alpine meadow along the ridge of Kumbel, 3200 m a.s.l., 23.08.1945, GSN.

Phragmidium bulbosum (Fr.) Schltdl. (II, III) – on *Rubus caesius* L., foothills, Glubokaya fissure, 900

m a.s.l., 09.11.1945, MNK; TG, 12.06, 10.11.1938, GSN; BAG, 43º04′56.8″N, 76º58′50.5″E, 13.08.2009, YVR; Aksai gorge, 1359 m a.s.l., 43º07′232″N, 76º47′835″E, 10.06.2011, YVR; Kuznetsov fissure cordon, 1526 m a.s.l., 43°21′63.1″N, 77°40′68.1″E, 15.08.2013, YVR; TG, at the confluence of the tributary with the Bear waterfall, 1427 m a.s.l., 43°16′28.9″N, 77°42′59.2″E, 27.07.2017, YVR; ibid., near the complex "Altyn Adam", deciduous forest, 1173 m a.s.l., 43º19′47.3″N, 77º37′02.0″E, 18.08.2019, G Sypabekkyzy; Zhetyzhol range, Akterek gorge, 1113 m a.s.l., 43º15′17.1′′N, 75º24′24.5″E, 27.06.2014, N Zhakhan; ibid., 1120 m a.s.l., 43º15′17.1′′N, 75º24′07.8″E, 27.06.2014, AK Dzhienbekov.

Phragmidium devastatrix Sorokin (III) – on *Rosa platyacantha* Schrenk, foothills, Glubokaya fissure, 900 m a.s.l., 11.06.1941, MNK; BAG, 1927 m a.s.l., 43º06′23.8″N, 76º56′46.4″E, 27.04.2018, UKJ; ibid., trail to the Big Almaty peak, spruce forest, 1628 m a.s.l., 43°06′26.0″N, 76°54′46.6″E, 29.08.2018, YVR; Shemolgan gorge, 43°10′14.0″N, 76°31′57.6″E, 02.12.2013, YVR; Karakastek gorge, 1353 m a.s.l., 43°02′08.6″N, 76°04′01.5″E, 03.08.2016, YVR; Zhetyzhol range, middle part of the Besmoyak gorge, 1944 m a.s.l., 43°06′21.7″N, 75°37′02.9″E, 06.07.2016, YVR; ibid., 1801 m a.s.l., 43°06′11.6″N, 75°38′24.5″E, 06.07.2016, YVR; on *Rosa* sp., Talgar gorge, 12.09.1935; 10.04-06.06.1936, GSN; Kaskelen gorge, 5 km above the ecological post, 1313 m a.s.l., 43º06′23.8″N, 76º36′35.6″E, 07.07.2010, YVR; ibid., 1307 m a.s.l., 43°06′16.3″N, 76°36′20.7″E, 03.08.2016, YVR; Ush-Konyr gorge, 1239 m a.s.l., 43º07′94.7″N, 76º30′85.4″E, 11.07.2010, YVR; pass of TG, 1344 m a.s.l., 43º31′64.6″N, 77º38′455″E, 15.08.2013, YVR; TG, floodplain forest, 1579 m a.s.l.,43°16′15.7″N, 77°44′22.9″E, 18.08.2019, AM Assylbek; Kastek range, Kastek gorge, 1854 m a.s.l., 42º59′70.7″N, 75º53′30.3″E, 29.06.2012, YVR; ibid., 1977 m a.s.l., 43°00′41.8″N, 75°53′69.5″E, 28.06.2012, YVR; ibid., 2036 m a.s.l., 42º59′08.0″N, 78º50′04.9″E, 08.09.2015, YVR; Zhetyzhol range, Akterek gorge, 1113 m a.s.l., 43º15′17.1′′N, 75º24′24.5″E, 27.06.2014, N Zhakhan; ibid., 1069 m a.s.l., 43º15′30.6′′N, 75º24′58.3′′E, 26.06.2014, YVR; ibid., 1297 m a.s.l., 43º13′42.6″N, 75º22′11.0″E, 16.11.2014, YVR; ibid., 1094 m a.s.l., 43º15′25.7′′N, 75º24′40.6″E, 26.06.2014, YVR.

Phragmidium fusiforme J. Schröt. (I) – on *Rosa alberti* Regel, Small Kemin gorge, Aktyuz, among juniper, 2400 m a.s.l., 06.09.1957, BK Kalymbetov; SAG, 20.06.1945, MNK; Kaskelen gorge, Kasymbek branch, 2122 m a.s.l., 43°02′08.1″N, 76°31′43.7″E, 03.06.2015, YVR; on *Rosa* sp., the upper reaches of the Pogansky fissure, 10.06.1937, GSN; Ayusai gorge, spruce forest, 1831 m a.s.l., 43°05′43.4″N, 76°56′44.9″E, 27.08.2018, AM Assylbek; PG, above the sanatorium Alma-Arasan, spruce forest, 2103 m a.s.l., 43°04′10.6″N, 76°54′43.9″E, 27.07.2012, YVR; TG, above the confluence of Karagaily, floodplain forest, 1446 m a.s.l., 43°16′29.4″N, 77°43′03.5″E, 21.05.2019, YVR; Kastek range, Kastek gorge, floodplain, 1812 m a.s.l., 42°59′99.3″N, 75°53′87.7″E, 29.06.2012, YVR.

Phragmidium kamtschatkae (H.W. Anderson) Arthur & Cummins (III) – on *Rosa platyacantha,* BAG, 1923 m a.s.l., 43º05′53.0″N, 76º57′12.8″E, 27.04.2018, SB Nurashov; on *Rosa* sp., Talgar gorge, 06.06.1936, GSN; BAG, spruce forest border, 1579 m a.s.l., 43°06′00.5″N, 76°56′52.0″E, 23.05.2019, YVR; TG, above the village Batan, spruce forest, 1757 m a.s.l., 43°14′10.0″N, 77°46′27.3″E, 22.05.2019, LAK; ibid., floodplain forest, 1446 m a.s.l., 43°16′29.4″N, 77°43′03.5″E, 21.05.2019, YVR.

Phragmidium mucronatum (Pers.) Schltdl. (I) – on *Rosa* sp., SAG, Aman-Dzhailau valley, 2600 m a.s.l., 14.08.1936; TG, 12.06.1938, GSN; PG, spruce forest, 2069 m a.s.l., 43°04′18.9″N, 76°54′28.6″E, 15.07.2019, UKJ; Kastek range, Kastek gorge, 1854 m a.s.l., 42°59′70.7″N, 75°53′30.3″E, 29.06.2013, YVR.

Phragmidium rosae-lacerantis Dietel (II, III) – on *Rosa alberti*, Kaskelen gorge, neighborhood of the village of Izvestkovoe, 1845 m a.s.l., 43°01′56.9″N, 76°37′09.0″E, 19.09.2012, YVR; IG, forest above the lake, 1761 m a.s.l., 43°14′43.1′′N, 77°28′35.7′′E, 14.07.2015, YVR; SAG, Kok-Dzhailau pass trail, aspen forest, 1790 m a.s.l., 43°09′35.3″N, 77°01′43.0″E, 19.08.2019, YVR; TG, floodplain forest, 1516 m a.s.l., 43°16′11.1″N, 77°44′26.4″E, 16.08.2019, G Sypabekkyzy; on *R. platyacantha*, SAG, Kok-Dzhailau pass trail, aspen forest, 1790 m a.s.l., 43°09′35.3″N, 77°01′43.0″E, 19.08.2019, YVR; on *Rosa* sp., Zhetyzhol range, Akterek gorge, 1069 m a.s.l., 43º15′30.6″N, 75º24′58.3″E, 26.06.2014, YVR; ibid., 1120 m a.s.l., 43º15′17.1″N, 75º24′07.8″E, 27.06.2014, AK Dzhienbekov; ibid., 1033 m a.s.l., 43°15′43.7′′N, 75°25′26.8′′E, 26.06.2014, YVR; ibid., 1113 m a.s.l., 43º15′17.1′′N, 75º24′24.5′′E, 27.06.2014, N Zhakhan; ibid., 1096 m a.s.l., 43º15′31.0′′N, 75º24′33.6′′E, 26.06.2014, GA Nam.

Phragmidium rubi-idaei (DC.) P. Karst. (III) – on *Rubus idaeus* L., Monk fissure, 24.08.1935; SAG, spruce forest, 2000 m a.s.l., 31.08.1946, MNK; BAG, spruce forest, 28.08.1922, Tupolev; ibid., trail

to the Big Almaty peak, spruce forest, 1628 m a.s.l., 43°06′26.0″N, 76°54′46.6″E, 29.08.2018, AM Assylbek; Ayusai gorge, spruce forest, 1776 m a.s.l., 43°05′45.5″N, 76°56′40.0″E, 27.08.2018, LAK; PG, above the sanatorium Alma-Arasan, spruce forest, 2103 m a.s.l., 43º04′10.6″N, 76º54′43.9″E, 27.07.2012, YVR; ibid., near the waterfall, 1886 m a.s.l., 43°04′56.1″N, 76°54′27.4″E, 14.07.2019, UKJ, ibid., above camp Young homebuilder, 1801 m a.s.l., 43°05′27.3″N, 76°54′22.3″E, 16.07.2019, LAK; TG, path to Kairak waterfall, 1814 m a.s.l., 43°13′23.6″N, 77°45′34.5″E, 12.07.2019, AM Assylbek.

Phragmidium saxatile Vleugel (I, II, III) – on *Rubus saxatilis* L., IG, floodplainforest above the Issyk lake, 1715 m a.s.l., 43º25′29.6″N, 77º48′43.8″E, 29.08.1947, MNK.

Phragmidium tuberculatum Jul. Müll. (I, II, III) – on *Rosa albertii*, SAG, along the Kazachka river bed, 1800 m a.s.l., 09.09.1939, MNK; TG, above the village Batan, spruce forest, 1646 m a.s.l., 43°14′02.9″N, 77°46′24.4″E, 11.07.2019, LAK.

Pucciniaceae Chevall.

Gymnosporangium clavariiforme (Wulfen) DC. (I) – on *Crataegus* sp., SAG, MNK; on *Juniperus sibirica* Burgsd., IG, 12.06.1936, Zakharova; on *Malus domestica* Borkh., SAG, 1800 m a.s.l., 20.08.1945, MNK; on *M. sieversii* (Ledeb.) M. Roem., SAG, Kok-Dzhailau pass trail, 1960 m a.s.l., 43º09′37.9″N, 77º01′52.1″E, 15.08.2012, YVR; ibid., Mynzhylki, 01.08.2015, RD Rakhimov; BAG, trail to the Big Almaty peak, mixed forest, 1477 m a.s.l., 43°06′37.0″N, 76°54′53.1″E, 29.08.2018, YVR; Aksai gorge, 1359 m a.s.l., 43º07′232″N, 76º47′835″E, 10.06.2011, YVR; Kuznetsov fissure, above the cordon, 1588 m a.s.l., 43º21′32.6″N, 77º40′94.8″E, 15.08.2013, YVR; PG, above camp Young homebuilder, 1801 m a.s.l., 43°05′27.3″N, 76°54′22.3″E, 16.07.2019, LAK; on *Malus* sp., Ayusai gorge, spruce forest, 1864 m a.s.l., 43°05′35.0″N, 76°56′52.9″E, 27.08.2018, YVR; ibid., spruce forest, 1776 m a.s.l., 43°05′45.5″N, 76°56′40.0″E, 27.08.2018, UKJ; TG, at the confluence of the tributary with the Bear waterfall, 1427 m a.s.l., 43°16′28.9″N, 77°42′59.2″E, 27.07.2017, YVR; on *Pyrus* sp., BAG, trail to the Big Almaty peak, birch forest, 1556 m a.s.l., 43°06′31.4″N, 76°54′43.8″E, 29.08.2018, LAK; on *Sorbus tianschanica* Rupr., SAG, path to the Kok-Dzhailau pass, 1960 m a.s.l., 43º09′37.9″N, 77º01′52.1″E, 15.08.2012, YVR; Kuznetsov fissure, 1517 m a.s.l., 43º21′98.5″N, 77º40′46.5″E, 15.08.2013, YVR; BAG, trail to the Big Almaty peak, spruce forest, 1582 m a.s.l., 43°06′29.5″N, 76°54′43.8″E, 29.08.2018, AM Assylbek; TG, above the village Batan, 2362 m a.s.l., 43°13′44.7″N, 77°49′06.6″E, 02.08.2016, YVR; Kastek range, Kastek gorge, 2036 m a.s.l., 42º59′08.0″N, 78º50′04.9″E, 08.09.2015, YVR; PG, spruce forest, 1871 m a.s.l., 43°04′47.4″N, 76°54′28.5″E, 14.07.2019, AM Assylbek.

Gymnosporangium confusum Polwr. (I) – on *Cotoneaster melanocarpus* G. Loddiges, TG, above the village Batan, floodplain forest, 1910 m a.s.l., 43°13′46.8″N, 77°47′25.3″E, 11.07.2019, YVR; on *Crataegus dsungarica* Zabel ex Lange (as *C. almaatensis* Pojark.), BAG, birch forest, 1507 m a.s.l., 43°06′15.7″N, 76°55′22.8″E, 23.05.2019, UKJ; TG, deciduous forest, 1281 m a.s.l., 43°17′21.4″N, 77°39′41.1″E, 20.05.2019, UKJ; ibid., above trout farming, deciduous forest, 1040 m a.s.l., 43°19′00.7″N, 77°38′22.9″E, 20.05.2019, LAK; on *C. pinnatifida* Bunge var. *major* N.E. Br. (as *C. korolkowii* L. Henry), IG, 02.08.1935, GSN; TG, at the confluence of the tributary with the Bear waterfall, 1427 m a.s.l., 43°16′28.9″N, 77°42′59.2″E, 27.07.2017, YVR; on *C. songarica* C. Koch, SAG, 06.06.1946, MNK; on *Crataegus* sp., Ayusai gorge, spruce forest,1776 m a.s.l., 43°05′45.5″N, 76°56′40.0″E, 27.08.2018, UKJ; BAG, near Ayusai, 1662 m a.s.l., 43º06′10.3″N, 76º56′61.8″E, 14.07.2011, YVR; ibid., 1754 m a.s.l., 43º05′615″N, 76º56′381″E, 14.07.2011, YVR; Right Talgar gorge, 1634 m a.s.l., 43º13′52.2″N, 77º17′47.7″E, 08.07.2010, S Userbayeva; IG, near the lake, 1744 m a.s.l., 43º15′35.7″N, 77º29′10.1″E, 23.06.2011, YVR; Kaskelen gorge, 1351 m a.s.l., 43º05′79.5″N, 76º36′63.0″E, 10.06.2011, YVR; Aksai gorge, 1487 m a.s.l., 43º06′44.7″N, 76º47′14.0″E, 10.06.2011, YVR; ibid., 1115 m a.s.l., 43º09′18.1″N, 76º47′93.3″E, 10.06.2011, YVR; Kuznetsov fissure, 1517 m a.s.l., 43º21′98.5″N, 77º40′46.5″E, 15.08.2013, YVR; TG, path to Kairak waterfall, spruce forest, 1814 m a.s.l., 43°13′23.6″N, 77°45′34.5″E, 12.07.2019, AM Assylbek; ibid., above the village Batan, spruce forest, 1901 m a.s.l., 43°13′55.2″N, 77°46′58.0″E, 11.07.2019, AM Assylbek; ibid., above trout farming, deciduous forest, 1040 m a.s.l., 43°19′00.7″N, 77°38′22.9″E, 20.05.2019, LAK; ibid., deciduous forest, 1281 m a.s.l., 43°17′21.4″N, 77°39′41.1″E, 20.05.2019, UKJ; Oi-Karagai gorge, 1866 m a.s.l., 43°11′68.0″N, 77°07′65.2″E, 20.09.2012, YVR.

Gymnosporangium fusisporum E. Fisch. (I) – on *Cotoneaster integerrimus* Medikus, SAG, 1400 m a.s.l., MNK; on *C. melanocarpus*, TG, path to Kairak waterfall, floodplain forest, 1737 m a.s.l., 43°13′55.8″N, 77°45′27.2″E, 12.07.2019, UKJ; on *C. oliganthus* Pojark., SAG, Aman-Dzhailau valley, 14.08.1936, GSN; on *C. uniflorus* Bunge, BAG, near

the lake, 2524 m a.s.l., 43º03′44.3″N, 76º59′22.5″E, 13.08.2009, YVR; on *Cotoneaster* sp., BAG, below peak Young geologist, 2513 m a.s.l., 43º06′87.9″N, 76º59′19.0″E, 18.07.2012, YVR; Kuznetsov fissure, 1588 m a.s.l., 43º21′32.6″N, 77º40′94.8″E, 15.08.2013, YVR; Kastek range, Kastek gorge, 1854 m a.s.l., 42º59′70.7″N, 75º53′30.3″E, 29.06.2012, YVR; ibid., 2036 m a.s.l., 42º59′08.0″N, 78º50′04.9″E, 08.09.2015, YVR.

Gymnosporangium juniperi Link (I) – on *Sorbus tianschanica*, BAG, 07.09.1937; Middle Talgar gorge, 13.08.1936, GSN; TG, above the village Batan, 2143 m a.s.l.,43º13′46.0″N, 77º49′07.1″E, 16.08.2019, YVR.

Gymnosporangium turkestanicum Tranzschel (I) – on *Juniperus turkestanica* Kom., SAG, 3700 m a.s.l.,13.05.1915, R Abolin; ibid., 2300 m a.s.l., 20.05.1946, MNK.

Puccinia atragenicola (Bubak) P. Syd. & Syd. (III) – on *Clematis sibirica* (L.) Mill. (as *Atragene sibirica* L.), TG, above the village Batan, floodplain forest, 1910 m a.s.l., 43°13′46.8″N, 77°47′25.3″E, 11.07.2019, YVR; BAG, spruce forest, 2407 m a.s.l., 43°04′00.6″N, 76°59′14.7″E, 31.08.2018, UKJ.

Puccinia brachypodii G.H. Otth (0, I) – on *Berberis heteropoda* Schrenk (as *B. sphaerocarpa*), Monk fissure 03.06.1935; SAG, 1500 m a.s.l., 09.05.1946, 12.09.1946, MNK; BAG, 1923 m a.s.l., 43º05′50.1″N, 76º57′30.0″E, 27.04.2018, LAK; ibid., spruce forest border, 1579 m a.s.l., 43°06′00.5″N, 76°56′52.0″E, 23.05.2019, YVR; ibid., birch forest at the foot of the slope, 1507 m a.s.l., 43°06′15.7″N, 76°55′22.8″E, 23.05.2019, UKJ; TG, above the village Batan, spruce forest,1757 m a.s.l., 43°14′10.0″N, 77°46′27.3″E, 22.05.2019, LAK.

Puccinia coronata Corda (I) – on *Rhamnus cathartica* L., BAG, trail to the Big Almaty peak, birch forest, 1556 m a.s.l., 43°06′31.4″N, 76°54′43.8″E, 29.08.2018, LAK; Zhetyzhol range, Akterek gorge, 1129 m a.s.l., 43º15′14.2″N, 75º24′19.6″E, 27.06.2014, UKJ; ibid., 1033 m a.s.l., 43º15′43.7″N, 75º25′26.8″E, 26.06.2014, YVR; on *Rhamnus* sp., Zhetyzhol range, Akterek gorge, 1113 m a.s.l., 43º15′17.1″N, 75º24′24.5″E, 27.06.2014, N Zhakhan.

Puccinia coronifera Kleb. (I) – on *Rhamnus cathartica*, foothills, 02.05.1932, ibid., Glubokaya fissure, 27.05.1946, MNK; Kaskelen gorge, 1351 m a.s.l., 43º05′79.5″N, 76º36′63.0″E, 10.06.2011, YVR; Aksai gorge, 1487 m a.s.l., 43º06′44.7″N, 76º47′14.0″E, 10.06.2011, YVR; ibid., 1115 m a.s.l., 43º09′18.1″N, 76º47′93.3″E, 10.06.2011, YVR; TG, above the confluence of the Karagayly river, floodplain forest, 1446 m a.s.l., 43°16′29.4″N, 77°43′03.5″E, 21.05.2019, YVR; ibid., path to the Bear waterfall, 1436 m a.s.l., 43°16′33.1″N, 77°42′41.2″E, 22.05.2019, AM Assylbek; ibid., above trout farming, deciduous forest, 1040 m a.s.l., 43°19′00.7″N, 77°38′22.9″E, 20.05.2019, LAK, ibid., 1281 m a.s.l., 43°17′21.4″N, 77°39′41.1″E, 20.05.2019, UKJ.

Puccinia festucae Plowr. (I) – on *Lonicera caerulea* L., IG, at a lake, mixed forest, 02.08.1935, GSN; on *L. hispida* Pall. ex Roem. & Schult., TG, spruce forest border, 1687 m a.s.l., 43°15′12.2″N, 77°45′26.6″E, 20.05.2019, AM Assylbek; on *L. heterophylla* Decne. (as *L. karelinii* Bunge ex P. Kir.), Big Kemin gorge, 2400 m a.s.l., 10.09.1957, BK Kalymbetov; BAG, spruce forest, 18.06.1941, MNK; SAG, 06.07.1936, MNK; foothills Kargaly gorge, 19.06.1941, MNK; on *L. tatarica* L.; BAG, spruce forest border, 1579 m a.s.l., 43°06′00.5″N, 76°56′52.0″E, 23.05.2019, YVR.

Puccinia graminis Pers. (0, I) – on *Berberis heteropoda* (as *B. sphaerocarpa*), SAG, Kamenskaya fissure, 06.07.1931, Sukach and Bulatov; ibid., 13.06.1946, MNK; Talgar gorge, 07.1931, GSN; Aksai gorge, 1115 m a.s.l., 43º09′18.1″N, 76º47′93.3″E, 10.06.2011, YVR; TG, deciduous forest, 1281 m a.s.l., 43°17′21.4″N, 77°39′41.1″E, 20.05.2019, UKJ; ibid., above trout farming, deciduous forest, 1040 m a.s.l., 43°19′00.7″N, 77°38′22.9″E, 20.05.2019, LAK; ibid., path to the Bear waterfall, floodplain forest, 1436 m a.s.l., 43°16′33.1″N, 77°42′41.2″E, 22.05.2019, AM Assylbek; BAG, spruce forest border, 1579 m a.s.l., 43°06′00.5″N, 76°56′52.0″E, 23.05.2019, YVR; Kastek range, Kastek gorge, 1854 m a.s.l., 42º59′70.7″N, 75º53′30.3″E, 29.06.2012, YVR; on *Berberis* sp., Uzyn-Kargaly gorge, above the dam, 1198 m a.s.l., 43º06′85.1″N, 76º26′01.7″E, 07.07.2010, YVR; Kaskelen gorge, at the base of the slope, 1313 m a.s.l., 43º06′23.8″N, 76º36′35.6″E, 07.07.2010, YVR; IG, near the lake, 1744 m a.s.l., 43º15′35. 7″N, 77º29′10.1″E, 23.06.2011, YVR.

Puccinia longirostris Kom. (III) – on *Lonicera hispida*, SAG, 03.07.1946, MNK; IG, 02.08.1935, GSN; Dzhaya gorge, 2700 m a.s.l., 09.06.1958, BK Kalymbetov; Ayusai gorge, spruce forest, 1888 m a.s.l., 43°05′18.4″N, 76°56′46.2″E, 28.08.2018, LAK; BAG, spruce forest, 1571 m a.s.l., 43°05′59.2″N, 76°55′51.1″E, 23.05.2019, LAK; ibid., spruce forest border, 1579 m a.s.l., 43°06′00.5″N, 76°56′52.0″E, 23.05.2019, YVR; TG, above the village Batan, floodplain forest, 1910 m a.s.l., 43°13′46.8″N, 77°47′25.3″E, 11.07.2019, YVR; ibid., above the confluence of the Karagayly river, floodplain forest, 1446 m a.s.l., 43°16′29.4″N, 77°43′03.5″E, 21.05.2019, YVR; PG, spruce forest, 2069 m a.s.l.,

43°04′18.9″N, 76°54′28.6″E, 15.07.2019, UKJ**;** ibid., 2085 m a.s.l., 43°03′59.7″N, 76°54′27.7″E, 15.07.2019, AM Assylbek**;** ibid., floodplain forest, 1287 m a.s.l., 43°16′17.1″N, 77°44′18.9″E, 20.05.2019, YVR; ibid., pine forest border, 1994 m a.s.l., 43°04′37.0″N, 76°54′28.6″E, 15.07.2019, LAK; on *L. olgae* Regel & Schmalh., SAG, Aman-Dzhailau valley, 2600 m a.s.l., 14.08.1936; ibid., Talgar pass, 28.08.1946, MNK; on *L. semenovii* Regel, between the mountains of Maitobe and Araltobe, 2500 m a.s.l., 01.09.1957, BK Kalymbetov; on *L. heterophylla* Decne. (as *L. karelinii*) and on *L. altmannii* Regel & Schmalh., Small Kemin gorge, Aktyuz, among juniper, 2400 m a.s.l., 06.09.1957, BK Kalymbetov; on *Lonicera* sp., Kastek range, Kastek gorge, bushes, 1854 m a.s.l., 42º59′70.7″N, 75º53′30.3″E, 29.06.2012, YVR; BAG, path to the lake, 2111 m a.s.l., 13.08.2009, YVR.

Puccinia platypoda Syd. & P. Syd. (I, III) – on *Atraphaxis caucasica* (Hoffm.) Pavlov, IG, near the stream, 27.06.1937, M Prokopenko; on *A. frutescens* (L.) Ewersm., BAG, 12.09.1937; IG, 17.08.1937, MNK; on *A. pyrifolia* Bunge, Talgar gorge, 24.07.1935; TG, 12.10.1938, MNK.

Puccinia pygmaea Erikss.(I) – on *Berberis heteropoda* (as *B. sphaerocarpa*),, foothills, 02.06.1936, Dobrotvorskaya; ibid., Kamenskaya fissure, 18.06.1930, Sukach and Bulatov; SAG, 13.06.1946, MNK; Monk fissure, 24.08.1935; Talgar gorge, 07.1936, GSN.

Puccinia recondita Roberge ex Desm. (I) – on *Clematis orientalis* L., foothills, 25.06.1941, MNK; TG, path to the Bear waterfall, floodplain forest, 1436 m a.s.l., 43°16′33.1″N, 77°42′41.2″E, 22.05.2019, AM Assylbek; on *Clematis sibirica* (L.) Mill. (as *Atragene sibirica* L.), SAG, spruce forest, 1600 m a.s.l., 16.06.1941, MNK; TG, floodplain forest, 1287 m a.s.l., 43°16′17.1″N, 77°44′18.9″E, 20.05.2019, YVR; ibid., above the village Batan, spruce forest, 1646 m a.s.l., 43°14′02.9″N, 77°46′24.4″E, 11.07.2019, LAK; ibid., path to Kairak waterfall, floodplain forest, 1862 m a.s.l., 43°12′48.6″N, 77°45′01.5″E, 13.07.2019, YVR; PG, near the waterfall, spruce forest, 1886 m a.s.l., 43°04′56.1″N, 76°54′27.4″E, 14.07.2019, UKJ; on *Clematis* sp., BAG, path to the lake, 2111 m a.s.l., 43º04′44.3″N, 76º59′01.8″E, 13.08.2009, YVR; Uzyn-Kargaly gorge, above the dam, 1198 m a.s.l., 43º06′85.1″N, 76º26′01.7″E, 07.07.2010, YVR.

Uromyces caraganae (Thüm.) Magnus (III) – on *Caragana* sp., Kaskelen gorge, 5 km above the ecological post, 1313 m a.s.l., 43º06′23.8″N, 76º36′35.6″E, 07.07.2010, YVR; ibid., 1307 m a.s.l., 43°06′16.3″N, 76°36′20.7″E, 03.08.2016, YVR.

Pucciniastraceae Gäum. ex Leppik

Melampsoridium betulinum (Pers.) Kleb. (II) – on *Betula pendula* Roth, SAG, spruce forest, 1400 m a.s.l., 18.09.1937, MNK; ibid., trail to the Kok-Dzhailau pass, 1960m a.s.l., 43°09′37.9″N, 77°01′52.1″E, 15.08.2012, YVR; ibid., 2113m a.s.l., 43°08′37.0″N, 77°00′56.2″E, 16.08.2012, YVR; Ayusai gorge, spruce forest, 1776 m a.s.l., 43°05′45.5″N, 76°56′40.0″E, 27.08.2018, LAK; IG, forest above the lake, 1761 m a.s.l., 43°14′43.1″N, 77°28′35.7″E, 14.07.2015, YVR; PG, near the waterfall, spruce forest, 1886 m a.s.l., 43°04′56.1″N, 76°54′27.4″E, 14.07.2019, UKJ; on *B. tianschanica* Rupr., SAG, spruce forest, 1700 m a.s.l., 14.08.1946, MNK; on *Betula* sp., Almaty Reserve, 07.09.1937; IG, near the lake, 02.08.1935; Talgar gorge, 24.07.1936, Sergazin; BAG, 1662 m a.s.l., 43º06′103″N, 76º56′618″E, 14.07.2011, YVR; IG, near the lake, 1744 m a.s.l., 43º15′35.7″N, 77º29′10.1″E, 23.06.2011, YVR.

Pucciniastrum areolatum (Fr.) G.H. Otth (II) – on *Padus avium* Mill., foothills, Kamenskaya fissure, 31.08.1933, K. Yatsynina; Talgar gorge, 24.08.1935; Middle Talgar gorge, 06.06.1936; IG, near the lake, 28.08.1938, MNK; on *Picea schrenkiana*, Talgar gorge, 23.06.1936; SAG, 05.05.1945, MNK.

Uropyxidaceae Cummins & Y. Hirats.

Tranzschelia pruni-spinosae (Pers.) Dietel (II, III) – on *Prunus prostrata* Labill. (as *Cerasus prostrata* (Labill.) Ser.), IG, 17.08.1937, MNK.

The highest number of species (23) of rust fungi on trees and shrubs was recorded in the Turgen gorge of Ile Alatau (Table 2). However, all identified species belonged only to four genera: *Melampsora, Gymnosporangium, Phragmidium,* and *Puccinia*. The high numbers of rust fungi species on woody plants were found in the Big and Small Almaty gorges: 22 and 19, respectively. The minimal number of species (6) was recorded in the Akterek gorge of the Zhetyzhol ridge, which is the western tip of the Ile Alatau.

Being obligate biotrophic plant parasites, rust fungi are strictly associated with their host plants, and on which they reproduce and complete their life cycles [17–19].

Consequently, a distribution of any rust fungi primarily depends on the distribution of their host plants. Totally, 56 vascular plants, including 22 species of trees, 30 species of shrubs, and 4 species of woody vines, were recorded as hosts for rust fungi. Almost 45% of species of rust fungi were found on representatives of the family Rosaceae. For the first time, 7 new host plants were registered: *Populus lau-*

rifolia for *Melampsora populnea*, Rosa *platyacantha* for *Phragmidium rosae-lacerantis, Malus sieversii* and *Sorbus tianschanica* for *Gymnosporangium clavariiforme, Cotoneaster melanocarpus* for *Gymnosporangium confusum, Lonicera hispida* and *L. tatarica* for *Puccinia festucae.*

Table 2 – The number of rust fungi species on woody plants in the main gorges of Ile Alatau

Genera	Gorges							
	BAG	**SAG**	**Talgar**	**Prokhod-noye**	**Issyk**	**Turgen**	**Kastek**	**Akterek**
Chrysomyxa	2	2	2	2	-	-	-	-
Gymnosporangium	3	3	2	1	2	4	2	-
Melampsora	3	1	1	2	2	3	2	2
Melampsoridium	1	1	1	1	1	-	-	-
Phragmidium	4	6	2	3	2	8	3	3
Puccinia	8	6	3	2	3	8	2	1
Pucciniastrum	-	-	1	-	1	-	-	-
Tranzschelia	-	-	-	-	1	-	-	-
Uromyces	1	-	-	-	-	-	-	-
Total	**22**	**19**	**12**	**11**	**12**	**23**	**9**	**6**

The highest species diversity of rusts is recorded for the levels 1300–1900 m a. s. l. (Figure 1).

The small-leaved forests (1400-1700 m a.s.l.) and dark coniferous forests and meadows (1700-2300 m a.s.l.) belts are typical for these levels, which are the hot spots of studied host plants distribution. Dark coniferous forests are composed of the main forest-forming species, *Picea schrenkiana* Fisch. et C. A. Mey., the undergrowth is composed of mountain ash, aspen, various species of wild rose, honeysuckle, juniper, willow. The lower zone of the Ile Alatau and river valleys are occupied by small-leaved and mixed deciduous-spruce forests. The codominant species here are *Malus sieversii* (Ledeb.) Roem., *Prunus armeniaca* L., willow, birch, aspen.

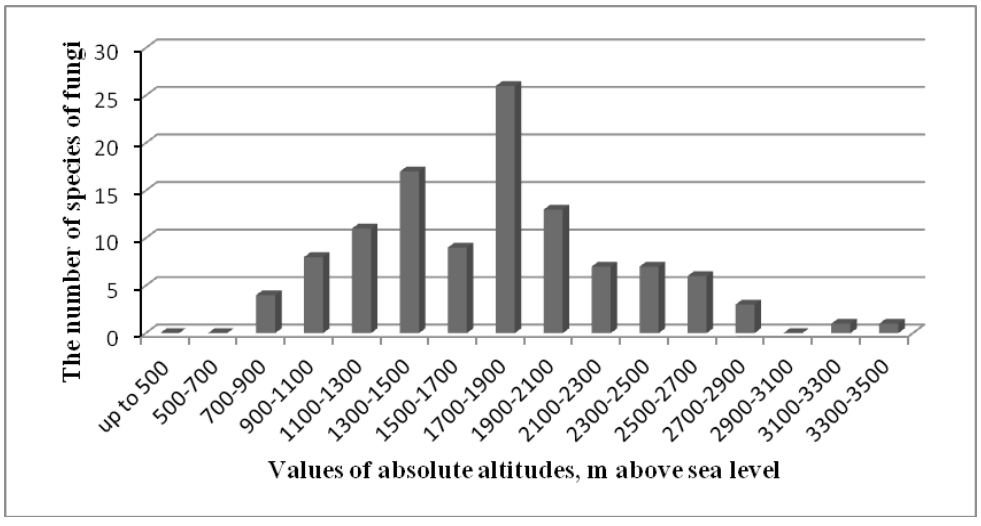

Figure 1 – Distribution of rust fungi species depending on the altitudinal zonation

The highest diversity can be recorded in most wet plant communities, because rust fungi prefer habitats with humid microclimatic conditions. Alpine level cannot provide optimal conditions neither for the host woody plants, nor for the rust fungi due to low temperatures and high insolation.

Comparing a distribution of the recorded rust fungi with the previous data [20, 21], we should note that the greatest species similarity is observed in the studied rust fungi species of Ile Alatau and Ketmen ridges (Table 3). The floristic similarity coefficient for these territories is 64,9% according to Jacquard (Kj). The most part of species is common to both ranges (*Chrysomyxa deformans, Melampsora epitea*, *M. populnea, M. salicina* (complex of species), *Ph. devastatrix, Ph. fusiforme, Ph. kamtschatkae, Ph. mucronatum, Ph. rosae-lacerantis, Ph. rubi-idaei, Ph. tuberculatum, Gymnosporangium clavariiforme, G. confusum, G. fusisporum, G. juniperi, Puccinia brachypodii, P. festucae, P. graminis, P. longirostris, P. platypoda, P. pygmaea, P. recondita, Uromyces caraganae, Melampsoridium betulinum*). *Pucciniastrum* and *Tranzschelia* species were found only in the Ile Alatau.

Table3 – Number of rust fungi species in the Ile Alatau and adjacent territories

Genera	Number of species		
	Ile Alatau ridge	**Terskei ridge**[19]	**Ketmen ridge** [20]
Chrysomyxa	2	2	1
Gymnosporangium	5	4	4
Melampsora	4	3	3
Melampsoridium	1	-	1
Phragmidium	10	4	8
Puccinia	10	11	7
Pucciniastrum	1	-	-
Tranzschelia	1	-	-
Uromyces	1	-	2
Total	**35**	**24**	**26**

The lowest species diversity is recorded for the Terskey ridge (the south of the Ile Alatau): only 24 species of rust fungi were found there [19]. The most part of species (19) is common with the Ile Alatau ridge (*Chrysomyxa deformans, Melampsora confluens*, *M. populnea, M. salicina* (complex of species), *Ph. devastatrix, Ph. saxatile, Ph. tuberculatum, Gymnosporangium confusum, G. fusisporum, G. juniperi, G. turkestanicum, Puccinia brachypodii, P. coronata, P. coronifera, P. festucae, P. graminis, P. longirostris, P. pygmaea, P. recondita*). The floristic similarity coefficient for the Terskey and the Ile Alatau is 47,5% according to Jacquard (Kj).

Conclusion

The presented work is devoted to the study of the diversity of rust fungi affecting all woody plants on the territory of the Ile Alatau, and to the establishment of their distribution in terms of host plants, geography (location in separate gorges) and absolute altitude. The material for the article was combined from both the authors' own collections from the research area and the Institute's herbarium data.

In the Ile Alatau we have recorded 35 species of rust fungi on woody plants, with the most spread genera *Phragmidium* and *Puccinia* (with 10 species of each). The Turgen gorge, as well as the Big and Small Almaty gorges, is characterized by high number of rust species (23, 22 and 19, respectively). The main factor influencing distribution of rust species is presence of host plants and optimal climatic conditions which corresponds to the small-leaved forests and dark coniferous forests and meadows belts in between 1300 and 1900 m a.s.l. The greatest similarity in the species composition of rust fungi on woody plants of Ile Alatau was detected with Ketmen ridge. The floristic similarity coefficient for these territories is 64,9 % according to Jacquard (Kj). Knowledge of the species composition and distribution of rust fungi will contribute to organize correctly practical measures to control of forest diseases in the territory of Ile Alatau.

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