

Rust Fungi from the Fergana Valley, Chatkal and Kurama Mountain Ranges in Uzbekistan

Y. GAFFOROV¹, A. ABDURAZZOKOV², M. YARASHEVA³ & Y. ONO⁴

Abstract: The paper contains preliminary results of rust fungal research conducted in the Fergana valley, Chatkal and Kurama mountain ranges in Uzbekistan. The results of these expeditions are several publications about the flora and mycobiota of the region. The literature review of publications about the study area showed no publication about rust fungi of this region. During our study, rusted and non-rusted specimens were collected, and we identified 95 species of rust fungi and 140 host plant species from the study area. The rust species belong to 7 genera and 3 families. The species richest and most widespread genera among the rust fungi are *Puccinia* and *Uromyces*. Most frequently they are infecting host plants of the families Compositae, Poaceae, Rosaceae, Leguminosae, Salicaceae, Apiaceae and Amaranthaceae. The list of rusts and their host plants in this area is provided. Among the studied taxa, *Puccinia obtusata* G.H. OTTH ex E. FISCH. on *Saccharum spontaneum* L. and *Uromyces kochiae* SYD. on *Bassia prostrata* (L.) BECK are newly reported for rust mycobiota of Uzbekistan and 6 new host-rust associations were recorded. 52 rust species are reported for the first time for the region and 23 species are reported for the second time.

Zusammenfassung: Die Arbeit berichtet vorläufige Ergebnisse zur Rostpilz-Forschung im Fergana-Valley und den Chatkal- und Kurama-Gebirgszügen in Usbekistan. Über die Ergebnisse dieser Expeditionen wird in mehreren Publikationen zur Flora und zu den Mycobiota der Region berichtet. Literaturrecherchen ergaben bisher keine Publikationen zu den Rostpilzen dieser Region. Im Zuge unserer Forschungen wurden Rost- und nicht-Rostpilze gesammelt, wobei 95 Arten von Rostpilzen und 140 Wirtspflanzen identifiziert werden konnten. Die Rostpilze gehören zu 7 Gattungen und 3 Familien. Die häufigsten und artenreichsten Gattungen sind *Puccinia* und *Uromyces*. Am häufigsten kommen sie auf Wirtspflanzen der Familien Compositae, Poaceae, Rosaceae, Leguminosae, Salicaceae, Apiaceae und Amaranthaceae vor. Listen der Rostpilze mit ihren Wirtspflanzen werden angegeben. Unter den untersuchten Taxa wurden *Puccinia obtusata* G.H. OTTH ex E. FISCH. auf *Saccharum spontaneum* L. und *Uromyces kochiae* SYD. auf *Bassia prostrata* (L.) BECK als neu für die Mycobiota von Usbekistan identifiziert. und 6 neue Wirtspflanze-Rostpilz-Assoziationen wurden gefunden. 52 Rostpilzarten wurden erstmals für diese Region gefunden, 23 Arten sind Zweitfunde.

Keywords: Central Asia, Basidiomycota, Pucciniales, biodiversity, new records, host plants, plant parasitic fungi..

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INTRODUCTION

The Fergana valley is a triangular intermountain basin of about 25,000 km² in what is a dry part of Central Asia. Fergana valley is framed by the Tien Shan mountain ridges of Kurama and Chatkal in the northwest of Uzbekistan, by Fergana in the north-east, and by the Turkestan and Alai ridges in the south (Fig. 1). The basin is a major important agricultural center of Uzbekistan and producer of cotton, fruits, and raw silk. The topography of Fergana valley is mostly level; a large part of it is an ancient terrace river of Syr-darya. In the central and western parts of the valley there are sands and calcium carbonate and gypsum soils. The climate is continental with hot and dry summers and low annual precipitation, rains increasing in frequency in October, relatively warm autumns and cold winters with severe frosts in December, January to -20 °C. In the valley there is a rich flowering plant flora, with 2625 species of vascular plants according to ARIFXANOVA (1967), and the vegetation consists of species adapted to arid conditions: halophytic, psammophilous, xerophytic gypsophilic, bush and shrubs, and juniper, walnut, mixed deciduous and coniferous forests, high alpine meadow plants.

It is known that richness of plant flora is an important factor in the diversity of fungi. Rust fungi are a larger group of Mycota; belonging to a single order, the Pucciniales (AIME et al. 2006) with an estimated 14 families, 168 genera and approximately 7,000 species in the Basidiomycota (KIRK et al. 2008) and are highly specialized obligate parasites of plants. Rust fungi infect ferns, conifers and angiosperms, with a high proportion of species growing on monocots throughout the world. These fungi have a world-wide distribution and are known as serious disease agents of important agricultural crops as well as of wild and medicinal herbs.

Knowledge of fungal diversity and of fungal diseases is incomplete even for Central Asian countries such as Uzbekistan. However, our knowledge of the diversity of rust fungi from Central Asia is disappointing, despite of their economic impact and ecological potential. No serious efforts have ever been made to understand the biodiversity of plant pathogenic rust fungi in the Fergana valley and adjacent regions. In contrast to the great number of publications dealing with the plant flora, few studies were carried out to document the microfungus biota of Fergana valley (ZAPROMETOV 1925, 1926, 1928; GOLOVIN 1950; KUCHMI 1970; RAMAZANOVA et al. 1986; SOLIEVA & GAFFOROV 2001, 2002; GAFFOROV & Ono 2007; GAFFOROV & YARASHEVA 2011; GAFFOROV 2002, 2005a, 2005b, 2010, 2015). The purpose of this study is to provide a preliminary study of plant pathogenic rust fungi from this region.

MATERIALS AND METHODS

During the intensive study of plant pathogenic/parasitic fungi from north-eastern Uzbekistan, the first author (YG) collected rust fungi in the Fergana valley, Chatkal and Kurama mountain range in 2000–2002, and 2011. Rusted and non rusted plant specimens were pressed and dried individually between blotting papers and labelled. Dried specimens were examined microscopically, and measured following standard methods. The rust specimens and their host plants were identified using the relevant literature (TRANSCHEL 1939; NEVODOVSKIY 1956; AZBUKINA

1974, 1984, 2005; KARBONSKAYA 1969; KUPREVICH & ULJANISHEV 1975; ULJANISHEV 1978; HIRATSUKA & SATO 1982; RAMAZANOVA et al. 1986; CUMMINS & HIRATSUKA 2003; Flora of Uzbekistan 1953–1962; Conspectus florum Asiae Mediae 1968–1993; PRA-TOV 1970). In this study, the taxonomic and nomenclatural basis for rust fungi is Index Fungorum (2015) and for the host plants ThePlantList (2015). The recently collected rust samples were deposited at TASM (Mycological Herbarium of the Institute of Gene Pool of Plants and Animals) Tashkent, Uzbekistan after examination.

RESULTS

95 species of rust fungi (Pucciniales) were reported from the Fergana valley, and the Chatkal and Kuraman mountain ranges to the northwest of this valley in Uzbekistan from 1914 to 2011. The rust species belong to 7 genera in 3 families. Fifty two of these were recorded and collected for the first time during the present field study, 20 species were found only in the literature and 23 species were represented in both accounts. Among the rusts recorded, *Puccinia* (54 species) and *Uromyces* (21 species) are the species rich genera, followed by *Phragmidium* (7 species), *Melampsora* (7 species), *Gymnosporangium* (3 species) and *Aecidium* (2 species), *Miyagia* (1 species). As a result of this research carried out in the study area, *Puccinia obtusata* G.H. OTTH ex E. FISCH. on *Saccharum spontaneum* L. and *Uromyces kochiae* SYD. on *Bassia prostrata* (L.) BECK are newly reported for rust mycobiota of Uzbekistan. 6 new host plants were also reported for the first time with 6 rust species in the host plant index of Uzbekistan and Central Asia: *Phragmidium mucronatum* (PERS.) SCHLTDL. – on *Rosa ecae* AITCH., *Puccinia poarum* NIELSEN – on *Tussilago farfara* L., *Uromyces scutellatus* (SCHRANK) LÉV. – on *Euphorbia esula* L. (new rust-host combinations for Uzbekistan) and *Phragmidium rosae-lacerantis* DIETEL – on *Rosa transturkestanica* N. Russanov, *Puccinia cousiniae* P. SYD. & SYD. – on *Cousinia strobilocephala* TSCHERNEVA ET VVED. (gloabally new rust-host combinations).

Puccinia is the most species-rich and widespread rust genus in this region, frequently found on Compositae, Poaceae in foothills and mountain areas; *Uromyces* species are found on Leguminosae, Polygonaceae, Scrophulariaceae, Cyperaceae; species of the genus *Gymnosporangium* are found on *Crataegus*, *Cydonia*, *Malus*, *Cotoneaster* trees. *Phragmidium* species are found on *Rosa*, *Rubus*, *Sanguisorba* host species of Rosaceae, and species of the genus *Melampsora* on plants of the families Salicaceae and Ephorbiaceae. Species of the genera *Puccinia*, *Uromyces* and *Aecidium*, mainly infected annual and biennial plants and those of *Phragmidium*, *Gymnosporangium* infected woodyshrubs.

Rust fungi were discovered on 140 species of flowering plants, belonging to 28 families and 92 genera. The host families with the greatest number of rust species were Compositae with 22 species (23%), Poaceae with 13 species (14%), Rosaceae with 10 (11%), Leguminosae with 7 (7%), Salicaceae with 6 (6%) and Apiaceae with 5 (5%), representing 70% of all rust species present in the study area (Tab. 1). The highest number of rust species is reported in the following host genera: *Artemisia* (5 species, 5.3%), *Populus*, *Rosa* (each 4; 4.2%), and *Cirsium*, *Euphorbia*, *Hordeum* and *Triticum* (each 3; 3.2%) (Tab. 1).

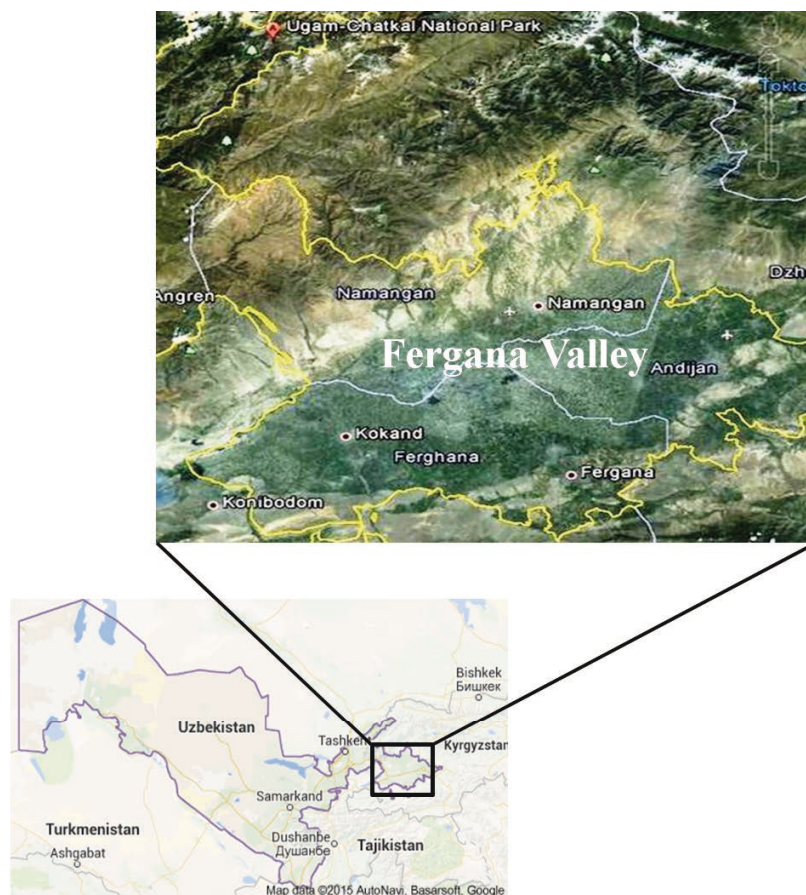


Fig. 1: Map of Fergana valley. Chatkal and Kurama mountain ranges and route of mycological investigation

Tab. 1: Number of rust species in the most representative host families and genera in the study area and percentages of total species number

Host Family	Num. of rust spp.	%	Host Genera	Num. of rust spp.	%
Compositae	22	23	<i>Artemisia</i>	5	5.3
Poaceae	13	14	<i>Populus</i>	4	4.2
Rosaceae	10	11	<i>Rosa</i>	4	4.2
Leguminosae	7	7	<i>Cirsium</i>	3	3.2
Salicaceae	6	6	<i>Euphorbia</i>	3	3.2
Apiaceae	5	5	<i>Hordeum</i>	3	3.2
Amaranthaceae	4	4	<i>Triticum</i>	3	3.2
Subtotal	67	70	Subtotal	25	26.3
Other families (21)	28	30	Other genera (85)	70	73.7
Total	95	100		95	100

The most representative host families are: Compositae (40 species in 22 genera: *Artemisia*-8, *Cousinia*-5, *Cirsium*-4), Poaceae (25 species in 18 genera: *Hordeum*-4, *Poa*-3, *Triticum*-2, *Elytrigia* spp., *Lolium* spp), Rosaceae (14 species in 7 genera: *Rosa*-5, *Cotoneaster*-3, *Crataegus* spp) and Salicaceae (6 species in 2 genera: *Populus*-3, *Salix*-3), Leguminosae 7 species belonging to 7 genera.

Among the rust fungi species found in the study area 73 species have incomplete life cycles and 22 species have complete life cycles. The most widespread types of development stage in all elevation zones are: Hemi-cyclic 30 species, 32%; Eu-cyclic 22, 23% and Brachy-cyclic 19, 20%; Micro-cycle 11, 12%; Op-si-cycle 7, 7% and with Endo-cyclic development represented by 6 species; 6% (Tab. 2).

Sixty of the rust fungi found are of the single-host (autoecious) type and the remaining 35 are of the many-host (heteroecious) type. Most of the autoecious species are in the genera *Puccinia* *Uromyces* and *Phragmidium*.

As a result of this study carried out in Fergana valley several rusts of economic importance and widespread species were found (Tab. 3). These rust fungi were collected from medicinal and cultivated plants that have been commercialized. Some of these plants and their parasitic diseases are already widespread: *Melampsora euphorbiae* (FICINUS & C. SCHUB.) CASTAGNE, *M. populina* (JACQ.) LÉV., *Puccinia striiformis* WESTEND., *P. cousinia*, *P. absinthii* DC., *P. recondita* DIETEL & HOLW., *P. calcitrapae* DC., *P. carthami* CORDA, *Gymnosporangium confusum* PLOWR., *G. fusisporum* E. FISCH., *Phragmidium mucronatum* (PERS.) SCHLTDL., *Ph. devastatrix* SOROKĪN, *Ph. sanguisorbae* (DC.) J. SCHRÖT.

LIST OF 95 SPECIES OF RUST FUNGI FROM STUDY AREA

Distributional novelties are indicated as:

- new record for Uzbekistan
- first time record for the study area
- ^a reported from field and in the literature
- ^ reported only in the literature

Melampsoraceae

Melampsora CASTAGNE

□^a *M. caprearum* THÜM. [as 'capraearum'], Mitt. Ver. Österr. 2: 34, 36 (1879).

On *Salix triandra* L., *Salix* sp., Uzbekistan: Fergana valley, Namangan prov., Pop district, Dugop village (VLG), Kurama mountain range (KMR), 26 September 2001, Yu.Sh. Gafforov (YG); Fergana prov., Quqon district (ZAPROMETOV 1924–1926; RAMAZANOVA et al. 1989)

□^a *M. euphorbiae* (FICINUS & C. SCHUB.) CASTAGNE, Observ. Uréd. 2: 18 (1843).

On *Euphorbia esula* L., *E. esula* subsp. *tommasiniana* (BERTOL.) KUZMANOV, *E. helioscopia* L., *E. turkestanica* REGEL, Uzbekistan: Namangan prov., Yangiqurgon district, river of Podshootasoy flood plain, 30 June 2001, YG, Chatkal mountain range

(CMR), Nanay VLG, 25 July 2002, YG, Pop district, KMR, near to river Irgaylisoy, 6 July 2001, YG, Turaqurgon district, Quymazor VLG, 6 October 2001, YG, Kosonsoy district, Oqtepa VLG, 5 October 2001, YG, Qorasuv VLG, 25 May 2002, YG, Chortoq district, Peshqurgon VLG, 26 May 2002, YG, Kushon VLG, 26 July 2002, YG, Chust district, Gova VLG, KMR, 23 July 2002, YG; Andijan prov., Xo'jaobod, 3 otr. Sovxoz, 25 July 1950, (GOLOVIN 1950; KUPREVICH & TRANZSCHEL 1957); Fergana prov., 04 August 1914–1924, 28 May 1949, (RAMAZANOVA et al. 1989).

Note: This species is widespread and the host plants are heavily infected in the study region. Its distribution ranges from the plains to mountain areas.

□^a *M. microspora* TRANZSCHEL & EREM., in TRANZSCHEL, Conspectus Uredinalium URSS: 155 (1939)

On *Populus euphratica* OLIVIER, Uzbekistan: Namangan prov., Mingbuloq district, Oqqum desert, 02 July 2001, YG

Note: First time record on *Populus euphratica* from Uzbekistan.

□^a *M. populina* (JACQ.) LÉV., Annl. Sci. Nat., Bot., sér. 3 8: 375 (1847).

On *Populus alba* L., Uzbekistan: Namangan prov., Uychi district, Qizilrovot VLG, 5 Nov 2000, YG.

^ *M. populnea* (PERS.) P. KARST., Bidr. Känn. Finl. Nat. Folk 31: 53 (1879).

On *Populus alba*, Uzbekistan: Fergana prov., Fergana district, Shohimardonsoy, 9 Jul 1950 (RAMAZANOVA et al. 1989).

□^a *M. pruinosa* TRANZSCHEL, in TRANZSCHEL & SEREBRIANIKOW, Mycotheca rossica, Fascicle 6 & 7: no. 265 (1912).

On *Populus alba*, *P. pruinosa* SCHRENK, Uzbekistan: Namangan prov., Mingbuloq district, Alami desert, 29 Sep 2000, YG; Yangiqurgon district, Kuksaroy dam olish maskani, CMR, 30 June 2001, YG; Fergana prov., 28 May 1949 (RAMAZANOVA et al. 1989).

Note: *Melampsora* species on *Populus* spp are similar morphologically or putative. For instance *M. pruinosa* urediniospores and teliospores differ from European species. It is necessary to conduct molecular studies in Central Asia.

□^a *M. salicina* DESM., Annl. Sci. Nat., Bot., sér. 3 8: 375 (1847).

On *Salix alba* L., Uzbekistan: Namangan prov., Mingbuloq district, Xorazm, 17 July 2000, YG.

Phragmidiaceae

Phragmidium LINK.

^ *Ph. bulbosum* (FR.) SCHLTDL., Fl. berol. (Berlin) 2: 156 (1824).

On *Rubus idaeus* L., Uzbekistan: Fergana prov., 1914–1924 (ZAPROMETOV 1925, 1926, 1928).

□^a *Ph. devastatrix* SOROKĪN, Bull. Soc. Imp. nat. Moscou 59 (1–2): 203 (1884).

On *Rosa ecae* AITCH., *R. fedtschenkoana* REGEL, Uzbekistan: Namangan prov., Yangiqurgon district, Nanay VLG, CMR, 10 May 2000, 29 April 2001, 25 May 2002, YG.

Tab. 2: Distribution of rust fungi according to cycles of development

Genus	Developmental stage						No. of rust spp.
	Eu-form	Brachy-form	Hemi-form	Opsi-form	Micro-form	Endo-form	
<i>Aecidium</i>	-	-	-	-	-	2	2
<i>Gymnosporangium</i>	-	-	-	3	-	-	3
<i>Melampsora</i>	1	-	6	-	-	-	7
<i>Miyagia</i>	-	1	-	-	-	-	1
<i>Phragmidium</i>	6	-	-	-	1	-	7
<i>Puccinia</i>	11	17	11	2	10	3	54
<i>Uromyces</i>	4	1	13	2	-	1	21
Total	22	19	30	7	11	6	95
%	23	20	32	7	12	6	100

Tab. 3: Rust species collected on medicinal and cultivated plants in the study area

Rust species	Host species
<i>Gymnosporangium confusum</i>	<i>Crataegus pseudoheterophylla</i> subsp. <i>turkestanica</i>
<i>Gymnosporangium fusisporum</i>	<i>Cotoneaster</i> sp., <i>C. oliganthe</i> , <i>C. pseudomultiflorus</i> , <i>Cydonia oblonga</i>
<i>Phragmidium mucronatum</i>	<i>Rosa</i> sp., <i>R. ecae</i> , <i>R. beggeriana</i>
<i>Melampsora euphorbiae</i>	<i>Euphorbia esula</i> , <i>E. esula</i> subsp. <i>tommasiniana</i> , <i>E. helioscopia</i>
<i>Puccinia absinthii</i>	<i>Artemisia absinthium</i> , <i>A. ferganensis</i> , <i>A. annua</i> , <i>Mausolea eriocarpa</i>
<i>Puccinia calcitrapae</i>	<i>Cirsium</i> sp., <i>C. alatum</i> , <i>C. vulgare</i> L., <i>C. arvense</i> , <i>Picnomon acarna</i>
<i>Puccinia carthami</i>	<i>Carthamus oxyacantha</i> , <i>Centaurea virgata</i> subsp. <i>squarrosa</i> , <i>C. iberica</i> , <i>Rhaponticum repens</i> , <i>Stizolophus balsamita</i> ,
<i>Puccinia cousiniae</i>	<i>Cousinia</i> sp., <i>C. microcarpa</i> , <i>C. strobilocephala</i> , <i>C. umbrosa</i> , <i>C. vicaria</i>
<i>Puccinia graminis</i>	<i>Aegilops</i> sp., <i>Avena sativa</i> , <i>A. sterilis</i> subsp. <i>ludoviciana</i> , <i>Berberis oblonga</i> , <i>B. vulgaris</i> , <i>Hordeum murinum</i> , <i>Poa bulbosa</i> , <i>Triticum aestivum</i>
<i>Puccinia recondita</i>	<i>Elymus repens</i> , <i>Lolium</i> sp., <i>Thalictrum minus</i> , <i>Triticum aestivum</i> ,
<i>Puccinia striiformis</i>	<i>Bromus sterilis</i> , <i>Calamagrostis pseudophragmites</i> , <i>Hordeum bulbosum</i> , <i>H. murinum</i> subsp. <i>leporinum</i> , <i>H. vulgare</i> , <i>Lolium</i> sp., <i>Triticum vulgare</i> , <i>T. aestivum</i>
<i>Puccinia cnici</i>	<i>Cirsium</i> sp., <i>C. arvense</i> , <i>C. vulgare</i> ,
<i>Uromyces rumicis</i>	<i>Rumex</i> sp., <i>R. aquaticus</i>

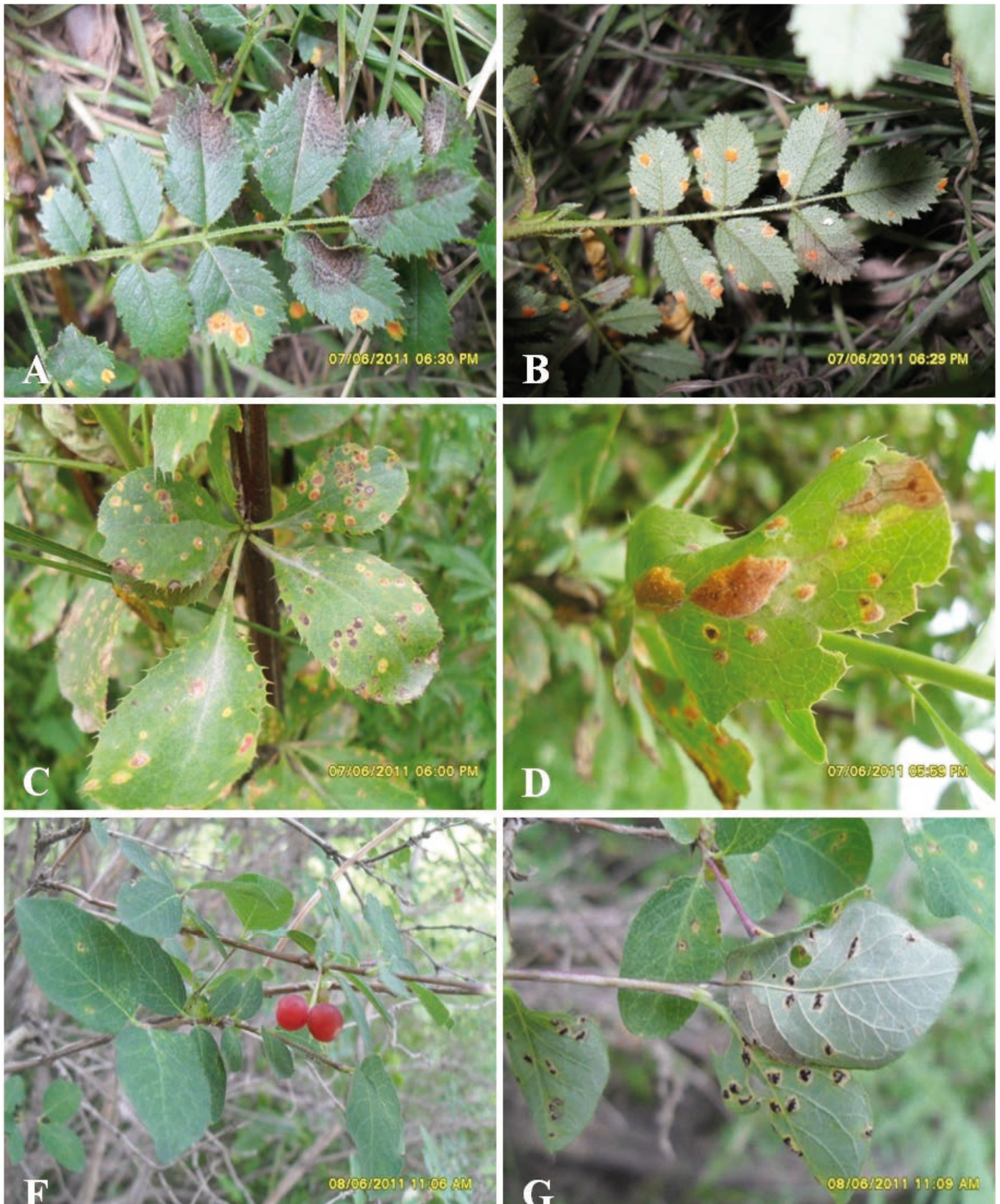


Fig. 2: *Phragmidium mucronatum* on *Rosa* sp. (Urediniospores: **A**. on the upper leaf surface, **B**. on the lower surface); *Puccinia graminis* on *Berberis oblonga* (Aeciospores: **C**. on the upper leaf surface, **D**. On the lower surface of barberry leaves); *Puccinia longirostris* on *Lonicera humilis* (Teliospores: **F**. on the upper leaf surface, **G**. lower leaf surface). Photographs by Yusufjon Gafforov.

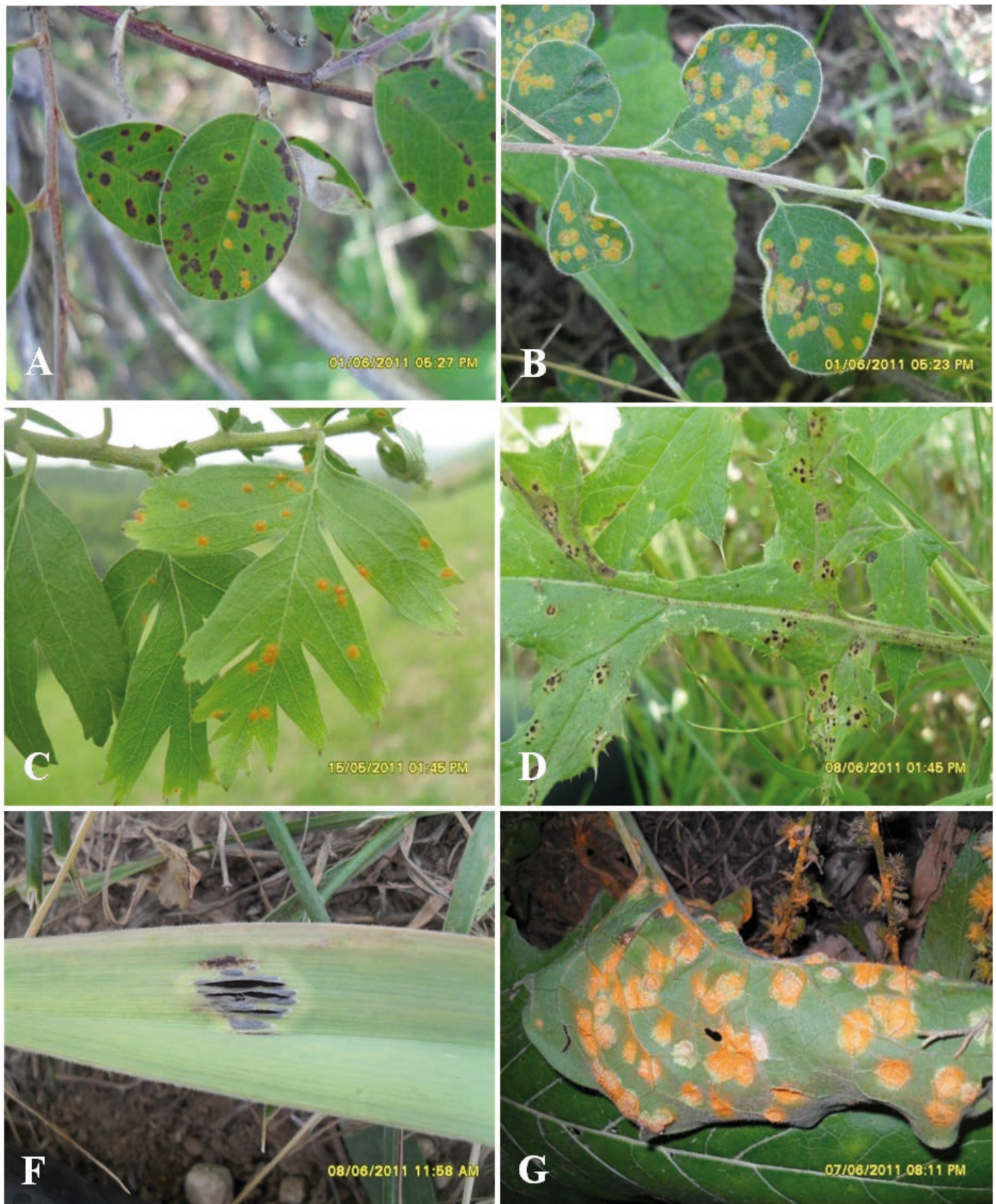


Fig. 3: *Gymnosporangium fusiforme* on *Cotoneaster pseudomultiflorus* (rust: **A.** on the upper leaf surface with other fungal spot, **B.** on the lower surface); *Gymnosporangium confusum* on *Crataegus pseudoheterophylla* subsp. *turkestanica* (**C.** on the upper and lower leaf surface); *Puccinia cal-citriferae* on *Cirsium* sp. (**D.** On the upper surface of host leaves); *Puccinia eremuri* on *Eremurus regelii* (**F.** on the upper leaf surface with dark brown color); *Puccinia cousinia* on *Cousinia umbrosa* (**G.** on the lower leaf surface). Photographs by Yusufjon Gafforov.

[Ⓜ]*Ph. mucronatum* (PERS.) SCHLECHT. Fl. berol. (Berlin) 2: 156 (1824).

On *Rosa ecae*, *R. beggeriana* SCHRENK EX FISCH. & C.A. MEY, *Rosa* sp., Uzbekistan: Namangan prov., Pop district, Qandagon VLG, KMR, 05 May 2000, YG; Andijan prov., river Qorasuv, 04 July 1948, (RAMAZANOVA et al. 1986); CMR, 07 June 2011, Fig. 2 (A, B), YG.

Note: First report of this rust species on *Rosa ecae* in Uzbekistan.

[Ⓜ]*Ph. rosae-lacerantis* DIETEL, Hedwigia 44: 336 (1905).

On *Rosa transturkestanica* N.F. RUSSANOV, *Rosa* sp., Uzbekistan: Namangan prov., Chust district, KMR, Dustlik bolalar dam olish lageri, 27 April 2001, 20 July 2001, 23 July 2002, YG, Yangiurgon district, CMR, Nanay VLG, 30 June 2001, YG.

Note: First report of this rust on *Rosa transturkestanica* in Central Asia. Many *Phragmidium* species on *Rosa* spp. are similar by morphology. That is why it is necessary to do molecular studies of this genus in the region.

[Ⓜ]*Ph. rubi-idaei* (DC.) P. KARST., Bidr. Känn. Finl. Nat. Folk 31: 52 (1879).

On *Rubus caesius* L., *R. idaeus* L., Uzbekistan: Namangan prov., Namangan district, Shurqishloq, 05 August 2000, YG, Chust district, KMR, Gova VLG, 23 May 2002, 23 July 2002, YG, Yangiurgon district, CMR, Kuksaroy dam olish maskani, 30 June 2001, YG, Pop district, Dugob VLG, KMR, 29 April 2001, 17 July 2002, YG; Fergana prov., 1922–1924, (ZAPROMETOV 1925, 1926, 1926).

[Ⓜ]*Ph. sanguisorbae* (DC.) J. SCHRÖT. in Cohn, Krypt.-Fl. Schlesiens (Breslau) 3.1(17–24): 352 (1887) [1889].

On *Sanguisorba minor* SCOP., Uzbekistan: Namangan prov., Yangiurgon district, CMR, Nanay dam olish maskani, 10 May 2000; 30 June 2001, 25 July 2002, YG, Chust district, Kaukliqurgon VLG, near to Choyxona, 02 May 2000, 23 July 2002, YG, Uchqurgon district, “Katta fargona” kanali, 29 April 2001, YG, in this district, 4-bulim, 29 May 2002, YG; Fergana prov., Janubiy fargona kanali, 8 July 1949 (RAMAZANOVA et al. 1986).

Note: The rust species is widespread from foothills to high mountains in the study area and heavily infecting the host plants.

[Ⓜ]*Ph. tuberculatum* J.MILL., Ber. dt. bot. Ges. 3: 391 (1885).

On *Rosa* sp., Uzbekistan: Namangan prov., Yangiurgon district, CMR, Nanay VLG, 30 June 2001, YG.

Puccinaceae

Gymnosporangium HEDW.

[Ⓜ]*G. confusum* PLOWR., Monograph Brit. Ured.: 232 (1889).

On *Crataegus pseudoheterophylla* subsp. *turkestanica* (POJARK.) K.I.CHR., Uzbekistan: Namangan prov., Yangiurgon district, CMR, Kuksaroy dam olish maskani, 29 April 2001, 30 June 2001, 25 May 2002, YG, Nanay VLG, 10 May 2000, YG; Chatkal range of Tashkent prov. side, 15 May 2011, Fig. 3 (C), YG.

Note: This rust is heavily infecting *Crataegus pseudoheterophylla* subsp. *turkestanica* at about 50%.

[Ⓜ]*G. fusisporum* E. FISCH., Mitt. naturf. Ges. Bern 3: 58 (1918).

On *Cotoneaster* sp., *C. oliganthe* POJARK., *C. pseudomultiflorus* POPOV, *Cydonia oblonga* MILL., Uzbekistan: Namangan prov., Pop district, KMR, Dugob VLG, 27 September 2001, YG, Yangiurgon district, Nanay VLG, CMR, 30 June 2001, 25 May 2002, 25 July 2002, YG, Kosonsoy district, Qorasuv VLG, 26 May 2002, YG; CMR, 01 June 2011, Fig. 3 (A, B), YG.

Note: The rust species is heavily infecting *Cotoneaster* spp. in mountain areas.

[Ⓜ]*G. tremelloides* R. HARTIG, Lehrb. Baumkrankh.: 55 (1882).

On *Malus domestica* BORKH., Uzbekistan: Namangan prov., Norin district, Norinkapa VLG, 30 September 2001, YG.

Miyagia MIYABE

[Ⓜ]*M. pseudosphaeria* (MONT.) JØRST., Nytt Mag. Bot. 9: 78 (1962)

On *Sonchus* sp., *S. transcaspicus* NEVSKI, Uzbekistan: Namangan prov., Uychi district, Qizilrovot VLG, 11 May 2000, YG, Kosonsoy district, Soyovul VLG, 08 May 2000, YG, Turaqurgon district, Kuymazor VLG, 24 April 2001 April 2001, YG, Norin district, Uchtepa VLG, 14 May 2000, YG.

Note: This rust species is collected only during spring (April, May) in the study region.

Puccinia PERS.

[Ⓜ]*P. absinthii* (HEDW. T.) D.C., Encycl. Méth. Bot. 8: 245 (1808)=*Puccinia chrysanthemi* ROZE, Bull. Soc. mycol. Fr. 16: 92 (1900).

On *Artemisia absinthium* L., *A. ferganensis* KRASCH., *A. annua* L., *Mausolea eriocarpa* (BUNGE) POLJAKOV EX PODELECH, Uzbekistan: Namangan prov., Uychi district, Qizilrovot VLG, 11 May 2000, YG, near school, 24 July 2000, YG, Yangiurgon district, CMR, Nanay VLG, 10 October 2001, YG, 25 July 2002, YG, Mingbuloq district, Alami VLG, 03 May 2000, YG, Oqqum VLG, 17 July 2000, YG, 23 November 2000, YG, Norin district, Norinkapa VLG, 30 September 2001, YG, 28 July 2002, YG, Pop district, KMR, near river Sansaloqsoy, 18 July 2000, YG, Dugob VLG, 03 May 2002, YG, 17 July 2002, YG, Uchqurgon district, 4-bulim, 24 July 2000, YG, 27 July 2002, YG; Fergana prov., Fergana district, river Shohimardon, 15 June 1949, 03 July 1950, (RAMAZANOVA et al. 1986), Gorchenko, 07 June 1949, (RAMAZANOVA et al. 1986).

Note: The rust species is widespread and the distribution covers different ecozones of *Artemisia* spp. in Uzbekistan.

[Ⓜ]*P. acroptili* P. SYD. & SYD., Monogr. Uredin. (Lipsiae) 1(1): 4 (1902) [1904].

On *Rhaponticum repens* (L.) HIDALGO, Uzbekistan: Namangan prov., Kosonsoy district, Chortoq foothills, Qozoqovul VLG, 22 July 2000, YG, Oqtepa VLG, 05 October 2001, YG, Qorasuv VLG, 24 July 2002, YG, Pop district, KMR, Dugob VLG, 27 September 2001, YG, Yangiurgon district, CMR, Nanay VLG, 01 October 2010, YG, Chust district, KMR, Gova VLG, 23 July 2002, YG.

Note: The rust species is heavily infecting the host plants.

[^]*P. aphanicondra* LINDR., Acta Soc. Sci. fenn. 22: 86 (1902).

On *Ligusticum discolor* LEDEB., Uzbekistan: Namangan prov., Yangiurgon district, Podsho-otasoy, 01 July 1925, (RAMAZANOVA et al. 1986).

[^]*P. artemisiicola* P. SYD. & SYD., Monogr. Uredin. (Lipsiae) 1(1): 14 (1902) [1904].

On *Artemisia tenuisecta* NEVSKI, Uzbekistan: Namangan prov., Pop district, KMR, Dugob VLG, Omon dacha, 29 September 2001, YG.

[^]*P. bardanae* (WALLR.) CORDA, Icon. fung. (Prague) 4: 17 (1840) = *Puccinia calcitrapae* DC., in LAMARCK & DE CANDOLLE, Fl. franç., Edn 3 (Paris) 2: 221 (1805).

On *Arctium tomentosum* MILL., Uzbekistan: Namangan prov., Chust district, KMR, Gova VLG, 23 Mar. 2002, YG.

[^]*P. bistortae* (F. STRAUSS) DC., in DE CANDOLLE & LAMARCK, Fl. franç., Edn 3 (Paris) 6: 61 (1815).

On *Persicaria bistorta* (L.) SAMP., Olovuddinsoy, 06 July 1950, (RAMAZANOVA et al. 1986).

[^]*P. calcitrapae* DC., in LAMARCK & DE CANDOLLE, Fl. franç., Edn 3 (Paris) 2: 221 (1805).

On *Picnomon acarna* (L.) CASS., *Cirsium alatum* (S.G. GMEL) BOBR., *C. vulgare* L., *C. arvense* (L.) SCOP., *Cirsium* sp., Uzbekistan: Namangan prov., Chust district, KMR, East side of mountain in Gova VLG, 27 July 2001, YG, 23 July 2002, YG, Uchqurgon district, 4-bulim, 29 April 2001, YG, 27 July 2002, YG, Yangiurgon district, CMR, Nanay VLG, 01 October 2001, YG, 25 July 2002, YG, Cortoq district, Peshqurgon VLG, 29 July 2001, YG, 26 May 2002, YG, Turaqurgon district, Kuymazor VLG, 12 May 2002, YG, Norin district, Norinkapa VLG, 28 July 2002, YG; CMR, 08 June 2011, Fig. 3 (D), YG.

Note: this rust species is widespread in the study region and strongly infects *Cirsium* spp. from desert to mountain areas. It was also reported on *Cirsium esculentum* (SIEV.) C.A.MEY. in Uzbekistan. (PANFILOVA & GAPONENKO 1963).

[^]*P. caricina* DC., in DE CANDOLLE & LAMARCK, Fl. franç., Edn 3 (Paris) 5/6: 60 (1815).

On *Carex* sp., *C. viridula* MICHX., Uzbekistan: Namangan prov., Uchqurgon district, Qugay VLG, 29 May 2002, YG, Kosonsoy district, Chatkal foothills, Qorasuv VLG, 24 July 2002, YG.

Note: The rust species mainly occur on *Carex* spp. in the Northern hemisphere; however, there are several *Puccinia* species reported on Cyperaceae from Taiwan (KUO & CHEN 1999). It appears that the rusts have a wide geographical distribution in Asia.

[^]*P. carthami* CORDA, Icon.fung. (Prague) 4: 15 (1840).

On *Centaurea virgata* subsp. *squarrosa* (BOISS.) GUGLER, *C. iberica* TREV. EX SPRENG., *Rhaponticum repens* (L.) HIDALGO, *Stizolophus balsamita* (LAM.) K.KOCH, *Carthamus oxyacantha* M.BIEB., Uzbekistan: Namangan prov., Yangiurgon district, CMR, Nanay VLG, 25 July 2002, YG, Chust district, KMR, Gova VLG, 28 July 2002, YG; Fergana prov., 16–20 May 1949, 10 August 1950, (RAMAZANOVA et al. 1986); Andijon prov., 02 July 1955, (RAMAZANOVA et al. 1986), near to Andijon railway, 06 June 1949, 12 July 1949, 07 July 1949 (RAMAZANOVA et al. 1986).

Note: The rust species widespread and heavily infecting the host plants in various genera of Compositae.

[^]*P. cesatii* J. SCHRÖT., in COHN, Beitr.Biol. Pfl. 3: 70 (1879).

On *Bothriochloa ischaemum* (L) KENG., Uzbekistan: Namangan prov., Yangiurgon district, CMR, Nanay VLG, 22 July 2000, YG, 25 July 2002, YG.

[^]*P. chondrillina* BUBÁK & SYD., Öst. bot. Z. 51: 17 (1901).

On *Chondrilla lejosperma* KAR. & KIR., Uzbekistan: Andijon prov., Qorasuv, 09 July 1949, (RAMAZANOVA et al. 1986).

[^]*P. cinae* TRANZSCHEL & KUPREV., Acta Inst. Bot. Acad. Sci. USSR Plant. Crypt., Ser. II 2: 406 (1935)

On *Artemisia serotina* BUNGE, *A. tenuisecta* NEVSKI., Uzbekistan: Namangan prov., Uchqurgon district, Qugay VLG, 26 June 2001, YG, Turaqurgon district, Kuymazor VLG, 30 April 2001, YG.

[^]*P. pnici* H. MART., Prodr. Fl. Mosq., Edn 2: 227 (1817).

On *Cirsium* sp., *C. arvense* (L.) SCOP., *C. vulgare* (SAVI) TEN., Uzbekistan: Namangan prov., Norin district, Uchtepa VLG, 25 July 2000, YG, 28 June 2001, YG, Chust district, Pop-Chust foothills, Kaklikqurgon VLG, 17 July 2000, YG, KMR, Gova VLG, 23 July 2002, YG, Pop district, KMR, Dugob VLG, 27 September 2001, YG; Fergana prov., 18 May 1949, (RAMAZANOVA et al. 1986), Muyan savxozi, 26 June 1950, (RAMAZANOVA et al. 1986).

[^]*P. conferta* DIETEL & HOLW., IN DIETEL, Erythea 1: 250 (1893)

On *Artemisia vulgaris* L., Uzbekistan: Namangan prov., Norin district, Norinkapa VLG, 28 May 2002, YG, Turaqurgon district, Kuymazor VLG, 12 May 2002, YG, Kosonsoy district, Qorasuv VLG, 26 June 2002, YG.

[^]*P. cousiniae* P. SYD.&SYD., Monogr. Uredin. (Lipsiae) 1(1): 62 (1902) [1904].

On *Cousinia* sp., *C. microcarpa* BLOSS., *C. vicaria* NULF., *C. strobilocephala* TSCHERN. ET VVED., *C. umbrosa* BUNGE., Uzbekistan: Namangan prov., Chust district, Dam VLG, 07 May 2000, YG, Norin district, Uchtepa VLG, 14 May 2000, YG, Pop district, KMR, near to river of Indigaysoy, 08 April 2001, YG, right side of river Qandagonsoy, Qizilqurt Mountain, 17 July 02, YG, CMR, 07 June 2011, Fig. 3 (G), YG.

Note: First report of this rust on *Cousinia strobilocephala* in Central Asia.

[^]*P. cyani* PASS., in RABENHORST, Fungi europ. exsicc.: no. 1767 (1874).

On *Cyanus depressus* (M.BIEB.) SOJÁK, Uzbekistan: Fergana prov., BFK, 06 June 1949, (RAMAZANOVA et al. 1986).

[^]*P. cynodontis* LACROIX EX DESM., Pl. Crypt. Nord France, 3 Edn: no. 655 (1859)

On *Plantago lanceolata* L., *Cynodon dactylon* (L.) PERS., Uzbekistan: Namangan prov., Uychi district, Qizilrovot VLG, 11. May 2000, YG, Kosonsoy district, Qorasuv VLG, 24 July 2002, YG; Fergana prov., 20 June 1950 (RAMAZANOVA et al. 1986).

Note: This rust species is widespread on *Cynodon dactylon* in all ecological zones. We reported O–I of the rust on *Plantago lanceolata* L. from study site.

♂*P. dactylidina* BUBÁK, Anns mycol. 3(3): 219 (1905).

On *Dactylis glomerata* L., Uzbekistan: Namangan prov., Yangiurgon district, CMR, Nanay VLG, 25 July 2002, YG..

♂*P. dictyospora* TRANZSCHEL, Acta Soc. Sci. fenn. 22: 48 (1902).

On *Elaeosticta hirtula* (REGEL & SCHMALH.) KLJUYKOV, PIMENOV & V.N. TIKHOM., Uzbekistan: Andijon prov., Andijon railway, 06 June 1949, (RAMAZANOVA et al. 1986).

♂*P. dracunculina* Fahrenh., Anns mycol. 39(2/3): 181 (1941).

On *Artemisia dracuncululus* L., *A. absinthium* L., Uzbekistan: Namangan prov., Pop district, KMR, Qandagon VLG, 18 July 2000, YG, Yangiurgon district, CMR, Nanay VLG, 29 April 2001, 29 April 2001, YG.

♂*P. echinopsis* DC., IN DE CANDOLLE & LAMARCK, Fl. franç., Edn 3 (Paris) 5/6: 57 (1815).

On *Echinops* sp., *Echinops karatavicus* REGEL & SCHMALH., Uzbekistan: Namangan prov., Kosonsoy district, Soyovul VLG, 08. May 2000, YG, Pop district, KMR, Dugob VLG, 17 July 2002, YG, Fergana prov., 1923, (ZAPROMETOV 1925, 1926; RAMAZANOVA et al. 1986).

♂*P. eremuri* KOMAROV, Scripta Bot. Horti Univ. Imper. Petrop.: 30 (1895).

On *Eremurus regelii* VVED., Uzbekistan: Namangan prov., Pop district, Guliston VLG, 17 July 2002, YG; CMR, 08 June 2011, Figure 3 (F), YG.

♂*P. graminis* PERS., Neues Mag. Bot. 1: 119 (1794).

On *Triticum aestivum* L., *Hordeum murinum* L., *Aegilops* sp., *Avena sativa* L., *A. sterilis* subsp. *ludoviciana* (DURIEU) GILLET & MAGNE, *Poa bulbosa* L., *Berberis oblonga* (RGL.) SCHNEID., *B. vulgaris* L., Uzbekistan: Namangan prov., Uchqurgon district, Qugay VLG, 13 May 2000, YG, Chortoq district, Chortoq foothills, Iskivot VLG, 11 May 2000, YG, Kosonsoy district, Soyovul VLG, 9 May 2000, 26 May 2002, YG, Turaqurgon district, Yangiobod VLG, 03 April 2001 April 2001, YG, Yangiurgon district, CMR, Nanay VLG, 30 June 2001, YG, Chust district, KMR, Gova VLG, 23 May 2002, YG, Fergana prov., 1912–1924, (ZAPROMETOV 1925, 1926, 1928; RAMAZANOVA et al. 1986); CMR, 07 June 2011, Fig. 2 (C, D), YG.

Note: We collected the rust on the alternate host *Berberis* spp in spring and summer, it heavily infected the hosts.

♂*P. hieracii* (Röhl.) H. Mart., Prodr. Fl. Mosq., Edn 2: 227 (1817)

On *Cichorium intybus* L., *Taraxacum officinale* WEGG., *T. brevirostre* HAND.-MAZZ., Uzbekistan: Namangan prov., Chortoq district, Peshqurgon VLG, 29 June 2001, YG, Chust district, KMR, Dustlik dam olish lageri, 10 July 2001, YG, Gova VLG, 23 May 2002, YG, Yangiurgon district, Kuksaroy dam olish maskani, 30 June 2001, YG, Nanay VLG, 25 July 2002, YG, Norin district, Norinkapa VLG, inside Kattabog, 28 June 2001, YG, Pop district, KMR, Dugob VLG, 17 July 2002, YG; Fergana prov., Fergana district, Shahimardan, 15 June 1949, (RAMAZANOVA et al. 1986).

Note: This rust species is widespread and infected *Cichorium intybus* heavily in the study area; the second collection of this rust species on *Taraxacum brevirostre*, the first collection was in 1949 in the Fergana valley.

♂*P. hordei* G.H. OTTH, Mitt. naturf. Ges. Bern 711–744: 114 (1871) [1870]

On *Hordeum murinum* L., *H. vulgare* L., Uzbekistan: Namangan prov., KMR, Chodak VLG, 06 May 2000, YG; Fergana prov., 1912–1924, (ZAPROMETOV 1925, 1926, 1928; RAMAZANOVA et al. 1986).

Note: It is the second collection from the study site on *Hordeum murinum* and previously collected on *H. vulgare* in 1912–1924.

♂*P. hyperici* GOLOVIN, Centr. Asian Univ. Stud., N.S. 14(no. 5): 13 (1950)

On *Hypericum perforatum* L., Uzbekistan: Namangan prov., Chust district, KMR, Dustlik dam olish lageri, 10 July 2001, YG, Uychi district, Qizilrovot VLG, 14 May 2000, YG.

♂*P. iridis* WALLR., in RABENHORST, Deutschl. Krypt.-Fl. (Leipzig) 1: 23 (1844)

On *Iris halophila* var. *sogdiana* (BUNGE) GRUBOV, Uzbekistan: Namangan prov., Yangiurgon district, CMR, Kuksaroy dam olish maskani, 29 April 2001, YG, 25 July 2002, YG.

♂*P. isiacae* (THÜM.) G. WINTER, in KUNZE, Plantae orient-ross.: 127 (1887).

On *Lepidium latifolium* L., Uzbekistan: Fergana valley, Namangan prov., 1924, (RAMAZANOVA et al. 1986); Fergana prov., south Fergana kanali, 06 June 1949, (RAMAZANOVA et al. 1986).

♂*P. komarovii* TRANZSCHEL EX P. SYD. & SYD. [as 'komarovi'], Monogr. Uredin. (Lipsiae) 1(3): 451 (1903) [1904].

On *Impatiens parviflora* DC., Uzbekistan: Namangan prov., Pop district, KMR, Qandagon VLG 26 September 2000, YG, Dugob VLG, 03 May 2002, YG.

♂*P. leveillei* MONT., in GAY, Hist. fis. y polit. Chile, Bot. 8: 41 (1852)

On *Geranium collinum* STEPHAN EX WILLD., Uzbekistan: Fergana prov., Ollovuddinsoy, 03 July 1950 (RAMAZANOVA et al. 1986).

♂*P. longirostris* KOM., Fungi Rossiae Exsicc.: no. 57 (1895).

On *Lonicera humilis* KAR. & KIR., Uzbekistan: Namangan prov., Yangiurgon district, CMR, Nanay VLG, 01 October 2001, YG; CMR, 08 June 2011, Fig. 2 (F, G), YG.

Note: The rust occurred together with *Microsphaera loniceriae* (DC.) WINT RABENH. on leaves of *Lonicera humilis*.

♂*P. magnusiana* KOERN., Hedwigia 15: 179 (1876).

On *Phragmites australis* (CAV.) TRIN. ET STEND., Uzbekistan: Namangan prov., Chortoq district, Peshqurgon VLG in watercourse, 23 July 2000, YG

Note: Only one collection from the foothills.

♂*P. malvacearum* MONT., Hist. fis. y polit. Chile, Bot. 8: 43 (1852).

On *Malva neglecta* WALLR., *Malva* sp., *Althaea nudiflora* LINDL., Uzbekistan: Namangan prov., Pop district, KMR, Chodak VLG, 06 May 2000, YG, Dugob VLG, 29 September 2001,

YG, Yangiqurgon district, CMR, Nanay VLG, 10 May 2000, YG, 25 May 2002, YG, 25 July 2002, YG, Chust district, KMR, Gova VLG, 23 May 2002, YG, 23 July 2002, YG, Fergana, 1914–1926, (ZAPROMETOV 1925, 1926, 1928; RAMAZANOVA et al. 1986).

Note: We found the rust fungi together with *Cercospora polymorpha* BUBAK. and other specimens with *Ramularia malvae* FUECKEL on leaves of *Malva neglecta*.

^*P. melasmioides* TRANZSCHEL, in Sydow & Sydow, Monogr. Uredin. (Lipsiae) 1(3): 538 (1904)

On *Aquilegia* sp., Uzbekistan: Fergana prov., (NEVODOVSKY 1956)

^*P. menthae* PERS., Syn. meth. fung. (Göttingen) 1: 227 (1801).

On *Mentha longifolia* (L.) L., *Origanum vulgare* subsp. *gracile* (K. KOCH) LETSW., Uzbekistan: Namangan prov., Pop district, KMR, Qandagon VLG, 18 July 2000, YG, Dugob VLG, 17 July 2002, YG, Chortoq district, Iskovot VLG, 23 July 2000, YG, Uychi district, Qizilrovot VLG, 24 July 2000, YG, 29 June 2001, YG, Chust district, KMR, Dustlik lageri, 10 July 2001, YG, 23 July 2002, YG, Fergana prov., Fergana district, river of Shohimardonsoy, 10 July 1950, 17 August 1965, (RAMAZANOVA et al. 1986).

Note: This species is widespread and can be collected in moist/wet foothills and mountains from the study region in June, July, August; it can be found high in the mountain area. The rust was also reported on *Nepeta mariae* REGEL, *N. olgae* REGEL in other areas of Uzbekistan (GOLOVIN 1950; PANFILOVA & GAPONENKO, 1963).

^*P. minussensis* THÜM., Bull. Soc. Imp. nat. Moscou 53: 214 (1878).

On *Lactuca orientalis* (BOISS.) BOISS., Uzbekistan: Fergana prov., Fergana district, Shohimardon, 15 June 1949, (RAMAZANOVA et al. 1986).

•*P. obtusata* G.H. Oth ex E. Fisch., Hedwigia 37: 57 (1898).

On *Saccharum spontaneum* L., Uzbekistan: Namangan prov., Mingbuloq district, Alami desert, 03 May 2000, YG.

Note: New record for mycobiota of Uzbekistan.

^*P. phragmitis* (SCHUM.) KORN., Hedwigia 15: 179 (1876).

On *Phragmites australis* (CAV.) TRIN., *Spinacia turkestanica* L., Uzbekistan: Namangan prov., Turaqurgon district, Kuymazor VLG, 24 April 2001, YG, Mingbuloq district, Alami desert VLG, 03 May 2000, YG., Chust district, Kakliqurgon VLG, 17 July 2000, Uchqurgon district, 4-bulim, 13 May 2000, YG.

Note: We collected the rust species one specimen with *Stagonospora cookei* E. CASTELL. & GERMANO and both pathogen fungal species were heavily infecting leaves of common reed.

^*P. plicata* KOM., Scripta Bot. Horti Univ. Imper. Petrop. 4: 28 (1895).

On *Prangos pabularia* LINDL., Uzbekistan: Namangan prov., Pop district, Guliston VLG, 17 July 2002, YG.

^*P. poarum* NIELSEN, Bot. Tidsskr. 3(2): 34 (1877).

On *Tussilago farfara* L., *Poa pratensis* L., *P. annua* L., Uzbekistan: Namangan prov., Pop district, KMR, Chodak VLG, 06 May 2000, YG, Qandagon VLG, 05 May 2000, YG, Yangi-

qurgon district, CMR, Nanay VLG, 25 May 2002, YG; Fergana prov., Fergana district, river of Shahimardansay, 17 July 1965 (RAMAZANOVA et al. 1986).

Note: First report of this rust in Uzbekistan on *Tussilago farfara*. O–I development phase.

^*P. punctata* LINK, Mag. Gesell. naturf. Freunde, Berlin 7: 30 (1816) [1815]

On *Galium aparine* L., Uzbekistan: Namangan prov., Chust district, KMR, inside Dustlik dam olish lageri, 10 July 2001, YG, 23 July 2002, YG.

^*P. punctiformis* (F. STRAUSS) RÖHL., Deutschl. Fl. (Frankfurt) 3(3): 132 (1813).

On *Cirsium* sp., Uzbekistan: Namangan prov., Turaqurgon district, Kuymazor VLG, 24 April 2001, YG.

^*P. pygmaea* ERIKS., Fungi paras. scand.: no. 449 (1895).

On *Berberis oblonga* (REGEL) SCHNEID. Uzbekistan: Namangan prov., Yangiqurgon district, CMR, Kuksaroy dam olish maskani, 25 May 2002, YG.

^*P. recondita* DIETEL & HOLW., Bull. Soc. bot. Fr. 4: 798 (1857).

On *Thalictrum minus* L., *Triticum aestivum* L., *Elymus repens* (L.) GOULD, *Lolium* sp., Uzbekistan: Fergana prov., Oloviddinsoy 06 June 1950, (RAMAZANOVA et al. 1986); Namangan prov., Norin district, Norinkapa VLG, 28 May 2002, YG, Uchtepa VLG, 14 May 2000, YG, Mingbuloq district, Xorazm jamoa xujaligi, 30 May 2002, YG, Yangiqurgon district, CMR, Nanay VLG, 25 July 2002, YG, Pop district, KMR, Sansaloq VLG, 18 July 2000, YG.

Note: We also found *Hendersonia stipae-pennatae* FAUTREY on leaves of *Elymus repens*. The two pathogenic species were infecting the host plant heavily. *Cladosporium* sp was collected on *Lolium* sp. with rust species.

^*P. schirajewskii* TRANZSCHEL, Mycotheca rossica 3 & 4: nos 109–110 (1911).

On *Serratula sogdiana* BUNGE, Uzbekistan: Fergana prov., Fergana district, Shohimardon, 10 June 1950, (RAMAZANOVA et al. 1986).

^*P. stipina* TRANZSCHEL, Krypt.-Fl. Brandenburg (Leipzig) 5a: 477 (1913).

On *Origanum vulgare* subsp. *gracile* (K. KOCH) LETSW., *Perovskia scrophulariifolia* BUNGE, Uzbekistan: Namangan prov., Yangiqurgon district, CMR, Kuksaroy dam olish maskani, 30 June 2001, YG; Fergana prov., Basin of Shohimardon, 10 July 1950, (RAMAZANOVA et al. 1986).

^*P. striiformis* WESTEND, Bull. Acad. R. Sci. Belg., Cl. Sci. 21(2): 235 (1854).

On *Triticum vulgare* WILLD., *T. aestivum* L., *Hordeum bulbosum* L., *H. murinum* subsp. *leporinum* (LINK) ARCANG., *H. vulgare* L., *Lolium* sp., *Bromus sterilis* L., *Calamagrostis pseudophragmites* (HALLER F.) KOELE Uzbekistan: Namangan prov., Chortoq district, Chortoq foothills, Peshqurgon VLG, 29 July 2001, YG, 26 May 2002, YG, Yangiqurgon district, CMR, Nanay VLG, 25 May 2002, YG, Chust district, KMR, Gova VLG, 23 July 2002, YG, Uchqurgon district, 4-bulim, 13 May 2000,

YG; Fergana prov., 03 July 1950, (RAMAZANOVA et al. 1986), Margilon city, 25 May 1949, (RAMAZANOVA et al. 1986), 1912–1924, (ZAPROMETOV 1925, 1926, 1928).

Note: This rust species was collected from various host plant genera.

^*P. tanacetii* DC., in LAMARCK & DE CANDOLLE, Fl. franç., Edn 3 (Paris) 2: 222 (1805).

On *Tanacetopsis* sp., Uzbekistan: Fergana prov., Margilon, 1923, (RAMAZANOVA et al. 1986).

^*P. thlaspeos* FICINUS & C. SCHUB., Fl. Geg. Dresd. 2: 254 (1823)

On *Thlaspi* sp., *Th. arvense* L., Uzbekistan: Fergana prov., Fergana district, Shohimardon basinin, Pamiro-Alai Mountain, 16 June 1949, (RAMAZANOVA et al. 1986); Namangan prov., Turaqurgon district, Kuymazor VLG, 05 August 2002, YG.

Note: These species have been collected the second time from study region since 1949.

^*P. xanthii* SCHWEIN., Schr. naturf. Ges. Leipzig 1: 73 (1822).

On *Xanthium strumarium* L., Uzbekistan: Namangan prov., Norin district, Norinkapa VLG, 28 June 2001, YG, 03 September 2001, YG, 28 July 2002, YG, Mingbuloq district, Amali desert, 28 September 2001, YG.

Note: This rust species was collected only in desert/dry zones and the vegetation is from June to September in the study area. It heavily infected the leaves of host plants. This rust economically damages sunflower in Europe. This fungus was first reported from Kashkadarya prov., south of Uzbekistan on 14 July 1995 (NURALIEV 1999). *P. xanthii* is originally distributed in the North America, South Africa and Europe (DÁVID et al. 2003). However, in 1995 it occurred in South Uzbekistan and 2000–2003 in north east Uzbekistan (GAFFOROV 2005b). Recently reported from Northeast China (ZHAO et al. 2014). It appears that the rust is now migrating to China, spreading to worldwide, and many varieties of rust species in other host plants species were described. We think that this is a species complex and molecular study of this rust on a globe scale are necessary.

^*P. vagans* (DC.) ARTHUR, Manual of the Rusts in the United States & Canada: 313 (1934)

On *Epilobium hirsutum* L., Uzbekistan: Namangan prov., Yangiqurgon district, CMR, near to river Nanaysoy, 01 October 2001, YG.

Note: Previously reported in 1954, 1961 from Tashkent prov. in Uzbekistan (PANFILOVA & GAPONENKO 1963; RAMAZANOVA et al. 1986).

^*P. vincae* (DC.) BERK., in Smith, Engl. Fl., Fungi (Edn 2) (London) 5(2): 364 (1836).

On *Vinca erecta* REGEL & SCHMALH., Uzbekistan: Fergana prov., foothills, 27 June 1970, (RAMAZANOVA et al. 1986).

^*P. violae* (SCHUMACH.) DC., in DE CANDOLLE & LAMARCK, Fl. franç., Edn 3 (Paris) 6: 62 (1815).

On *Viola suavis* M.BIEB., Uzbekistan: Fergana prov., Fergana district, Shohimardon, 15 June 1949, (RAMAZANOVA et al. 1986).

^*P. ziziphorae* P. SYD. & SYD., Monogr. Uredin. (Lipsiae) 1(2): 304 (1902) [1904].

On *Ziziphora pedicellata* PAZIJ. ET VVED., Uzbekistan: Namangan prov., Pop district, KMR, Qandagon VLG, 18 July 2000, YG, 17 July 2002, YG.

Uromyces LINK.

^*U. agrostidis* (GONZ.FRAG.) A.L. GUYOT, Encyclop. Mycol. 8: 73 (1938).

On *Agrostis gigantea* ROTH., Uzbekistan: Namangan prov., Pop district, KMR, Chodak VLG in the foothills, 06 May 2001, YG.

^*U. alhagi* SZEMB., Mater. Mikol. Fitopat. Ross. 1(1): 27 (1915).

On *Alhagi sparsifolium* (SHAP.) SHAP., Uzbekistan: Namangan prov., 1916 (ZAPROMETOV 1925, 1926, 1928).

^*U. appendiculatus* F. STRAUSS, Exanth. Pflanzen. (Wien): 277 (1833).

On *Phaseolus vulgaris* L., Uzbekistan: Namangan prov., Norin district, Norinkapa VLG, 28 July 2002, YG.

^*U. cobresiae* KORBONSK, Notul. syst. Sect. cryptog. Inst. bot. Acad. Sci. U.S.S.R. 7: 178 (1951)

On *Carex* sp, Uzbekistan: Namangan prov., Pop district, KMR, near to river Indigansoy, 06 July 2001, YG.

^*U. eurotiae* TRANZSCHEL, Annl. mycol. 5(6): 549 (1907).

On *Krascheninnikovia ceratoides* (L.) GUELLENST., Uzbekistan: Namangan prov., Turaqurgon district, Kuymazor VLG, Chust-Pop foothills, 12 May 2002, YG.

^*U. glycyrrhizae* (RABENH.) MAGNUS, Ber. dt. bot. Ges. 8: 383 (1890).

On *Glycyrrhiza glabra* L., Uzbekistan: Namangan prov., Chust district, Dam VLG, 06 May 2000, YG, Mingbuloq district, Momoxon VLG, 16 July 2000, YG; Fergana prov., 1914–1924 (RAMAZANOVA et al. 1986).

^*U. fallens* (DESM.) KERN. ET BARTH., Handbook of North American Ured., Edn 1: 61 (1928).

On *Trifolium pratense* L., Uzbekistan: Namangan prov., Uchqurgon district, Qugay VLG, 13 May 2000, YG.

^*U. lineolatus* (DESM.) J. SCHRÖT., in RABENHORST, Fungi europ. exsicc.: no. 2077 (1876).

On *Daucus carota* L., Uzbekistan: April 1949, (GOLOVIN 1950; RAMAZANOVA et al. 1986).

•*U. kochiae* SYD. & P. SYD., Annl. mycol. 10(2): 215 (1912).

On *Bassia prostrata* (L.) BECK, Uzbekistan: Namangan prov., Turaqurgon district, Kuymazor VLG, Chust-Pop foothills, 30 April 2001, YG.

Note: New record for mycobiota of Uzbekistan.

^*U. nidificans* TRANZSCHEL, Annl. mycol. 5(6): 548 (1907).

On *Climacoptera korshinskyi* (DROBOW) BOTSCH., Uzbekistan: Namangan prov., 06 June 1949, (RAMAZANOVA et al. 1986).

[♁]*U. pisi-sativi* (PERS.) LIRO, Bidr. Känn. Finl. Nat. Folk 65: 100 (1908).

On *Astragalus* sp., Uzbekistan: Namangan prov., Yangiqurgon district, CMR, Kuksaroy dam olish maskani, 30 June 2001, YG.

[♁]*U. polygona* MAGN. = *Uromyces polygona-avicularis* (PERS.) G.H. OTTH, Mitt. naturf. Ges. Bern 531–552: 87 (1864) [1863].

On *Polygonum aviculare* (PERS.) KARST., Uzbekistan: Namangan prov., Pop district, KMR, upper river Irgalisoy, 07 July 2001, YG.

[♁]*U. rumicis* (SCHUM.) WINT., Pilze Deutschl.: 145 (1884).

On *Rumex* sp., *R. aquaticus* L., Uzbekistan: Namangan prov., Yangiqurgon district, CMR, Nanay VLG, 01 October 2001, 25 July 2002, YG, Cust district, Boymoq VLG, 07 May 2000, YG, Turaqurgon district, Kuymazor VLG, 30 April 2001, YG.

[♁]*U. salsolae* REICHARDT, Verh.zool.-bot. Ges. Wien 27: 842 (1877).

On *Climacoptera* sp., Uzbekistan: Namangan prov., Mingbuloq district, Alami desert, 23 November 2000, YG.

Note: This rust species occurs together with *Phoma salsala* SACC on *Climacoptera* sp. in steppe area

[♁]*U. scrophulariae* (DC.) BERK. & BROOME EX J. SCHRÖT., Symbolae mycologicae: 63 (1869).

On *Scrophularia* sp., Uzbekistan: Namangan prov., Yangiqurgon district, CMR, Nanay VLG, 01 October 2001, YG.

[♁]*U. scutellatus* (PERS.) LEV., Annls Sci. Nat., Bot., sér. 3 8: 371, 375 (1847).

On *Euphorbia esula* L., Uzbekistan: Namangan prov., Pop district, KMR, Qandagon VLG, Irgaliysoy, 05 July 2001, YG.

Note: First report on *Euphorbia esula* from Uzbekistan.

[♁]*U. setariae-italicae* YOSHINO, Bot. Mag., Tokyo 20: 247 (1906).

On *Setaria viridis* (L.) BEAUV., Uzbekistan: Namangan prov., Pop district, KMR, 26 September 2001, YG.

[♁]*U. sophorae-flavescentis* KUSANO, Bot. Mag., Tokyo 18: 4 (1904).

On *Styphnolobium japonicum* (L.) SCHOTT, Uzbekistan: Fergana prov., Fergana city, 06 June 1919, (RAMAZANOVA et al. 1986).

[♁]*U. striatus* J. SCHRÖT., Abh. Schles. Ges. Vaterl. Kult. Abth. Naturwiss. 48: 11 (1870) [1869].

On *Medicago sativa* L., Uzbekistan: Namangan prov., Yangiqurgon district, CMR, Nanay VLG, 10 May 2000, YG, Mingbuloq district, Momoxon VLG, 15 July 2000, YG, Fergana prov., 1922–1924 (ZAPROMETOV 1925, 1926, 1928), Chinboy district, Andreyeva opitnaya stansiya, September, 1952 (RAMAZANOVA et al. 1986).

[♁]*U. thapsi* (OPIZ) BUBÁK, ARCH. PŘÍRODOV. Výzk. Čech. 13(5): 96 (1906).

On *Verbascum blattaria* L., Uzbekistan: Namangan prov., Pop district, KMR, Qandagon VLG, 05 May 2000, YG.

[♁]*U. tuberculatus* (FUCKEL) FUCKEL, Jb. Nassau. Ver. Naturk. 23–24: 64 (1870) [1869–70].

On *Euphorbia franchetii* B. FEDTSCH., Uzbekistan: Fergana Province, Fergana district, Basin of Shahimardan, 10 July 1948, (RAMAZANOVA et al. 1986).

UNCONNECTED RUSTS

Aecidium PERS.

[♁]*A. orbiculare* BARCLAY, J. Asiat. Soc. Bengal, Pt. 2, Nat. Sci. 60(2): 227 (1891).

On *Clematis orientalis* L., Uzbekistan: Namangan prov., Yangiqurgon district, CMR, around floodplain forest of Podshootasoy, 30 June 2001, 25 May 2002, YG, Uchqurgon district, Qugay VLG, 29 September 2002, YG.

[♁]*A. ranunculacearum* DC., in DE CANDOLLE & LAMARCK, Fl. franç., Edn 3 (Paris) 5/6: 97 (1815).

On *Ceratocephala falcata* (L.) PERS., Uzbekistan: Namangan prov., Mingbuloq district, Alami VLG, Qoraqalpoq steppe, 03 May 2000, YG.

DISCUSSION

Considering the Fergana valley flora, which comprises about 2625 plant species (ARIFXANOVA 1967), it could be concluded that the number of 95 rust species recorded so far is relatively small. In comparison, in the much smaller basin of Angren river basin with more than 1500 plant species PANFILOVA & GAPONENKO, (1963) reported 124 rust species on 212 host plants. The Uzbekistan plant flora consists of more than 4500 species and 261 rusts species were found (RAMAZANOVA et al. 1986).

Without taking into account the fifty two new rust fungi records, it can be seen that as few as 43 rust species were recorded in Fergana valley between 1914 and 1950. From ZAPROMETOV'S publication (1925, 1926, 1928; GOLOVIN, 1950) until 2011, 52 rusts new to study area have been determined. The following species, which we did not find during our field work, have been reported previously from Fergana valley: from *Puccinia* 13 species, *Uromyces* 5, *Phragmidium* 1 and *Melampsora* 1 in total 20 species (ZAPROMETOV 1925, 1926, 1928; RAMAZANOVA et al. 1986). The number of rust fungi reported from the study site now totals 95 species. More than a quarter of the rust species found in the area live on host species belonging to Compositae namely from the genera *Artemisia* (*A. absinthium*, *A. annua*, *A. dracuncululus*, *A. ferganensis*, *A. tenuisecta*, *A. serotina*, *A. vulgaris*), *Cousinia* (*C. microcarpa*, *C. vicaria*, *C. strobilocephala*, *Cousinia* sp) Poaceae, *Hordeum* (*H. murinum*, *H. murinum* subsp. *leporinum*, *H. bulbosum*, *H. vulgare*), Rosaceae, *Rosa* (*R. ecae*, *R. fedtschenkoana*, *R. beggeriana*, *R. transturkestanica*, *Rosa* sp.); Euphorbiaceae, *Euphorbia* (*E. esula*, *E. helioscopia*, *E. esula* subsp. *tommasiniana*, *E. franchetii*, *E. turkestanica*); Salicaceae, *Populus* and *Salix* (each genus 3 species). 67 rust species found in these 7 host families and constitute 70% rusts biota in the Fergana valley and adjacent area. The predominant rust fungi on plant families of the study region are more similar to those of rust biota on plants in the southern regions of Central Asia as shown by the mycological data obtained by GOLOVIN

(1944); GAMALICKAYA (1964); KOSHKILOVA (1964); KURBAN-SAKHATOV (1975); KOSHKILOVA & FROLOV (1973); KARBONSKAYA (1969) and others.

Of great significance in the economy of the study area are grain crops, which badly suffered from diseases. Thus, the wheat is infected by stripe rust (*Puccinia striiformis*) at early growth stages of the host plants and stem or black rust (*Puccinia graminis*) causes considerable damage, especially during seasons with much rainfall.

Medicinal plants suffer especially badly from causative agents. Such medicinal herbs as *Rosa*, *Crataegus*, *Spiraea*, *Berberis*, *Artemisia*, *Cichorium*, *Rumex*, *Polygonum*, *Trifolium*, *Althaea*, *Malva*, *Lonicera*, *Sonchus*, *Cirsium*, *Euphorbia*, *Arctium*, *Ziziphora*, and *Medicago* are infected by rust, which retard growth and development of plants, decreasing the yield of biomass and their commercial value.

Fergana valley has approximately 36% of the currently known rust biota of Uzbekistan. This diversity is represented by 7 genera and 95 species. Rust fungi parasitize 140 host species belonging to 28 families and 92 genera. The present study indicated that increased taxon samplings from other continents are needed to elucidate the taxonomy and diversity of Uredinales from Central Asia. However, an additional survey is needed in Uzbekistan to obtain a more precise assessment of the major rust fungi species that may be found. The checklist from Uzbekistan should be considered provisional as a great deal of exploration, investigation, and taxonomic revision is required before a complete checklist of the study area is obtained. This publication represents progress toward that goal.

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