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First checklist of rust fungi in the genus *Puccinia* from Himachal Pradesh, India

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Abstract

A checklist of rust fungi belonging to the genus *Puccinia* was prepared for Himachal Pradesh, India. All *Puccinia* species published until 2014 are included in this list. A total of 80 species have been reported on 91 plant species belonging to 33 families. The family Poaceae supports the highest number of species (26 species) followed by Ranunculaceae (8), Asteraceae (7), Apiaceae and Polygonaceae (6 each), Rubiaceae and Cyperaceae (3 each), Acanthaceae, Berberidaceae, Lamiaceae and Saxifragaceae (2 each). The other host plant families are associated with a single species of *Puccinia*. This study provides the first checklist of *Puccinia* from Himachal Pradesh.

Key words – checklist – Himachal Pradesh – *Puccinia* spp. – rust fungi

Introduction

Himachal Pradesh is a hilly state situated in the heart of Himalaya in the northern part of India. The state extends between 30° 22' 40" – 33° 12' 20" north latitudes and 75° 44' 55" – 79° 04' 20" east longitudes. The total area of the state is 55,670 km², covered with very high mountains to plain grasslands. It is a mountainous state with elevation ranging from about 350 to 7,000 meters above sea level. The climatic conditions vary from hot and sub-humid tropical in the southern tracts to cold, alpine and glacial in the northern and eastern mountain ranges with increasing elevation. These variations lead to great biodiversity in the state. Two-thirds of the area is covered by very dense evergreen to deciduous forest types. Alpine shrub and meadows are found in west and northeast Himalaya; alders, birches, rhododendrons and moist alpine shrubs are found as the regional vegetation. Himachal Pradesh has 12 major national parks and sanctuaries to conserve the flora and fauna of the main Himalayan range. However, the main threat for extinction of floral diversity is no doubt, the activities of human beings, but plant diseases also contribute to decline. The changeable geographical and climatic conditions of the state are favourable for the growth and development of plant pathogens. Bacteria, fungi and viruses have been reported as plant pathogens from the state of which rusts contribute as the main fungal group reported here. Much is known about these fungi from the state. One of the most important characteristics of plant rusts is their exceptionally high degree of host specificity. The vast biodiversity and climatic conditions of the

state contribute to the vast diversity, distribution and host range of this fungal group (<http://hpplanning.nic.in>; https://en.wikipedia.org/wiki/Geography_of_Himachal_Pradesh).

Puccinia Pers. (1801) is an obligate plant pathogen genus and contains about 4,000 species. This checklist provides the first comprehensive overview of the rust genus *Puccinia* in Himachal Pradesh. It facilitates access to scattered Himalayan literature with special reference to the state on the topic that may not be readily available to students studying plant pathology in India and abroad.

Materials & Methods

This checklist was based on an exhaustive bibliographic survey of the literature published in various national and international journals, monographs, books, book chapters and even magazines on the rust genus *Puccinia*. A geographical map of the state is provided in order to understand the distribution of the rust fungi in Himachal Pradesh (Fig. 1). Family wise list of susceptible plant host was prepared to assess the host range of *Puccinia* in the state. Species distribution was assessed on the basis of their occurrence on plant host and their families and their geographical distribution. A brief description on taxonomy and occurrence of this fungus in different regions of the country is also presented. Some species names as reported in the cited publications have been replaced with their currently accepted name according to the Species Fungorum (www.speciesfungorum.org) website.



Fig 1 – Map of Himachal Pradesh

Results

A total of 80 species of *Puccinia* have been identified and reported from Himachal Pradesh. The rusts were recorded on 91 plant host species that belong to 80 genera and 33 families. Twenty-six species were found associated with family Poaceae followed by Ranunculaceae (8), Asteraceae (7), Apiaceae and Polygonaceae (6 each), Rubiaceae and Cyperaceae (3 each), Acanthaceae, Berberidaceae, Lamiaceae, and Saxifragaceae (2 each). The remaining host plant families were associated with a single species of *Puccinia* (Table 1). After compilation of the literature it was noticed that most of the rust fungi were reported from Shimla and nearby regions. However, reports are also available from various regions of Solan, Kangra, Kullu, Chamba, Hamirpur, Una and even

Lahul Spiti. In addition to Himachal Pradesh, the fungal group was found distributed outside the state as from Jammu & Kashmir (J&K); Punjab (PB); Haryana (HR); Delhi; Uttarakhand (Uttk); Uttar Pradesh (UP); Rajasthan (RJ); Madhya Pradesh (MP); Gujarat (GJ); Bihar, Chhattisgarh, Tamil Nadu (TN); Andhra Pradesh (AP); Maharashtra (MS); Karnataka; Kerala; Assam; West Bengal (WB) and Nagaland (NL). The abbreviated state names are used in the list. The morphological appearance of the rust pathogen on plant hosts and microscopic characteristics of urediniospores and teliospores are presented (Figs 2, 3).

Table 1 *Puccinia* species reported from Himachal Pradesh on different host families.

Family	<i>Puccinia</i> species	Number of <i>Puccinia</i> species
Acanthaceae	<i>P. tweediana</i> , <i>P. polliniae</i>	2
Amaryllidaceae	<i>P. allii</i>	1
Apiaceae	<i>P. bupleuri-falcate</i> , <i>P. ellisii</i> , <i>P. pimpinellae</i> , <i>P. apii</i> , <i>P. bulbocastani</i> , <i>P. saviculae</i>	6
Asteraceae	<i>P. ahmadiana</i> , <i>P. atropuncta</i> , <i>P. carthami</i> , <i>P. sonchi</i> , <i>P. tanaceti</i> , <i>P. tricholepidis</i> , <i>P. opizii</i>	7
Balsaminaceae	<i>P. komarovi</i>	1
Berberidaceae	<i>P. brachypodii</i> , <i>P. calthae</i>	2
Brassicaceae	<i>P. thlaspeos</i>	1
Caryophyllaceae	<i>P. arenariae</i>	1
Cyperaceae	<i>P. caricis</i> var. <i>himalayensis</i> , <i>P. caricis-filicinae</i> , <i>P.</i> <i>caricis-nubigenae</i>	3
Discoraceae	<i>P. dioscoreae</i>	1
Gentianaceae	<i>P. gentianae</i>	1
Geraniaceae	<i>P. geranii-sylvaticae</i>	1
Iridaceae	<i>P. iridis</i>	1
Lamiaceae	<i>P. excels</i> , <i>P. menthae</i>	2
Oleaceae	<i>P. chrysopogi</i>	1
Onagraceae	<i>P. circaeae</i>	1
Oxalidaceae	<i>P. sorghi</i>	1
Plantaginaceae	<i>P. pacifica</i>	1
Poaceae	<i>P. andropogonis</i> , <i>P. anthistiriae</i> , <i>P. arthraxonis</i> , <i>P.</i> <i>chrysopogi</i> , <i>P. coronata</i> , <i>P. coursinae</i> , <i>P.</i> <i>cynodontis</i> , <i>P. dactylidina</i> , <i>P. duthiae</i> , <i>P. eulaliae</i> , <i>P.</i> <i>erianthi</i> , <i>P. glumarum</i> , <i>P. graminis</i> , <i>P. graminis-</i> <i>agropyri</i> , <i>P. graminis-poeae</i> , <i>P. himalensis</i> , <i>P.</i> <i>invenusta</i> , <i>P. neyaudiae</i> , <i>P. minutissima</i> , <i>P.</i> <i>pogonatheri</i> , <i>P. purpurea</i> , <i>P. pusilla</i> , <i>P. recondite</i> var. <i>simlensis</i> , <i>P. sorghi</i> , <i>P. striiformis</i> , <i>P. striiformis</i> f. <i>muehlenbergii</i>	26
Polygonaceae	<i>P. bistortae</i> , <i>P. fagopyri</i> , <i>P. nepalensis</i> , <i>P. nitida</i> , <i>P.</i> <i>polygone</i> , <i>P. polygone-amphibii</i>	6
Ranunculaceae	<i>P. agrostidis</i> , <i>P. calthae</i> , <i>P. lycoctoni</i> , <i>P. persistens</i> , <i>P. recondita</i> var. <i>simlensis</i> , <i>P. rubigo-vera</i> , <i>P. trolii</i> , <i>P. ustalis</i>	8
Rhamnaceae	<i>P. himalensis</i>	1

Table 1 continued

Family	<i>Puccinia</i> species	Number of <i>Puccinia</i> species
Rosaceae	<i>P. flavipes</i>	1
Rubiaceae	<i>P. colletiana</i> , <i>P. leptodermidis</i> , <i>P. punctata</i>	3
Saxifragaceae	<i>P. saxifragae-cilliatae</i> , <i>P. saxifragae-micranthae</i>	2
Smilacaceae	<i>P. prainiana</i>	1
Urticaceae	<i>P. urticae</i>	1
Violaceae	<i>P. violae</i>	1
Xanthorrhoeaceae	<i>P. eremuri</i>	1
Zingiberaceae	<i>P. roscoae</i>	1

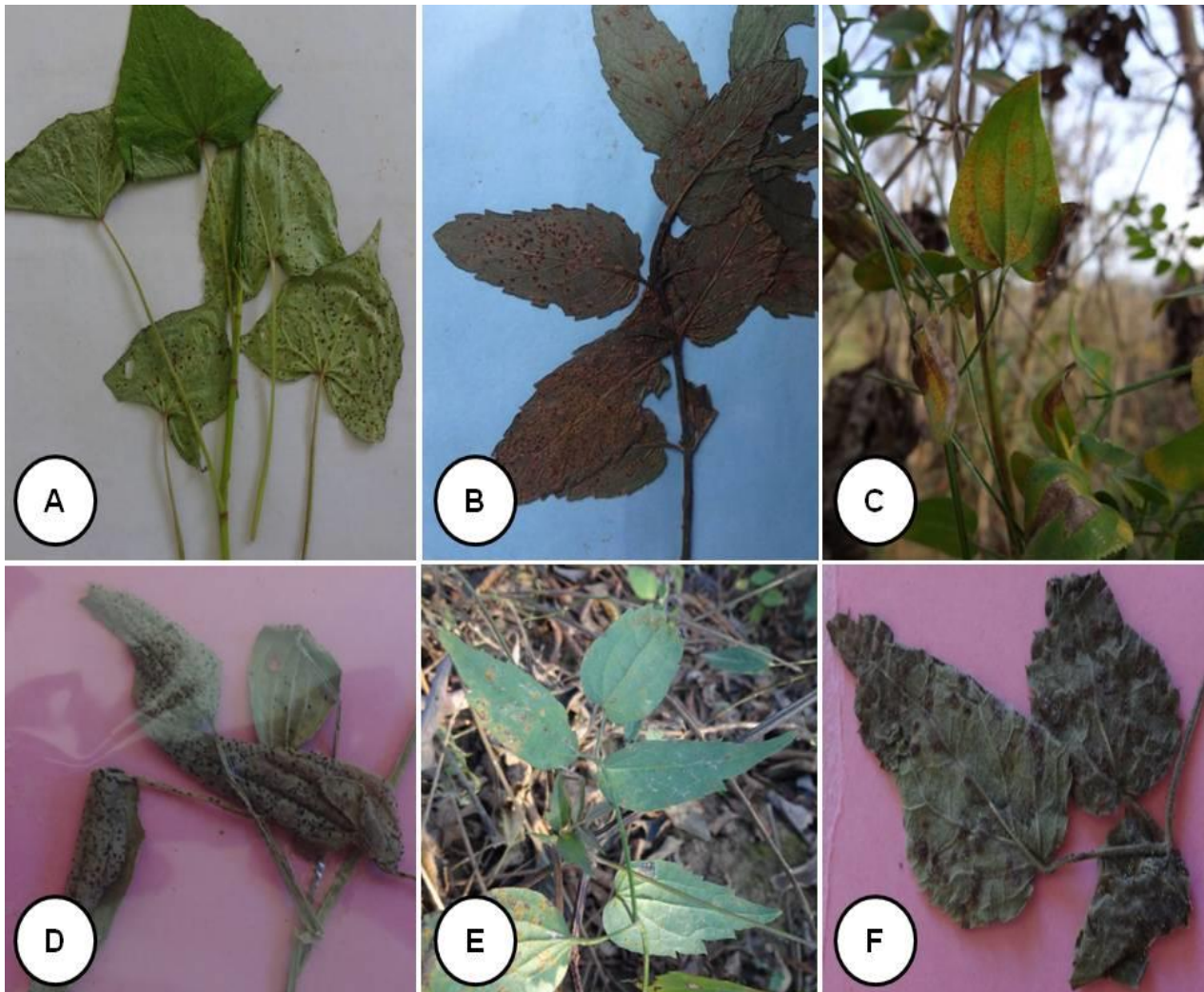


Fig 2 – Plant hosts showing rust infection. A) *Puccinia fagopyri* on *Fagopyrum esculentum* B) *P. menthae* on *Mentha longifolia* C, D *P. colletiana* on *Rubia cordifolia* (uredinia and telia) E, F *Puccinia* sp. on *Clematis* sp. (uredinia and telia).

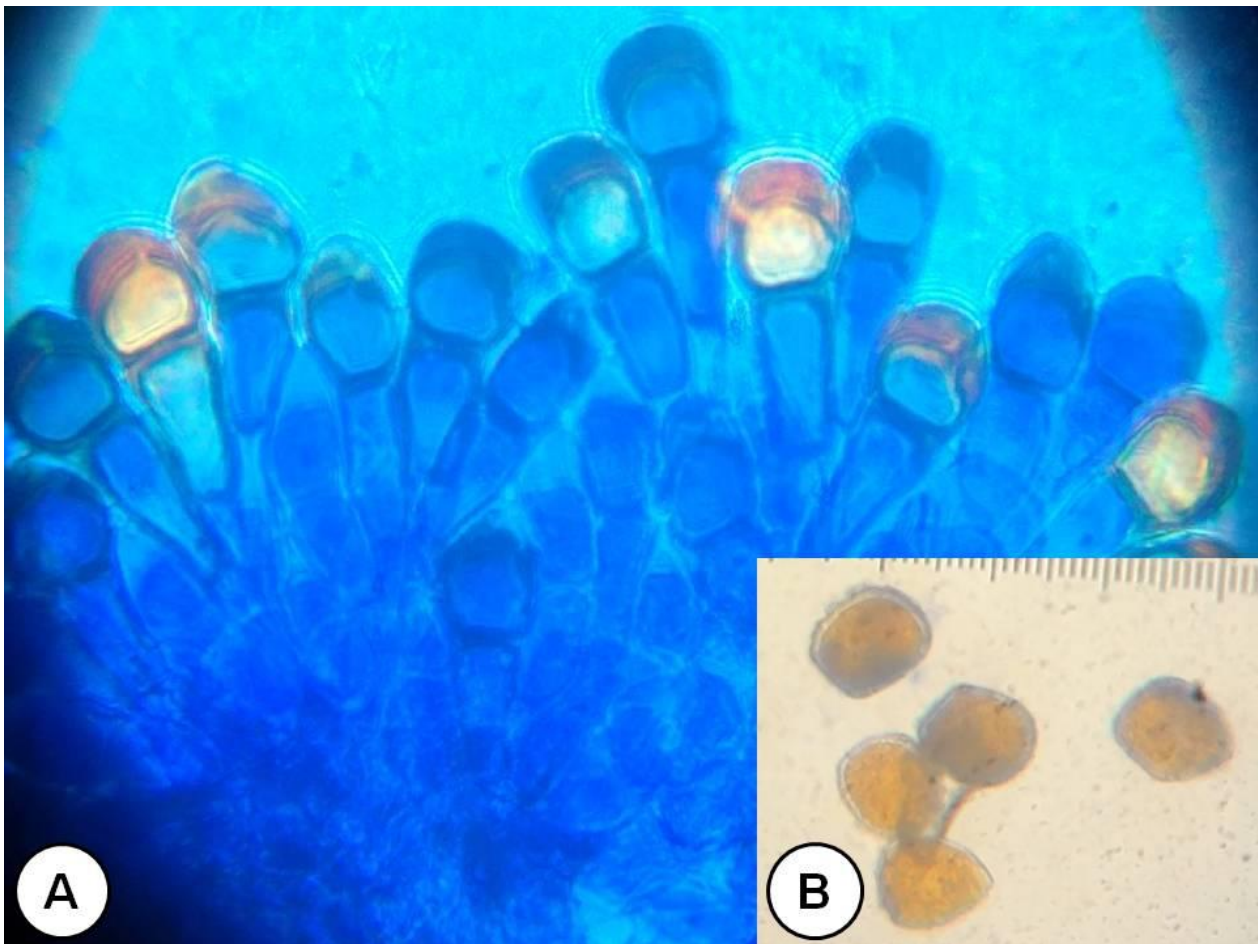


Fig 3 – Microscopic characteristics of *Puccinia*. **A** teliospores; **B** urediniospores.

A complete list of *Puccinia* species recorded in Himachal Pradesh, India is presented in alphabetical order followed by family of host plant and related reference. Apart from the distribution in Himachal Pradesh, the distribution of *Puccinia* outside the state is also provided.

Order: Puccinales, **Family:** Puccinaceae, **Genus:** *Puccinia*

Puccinia agrostidis Plowr. (Ranunculaceae) (Barclay 1891)
Distribution: Shimla (H.P.).

Puccinia ahmadiana Syd. (Asteraceae) (Sydow 1938)
Distribution: Reported from various localities including Puti Ruhi, Lahul, Kullu Valley of Himachal Pradesh. No reports are available from outside the state.

Puccinia allii (DC.) F. Rud. (Amaryllidaceae) (Butler & Bisby 1931)
Distribution: Kullu (H.P.).

Puccinia andropogonis Schw. (Poaceae) (Barclay 1890 a, b)
Distribution: Shimla (H.P.).

Puccinia anthistiriae Barclay (Poaceae) (Sydow & Butler 1912)
Distribution: Reported from Shimla (H.P.). It is also reported from Harwan (J&K).

- Puccinia apii*** Desm. (Apiaceae) (Barclay 1890 a, b)
Distribution: Shimla (H.P.).
- Puccinia arenariae*** (Schumacher) J. Schröt. (Caryophyllaceae) (Barclay 1891)
Distribution: Narkanda Shimla (H.P.).
- Puccinia arthraxonis*** (P. Henn.) Syd., P. Syd. & E.J. Butler (Poaceae) (Golatkar 1976)
Distribution: Reported from Kasauli (H.P.) and from Dehradun, Kumaon and Massoori (Uttk.).
- Puccinia atropuncta*** Peck & Clint. (Asteraceae) (Chona et al. 1956)
Distribution: Shimla (H.P.).
- Puccinia bulbocastani*** (A. Cumino) Fuckel (Apiaceae) (Bhardwaj & Sharma 1990)
Distribution: Reported only from Himachal Pradesh.
- Puccinia bistortae*** (F. Strauss.) DC. (Polygonaceae) (Sydow 1938)
Distribution: Losar, Spiti (H.P.).
- Puccinia brachypodii*** G.H. Otth. (Berberidaceae) (Payak 1965)
Distribution: Shimla (H.P.).
- Puccinia bupleuri-falcate*** (DC.) G. Wint. (Apiaceae) (Barclay 1890 a, b)
Distribution: Reported from Shimla (H.P.). It was also reported from Rajendragarh (Pb) and Nainital (Uttk.).
- Puccinia calthae*** Link (Ranunculaceae and Berberidaceae) (Arthur & Cummins 1933, Chona & Munjal et al. 1956)
Distribution: In Himachal Pradesh the rust was reported from Dhramshala; Rohtang pass, Kullu, while Pahalgam from (J&K).
- Puccinia caricis var. himalayensis*** Barclay (Cyperaceae) (Butler & Bisby 1931, Padwick & Khan 1944)
Distribution: Reported from Shimla (H.P.) and Mussoorie (Uttk.).
- Puccinia caricis-filicinae*** Barclay (Cyperaceae) (Mitter & Tandon 1938)
Distribution: Reported from Shimla (H.P.) and Ranikhet & Nainital (Uttk.).
- Puccinia caricis-nubigenae*** Padwick & A. Khan (Cyperaceae) (Mitter & Tandon 1938)
Distribution: Reported only from Kufri, Shimla (H.P.).
- Puccinia carthami*** Corda (Asteraceae) (Sydow & Butler 1901)
Distribution: Reported from Kangra (H.P.) and Bihar, Punjab, Hyderabad (A.P.).
- Puccinia chrysopogoni*** Barclay (Oleaceae and Poaceae) (Barclay 1890 a, b, Sydow & Butler 1907)
Distribution: Reported from Shimla (H.P.), Kumaon & Jaunsar (Uttk) and Aurangabaad (M.S.).
- Puccinia circaeae*** Pers. (Onagraceae) (Barclay 1890 a, b)
Distribution: Reported from Shimla (H.P.), Aru (J&K) and Nainital (Uttk.).
- Puccinia collettiana*** Barclay (Rubiaceae) (Barclay 1890 a, b, Ganguly & Pandotra 1963)
Distribution: Reported from Shimla, Kasauli, Nagar (Kullu) of Himachal Pradesh, Ranikhet, Mussoorie & Nainital (Uttk) and Mahabaleshwar (M.S.).

- Puccinia coronata* var. *avenae*** P. Syd. & Syd. (Poaceae) (Mishra et al. 1964)
Distribution: Reported from Shimla (H.P.) while Kalimpong & Darjling from West Bengal.
- Puccinia coursinae*** P. Syd. & Syd. (Poaceae) (Padwick 1945)
Distribution: Spiti (H.P.).
- Puccinia cynodontis*** Lacroix ex Desm. (Poaceae) (Sharma & Sachan 1994)
Distribution: In addition to H.P., the fungus is also reported from Saharanpur (U.P.); Poona (M.S.); Kanpur (U.P.); Surat (GJ); Kashmir (J&K); Muzaffarpur (Bihar); Gwalior & Jabalpur (M.P.).
- Puccinia dactylidina*** Bubak (Poaceae) (Sydow & Butler 1912)
Distribution: Reported from Shimla (H.P.) and Harwan (J&K).
- Puccinia dioscoreae*** Kom (Dioscoreaceae) (Pandotra & Ganguly 1962)
Distribution: Manali (H.P.).
- Puccinia duthiae*** Ellis & Tracy (Poaceae) (Sydow & Butler 1911)
Distribution: This fungus has a very wide distribution. In Himachal Pradesh it was reported from Kasauli and Dehradun (Uttk.), Poona (M.S.), Phulguru, Jabalpur (M.P.), Dharwar (Kanataka), and Rajgir (Bihar)
- Puccinia ellisii*** De Toni (Apiaceae) (Barclay 1891)
Distribution: Reported only from Phagu, Shimla (H.P.).
- Puccinia eremuri*** Kom. (Xanthorrhoeaceae) (Barclay 1891)
Distribution: Kullu (H.P.).
- Puccinia erianthi*** Padwick & A. Khan (Poaceae) (Padwick & Khan 1944)
Distribution: The fungus was reported from Shimla (H.P.) and from Coimbatore (T.N.), Hydrabead (A.P.), New Delhi.
- Puccinia eulaliae*** Barclay (Poaceae) (Butler & Bisby 1960)
Distribution: Reported from Shimla (H.P.) only.
- Puccinia excelsa*** Barclay (Lamiaceae) (Barclay 1891)
Distribution: Reported from Mahasu & Huttoo Peak, Shimla (H.P.).
- Puccinia fagopyri*** Barclay (Polygonaceae) (Barclay 1890 a, b)
Distribution: Reported from Shimla & Sangla valley (H.P.) and Mussoorie (Uttrakhand).
- Puccinia flavipes*** Syd. & P. Syd. (Rosaceae) (Barclay 1890 a, b)
Distribution: Shimla (H.P.).
- Puccinia gentianae*** (F. Strauss.) Link. (Gentianaceae) (Barclay 1890 a, b)
Distribution: Reported from Shimla (H.P.) and Chillam (North West Himalayan region including Uttk.).
- Puccinia geranii-silvatici*** P. Karst. (Geraniaceae) (Barclay 1890 a, b)
Distribution: Reported from Shimla (H.P.) and Verinag (J&K).

- Puccinia glumarum*** (Schw.) Eriks & P. Henn. (Poaceae) (Prasada 1948)
Distribution: In Himachal Pradesh the fungus was reported from Shimla while from Hisar (HR), Dehradun (Uttk.) outside the state.
- Puccinia graminis*** Pers. (Poaceae) (Barclay 1890a)
Distribution: Reported from entire states of Northern India including Shimla, Kullu (H.P.) and Harwan (J&K), Nainital (Uttarakhand), New Delhi, Hsar (Haryana) and even from Kolhapur (Maharashtra), Jabalpur (M.P.).
- Puccinia graminis-agropyri*** P.R. Mehta & R. Prasad (Poaceae) (Prasada 1948)
Distribution: Shimla (H.P.).
- Puccinia graminis-poa*** (Pers.) Erikss. & Henning (Poaceae) (Prasada 1948)
Distribution: Shimla (H.P.).
- Puccinia himalensis*** (Barclay) Diet. (Rhamnaceae, Poaceae) (Padwick 1946, Sydow & Butler 1906 & 1907)
Distribution: Reported from Shimla (H.P.) and Kuaon, Nainital (Uttk.) and Harwan (J&K).
- Puccinia invenusta*** Syd. & P. Syd. (Poaceae) (Sharma & Sachan 1994)
Distribution: In addition to H.P., also reported from Bihar, Delhi, Assam and U.P.
- Puccinia iridis*** (DC.) Wallr. (Iridaceae) (Sydow & Butler 1912)
Distribution: Reported from Shimla in the state of Himachal Pradesh. Outside the state it was reported from Harwan, Srinagar, Jammu (J&K), Mussoorie (Uttk.) and Kohima (NL).
- Puccinia komarovi*** Tranzschel ex P. Syd. & Syd. (Balsaminaceae) (Khanna 1961)
Distribution: Reported from Shimla (H.P.) and Mussoorie (Uttk.) and Sonamarg (J&K).
- Puccinia leptodermidis*** Barclay (Rubiaceae) (Barclay 1890 a, b, Sydow & Butler 1912)
Distribution: Shimla & Kasauli (H.P.).
- Puccinia lycoctoni*** Fuckel (Ranunculaceae) (Sydow & Butler 1907)
Distribution: Shimla (H.P.).
- Puccinia menthae*** Pers. (Lamiaceae) (Pandotra & Ganguly 1964, Sydow & Butler 1912, Sydow 1938)
Distribution: This species has a wide host distribution. It was reported from Shimla and Kasauli, Kullu, Busher in Himachal Pradesh, whereas, from Harwan & Verinag, Shadipur, Landhari, Batote in J&K, Mussoorie, Ranikhet in Uttarakhand, Bilaspur (M.P.) and Kohima (NL).
- Puccinia minutissima*** Arthur (Poaceae) (Munjal & Gill 1962)
Distribution: Reported from Manali (H.P.) and Mussoorie (Uttk.).
- Puccinia nepalensis*** Barclay & Dietel (Polygonaceae) (Barclay 1890 a, b, Ramakrishnan 1952)
Distribution: Reported from Shimla and Kasauli (H.P.), Mussoorie & Nainital (Uttk.), Ootacamund (TN) and Harwan (J&K).
- Puccinia neyraudiae*** Syd. (Poaceae) (Sharma & Sachan 1994)
Distribution: The fungus was also reported from Darjeeling (W.B.) in addition to H.P.

Puccinia nitida (F. Strauss) Barclay (Polygonaceae) (Sydow & Butler 1912)
Distribution: Reported from Mashobra, Shimla, Rohtaang Pass (H.P.) and Tukwar, Darjling (W.B.), Mussoorie & Nainital (Uttk.), Jammu, Verinag and Banihal Pass (J&K).

Puccinia opizii Bubák (Asteraceae) (Arthur & Cunmins 1933)
Distribution: Reported only from Alwas (Chamba) of Himachal Pradesh.

Puccinia pacifica Blasdale ex Arthur (Plantaginaceae) (Chona et al. 1956)
Distribution: Shimla (H.P.).

Puccinia persistens Plowr. (Ranunculaceae) (Barclay 1890 a, b)
Distribution: Reported from Shimla (H.P.) and Nainital (Uttk.).

Puccinia pimpinellae (F. Strauss) Roehling (Apiaceae) (Barclay 1890 a, b)
Distribution: Reported from Shimla (H.P.), Kumaon & Mussoorie (Uttk.) Harwan & Batote (J&K).

Puccinia pollinae Barclay (Acanthaceae) (Barclay 1890 a, b)
Distribution: Reported from Shimla (H.P.), Nainital, Dehradun & Mussoorie (Uttk.) and Mysore (Karnataka).

Puccinia pogonatheri Petch (Poaceae) (Sharma & Sachan 1994)
Distribution: In addition to Himachal Pradesh, also reported from Singampath (T.N.).

Puccinia polygoni Alb. & Schw. (Polygonaceae) (Ganguly & Pandotra 1963)
Distribution: Reported from Katrain (H.P.) and Mussoorie, Nainital (Uttk.) and Jammu (J&K).

Puccinia polygoni-amphibii Pers. (Polygonaceae) (Mishra & Sharma 1964)
Distribution: Reported from Shimla (H.P.) and also from Mussoorie (Uttk.) and Harwan, Srinagar (J&K), Jabarkhet Landour (U.P.) and Assam.

Puccinia prainiana Barclay (Smilacaceae) (Barclay 1890 a, b)
Distribution: This fungus has a very wide distribution in India. In Himachal Pradesh it was reported from Shimla. In rest of the country reported from Mussoorie, Ranikhet & Kumaon (Uttk.), Droog, Nilgiris (T.N.), Wynad (Kerala), Khasi Hills (Assam), Yercaud (Karnataka), Purnea (Bihar), and Mahabaleshwar, Kanheri forests, Amboli Panhala (MS)

Puccinia punctata Link (Rubiaceae) (Barclay 1890 a, b)
Distribution: Reported from Shimla (H.P.), Nainital (Uttk.) and Batote (J&K).

Puccinia purpurea Cooke (Poaceae) (Sharma & Sachan 1994)
Distribution: In addition to Himachal Pradesh also reported from Dehradun, (Uttk.); Patna (Bihar); Arvi & Phulgaon, Jabalpur (M.P.); Mount Abu (Raj); Coimbatore (T.N.), Poona, Kolhapur (M.S.); Surat (GJ.); Ranchi (Chattisgarh); Dharwar (Karnataka).

Puccinia pusilla Syd. & P. Syd. (Poaceae) (Sharma & Sachan 1994)
Distribution: In addition to Himachal Pradesh the fungus was also reported from Dehradun, Ranikhet, Bhowali (Uttk.); Parasnath Hills (Bihar); Jabalpur (M.P.); Assam and Idukki (Kerala).

Puccinia recondita* var. *simlensis Misra, Ahmad & Singh. (Ranunculaceae and Poaceae) (Gupta 1977)
Distribution: Shimla (H.P.).

Puccinia roscoae Barclay (Zingiberaceae) (Gupta 1977)

Distribution: Reported from Shimla (H.P.) and Mussoorie (Uttk.).

Puccinia rubigo-vera (DC.) G. Winter (Ranunculaceae) (Arthur & Cummins 1933, Jain et al. 1966)

Distribution: Reported from Dharamshala, Chamba, Kote, Keylog, Kullu in Himachal Pradesh. It was also reported from Sonamarg, Kashmir (J&K) and Kanpur (U.P.)

Puccinia saviculae Grev. (Apiaceae) (Barclay 1890 a, b)

Distribution: Reported from Shimla (H.P.) and Kumaon (Uttk.).

Puccinia saxifragae-cilliatae Barclay (Saxifragaceae) (Barclay 1890 a, b)

Distribution: Reported from Shimla (H.P.), Mussoorie & Nainital (Uttk.) Jehlam valley, Kilanmarg (J&K).

Puccinia saxifragae-micranthae Barclay (Saxifragaceae) (Barclay 1891)

Distribution: Bushar & Shimla (H.P.).

Puccinia sonchi Roberge ex Desm. (Asteraceae) (Sydow 1938)

Distribution: Reported from Kullu (H.P.) and Koppa, Mysore (Karnataka), Srinagar (J&K) and Kumaon (Uttk.).

Puccinia sorghi Schwein. (Poaceae and Oxalidaceae) (Anonymous 1950, Mishra 1963)

Distribution: Reported from Mashobra & Shimla (H.P.). It was also reported from Manjiri, Mumbai (MS.), Kashmir (J&K), Dumraon (Bihar).

Puccinia striiformis Westend. (Poaceae) (Vasudeva 1958, Joshi & Merchand 1963, Mishra et al. 1965, 1975, Ahmad et al. 1969)

Distribution: In Himachal Pradesh the fungus was reported only from Shimla but also from Punjab, Jabalpur (M.P.) and Jhansi (U.P.) outside the state.

Puccinia striiformis f. muehlenbergii Misra & Lele. (Poaceae) (Mishra & Lele 1963)

Distribution: Reported only from Shimla (HP).

Puccinia tanacetii DC. (Asteraceae) (Sharma & Sachan 1994, Bharat 2008)

Distribution: In addition to Himachal Pradesh, also reported from Kashmir (J&K) and Bihar.

Puccinia thlaspeos Ficus & C. Schub. (Arthur 1934, Arthur & Cummins 1933) Brassicaceae

Distribution: The fungus was reported only from Hunan Nallah, Pangi & Chamba (H.P.).

Puccinia tricholepidis Syd. (Asteraceae) (Sydow 1938)

Distribution: Saharan & Bushar (H.P.).

Puccinia trolüi P. Karst. (Ranunculaceae) (Arthur & Cummins 1933)

Distribution: Reported only from Alwas, Chamba (H.P.).

Puccinia tweediana (Speg.) T.S. Ramakr. & K. Ramakr. (Acanthaceae) (Chona & Munjal 1955, Ramakrishnan & Ramakrishnan 1948)

Distribution: Reported from Kullu; Shimla in Himachal Pradesh whereas, from Yercaud (T.N.) and Mussoorie (Uttk.).

Puccinia urticae Barclay (Urticaceae) (Barclay 1890 a, b)

Distribution: Reported from Shimla & Kasauli (H.P.) and Mussoorie & Nainital (Uttk.).

Puccinia ustalis Berk. (Ranunculaceae) (Berkeley 1856)

Distribution: Mathana, Shimla (H.P.).

Puccinia violae (Schumach.) DC. (Violaceae) (Bilgrami 1963)

Distribution: Reported from Shimla (H.P.), Harwan (J&K) and Nainital & Mussoorie (Uttk.).

Host index

In this section scientific names of host plants along with the *Puccinia* species occurring on them are provided.

Aconitum lycoctonum – *Puccinia lycoctoni*.

Agropyron semicostatum – *Puccinia graminis-agropyri*

Agrosotis stolonifera – *Puccinia himalensis*

Allium sativum – *Puccinia allii*

Andropogon tristis – *Puccinia andropogonis*

Andropogon pertusus – *Puccinia duthiae*

Anemone polyanthes – *Puccinia trolii*

Angelica glauca – *Puccinia ellisii*

Anthistiria anathera – *Puccinia anthistiriae*

Apium graveolens – *Puccinia apii*

Aquilegia vulgaris – *Puccinia agrostidis*

Aquilegia vulgaris – *Puccinia rubigo-vera*

Artemisia nilagirica – *Puccinia tanacetii*

Arthraxon prionodes – *Puccinia arthraxonis*

Avena sativa – *Puccinia coronata* var. *avenae*

Berberis aristata – *Puccinia brachypodii*

Berberis lyceum – *Puccinia brachypodii*

Brachypodium sylvaticum – *Puccinia glumarum*

Brachypodium sylvaticum – *Puccinia himalensis*

Bromus japonicus – *Puccinia striiformis*

Bunium persicum – *Puccinia bulbocastani*

Bupleurum falcatum – *Puccinia bupleuri-falcatum*

Caltha palustris var. *alba* – *Puccinia calthae*

Caltha palustris var. *normalis* – *Puccinia calthae*

Capillipendium assimile – *Puccinia pusilla*

Carex filicina – *Puccinia caricis-filicinae*

Carex nubigena – *Puccinia caricis-nubigenae*

Carex setigera – *Puccinia caricis* var. *himalayensis*

Carthamus oxycantha – *Puccinia carthami*

Chrysopogon gryllus – *Puccinia chrysopogi*

Circaea alpina – *Puccinia circaeae*

Clematis gouriana – *Puccinia walliana*

Coursinia thomsoni – *Puccinia coursiniae*

Cynodon dactylon – *Puccinia cynodontis*

Dactylis glomerata – *Puccinia dactylidina*

Dicliptera bupleuroides – *Puccinia tweediana*

Dicliptera sp. – *Puccinia tweediana*

Dioscorea deltoidea – *Puccinia dioscoreae*

Draba laneolata – *Puccinia thlaspeos*

Eremurus himalaicus – *Puccinia eremuri*

Erianthus fulvus – *Puccinia erianthi*
Fagopyrum esculentum – *Puccinia fagopyri*
Festuca gigentia – *Puccinia graminis*
Festuea gigentia – *Puccinia himalensis*
Fragaria vesca – *Puccinia flavipes*
Galium aparnie – *Puccinia punctata*
Gentiana kurroo – *Puccinia gentianae*
Geranium nepalense – *Puccinia geranii-sylvaticae*
Rhamnus dahurica – *Puccinia himalensis*
Thalictrum javanicum – *Puccinia recondita* var. *simlensis*
Helicotrichon virens – *Puccinia recondita* var. *simlensis*
Impatiens amphorata – *Puccinia komarovi*
Iris florentina – *Puccinia iridis*
Iris pallid – *Puccinia iridis*
Jasminum humile – *Puccinia chrysopogi*
Lactuca decipiens – *Puccinia opizii*
Leptodermis lenceolata – *Puccinia leptodermidis*
Lolium perenne – *Puccinia striiformis*
Mentha longifolia – *Puccinia menthae*
Mentha sylvestris – *Puccinia menthae*
Muehlenbergia huegelii – *Puccinia striiformis*
Neyaudia arundi-aceaea – *Puccinia neyaudiae*
Origanum vulgare – *Puccinia menthae*
Oryzopsis holiciforme – *Puccinia himalensis*
Oxalis corniculata – *Puccinia sorghi*
Oxalis latifolia – *Puccinia sorghi*
Phlomis bracteosa – *Puccinia excels*
Phramites karka – *Puccinia invenusta*
Pimpinella diversifolia – *Puccinia pimpinellae*
Plantago tibetica – *Puccinia pacifica*
Poa nemoralis – *Puccinia graminis-poeae*
Pogonatherum paniceum – *Puccinia pogonatheri*
Pollinia japonica – *Puccinia eulaliae*
Pollinia nuda – *Puccinia polliniae*
Polygonum amplexicaule – *Puccinia nitida*
Polygonum orientale – *Puccinia polygone*
Polygonum viviparum – *Puccinia bistortae*
Pogonatherum paniceum – *Puccinia pogonatheri*
Prenanthes brunoniana – *Puccinia atropuncta*
Pterotheca falconeri – *Puccinia ahmadiana*
Ranunuculus hirtellus – *Puccinia ustalis*
Rhamnus dahurica – *Puccinia himalensis*
Rhamnus virgeta – *Puccinia himalensis*
Roscoea alpine – *Puccinia roscoeae*
Roscoea procera – *Puccinia roscoeae*
Rubia cordifolia – *Puccinia colletiana*
Rumex nepalensis – *Puccinia nepalensis*
Saccharum officinarum – *Puccinia minutissima*
Savicula europea – *Puccinia saviculae*
Saxifraga ligulata var. *cilliata* – *Puccinia saxifragae-cilliatae*
Saxifraga micrantha – *Puccinia saxifragae-micranthae*
Smilax aspera – *Puccinia prainiana*

Sonchus sp. – *Puccinia sonchi*
Sorghum halepense – *Puccinia purpurea*
Stellaria paniculata – *Puccinia arenariae*
Strobilanthes dalhausianus – *Puccinia pollinae*
Thalictrum javanicum – *Puccinia persistens*
Thalictrum javanicum – *Puccinia recondita* var. *simlensis*
Thalictrum minus – *Puccinia rubigo-vera*
Thalictrum sp. – *Puccinia rubigo-vera*
Tricholepis elongate – *Puccinia tricholepidis*
Triticum vulgare – *Puccinia striiformis*
Urtica parviflora – *Puccinia caricis* var. *himalayensis*
Urtica parviflora – *Puccinia urticae*
Viola serpens – *Puccinia violae*
Zea mays – *Puccinia sorghi*

Discussion

The genus *Puccinia* is the largest in the Pucciniales and is considered as the most economically important genus of biotrophic fungi. Members of this genus are ubiquitous plant pathogens and affect almost all types of plants. A very broad host range of the genus makes it responsible for numerous plant diseases having very serious consequences.

It is observed that almost all the reports are from Shimla and nearby regions. So other regions of the state should also be explored in order to explore the biodiversity and host range of the fungi. Additionally, we did not find any information on molecular identification of *Puccinia* species from the state. Therefore, more studies including molecular work are required in order to confirm the fungal species.

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References

- Ahmad ST, Singh HS, Mishra DP. 1969 – Additions to wheat rusts races in India race 14 & 38 of *Puccinia striiformis* identified during 1965. *Indian Phytopathology* 22, 525–526.
- Anonymous. 1950 – List of common names of Indian plant diseases. *Indian Journal of Agricultural Research* 20, 107–142.
- Arthur JC. 1934 – Manual of rusts in United States and Canada. Lafayette, Indiana.
- Arthur JC, Cummins GB. 1933 – Rusts of North West Himalayas. *Mycologia* 25, 397–406.
- Barclay A. 1890a – Descriptive list of Uredineae occurring in the neighborhood of Shimla. *Journal Asiatic Society of Bangal* 56, 161–165.
- Barclay A. 1890b – Descriptive list of Uredineae occurring in the neighborhood of Shimla. *Journal Asiatic Society of Bangal* 56, 350–375.
- Barclay A. 1891 – Additional Uredineae from the neighborhood of Shimla. *Journal Asiatic Society of Bangal* 60, 211–230.
- Berkeley MJ. 1856 – Decades of fungi; Decas 1–62 nos 1–620. *Hooker's London Journal of Botany* 3–8, 844–1856.
- Bhardwaj LN, Sharma PN. 1990 – Occurrence of rust on black zira in Himachal Pradesh. *Indian Journal of Mycology and Plant Pathology* 20 (3), 270.
- Bilgrami KS. 1963 – A new species of *Periconia* on the leaves of *Typha latifolia*. *Science and Culture* 29, 47–48.
- Bharat NK. 2008 – Occurrence of rust on *Artemisia dracuncululus* L. in Himachal Pradesh. *Indian Forester* 134, 140.

- Butler EJ, Bisby GR. 1931 – The fungi of India. Imperial Council of Agricultural Research India. Science Monograph I XVIII+237pp.
- Butler EJ, Bisby GR. (Revised by Vasudeva RS.) 1960 – The fungi of India. ICAR Publications New Delhi, India, 552 pp.
- Chona BL, Munjal RL. 1955 – Notes on miscellaneous fungi – II. Indian Phytopathology 8, 184–198.
- Chona BL, Munjal RL. 1956 – Notes on miscellaneous fungi-III. Indian Phytopathology 9, 53–56.
- Chona BL, Munjal RL, Kapoor JN. 1956 – Notes on miscellaneous Indian fungi-IV. Indian Phytopathology 9, 125–132.
- Ganguly D, Pandotra VR. 1963 – Fungi on medicinal and aromatic plants in North West Himalays – I. Mycopathologia et Mycologia Applicata 20, 39–40.
- Golatkar VV. 1976 – *Harknessia*: a new generic record to India. Current Science 45, 269–270.
- Gupta SC. 1977 – New diseases of sugarcane in U.P. India. Current Science 46, 27.
- Jain AC, Nikam BG, Kulkarni SN, Sharma OP. 1966 – Fungi of Gwalior and Indore region. The Vikram 4, 181–187.
- Joshi LM, Merchand WC. 1963 – *Bromus japonicas* Thunb. susceptible to wheat rust under normal conditions. Indian Phytopathology 16, 312–313.
- Khanna PK. 1961 – A new report of a new host of *Puccinia kanmorensis* Cummins from India. Proceedings from National Academy of Sciences India. 113 pp.
- Mishra DP. 1963 – Natural occurrence of the aecial stage of *Puccinia sorghi* Schw. *Oxalis corniculata* Linn. in Nepal. Indian Phytopathology 16, 8–9.
- Mishra DP, Lele VC. 1963 – *Choanephora cucubitarum* on *Cajanus cajan* in India. Indian Phytopathology 22, 515–517.
- Mishra DP, Sharma SK. 1964 – Natural infection of *Oxalis corniculata*, the alternate host of *Puccinia sorghi* in India. Indian Phytopathology 17, 138–141.
- Mishra DP, Sharma SK, Joshi PC, Singh S. 1964 – Further studies in the crown rust of oat in India. Indian Phytopathology 17, 142–145.
- Mishra DP, Ahmad ST, Singh HS. 1965 – Natural occurrence of specialized forms of *Puccinia graminis* and *Puccinia striiformis* on *Lolium perenne*. Indian Phytopathology 18, 214–215.
- Mishra DP, Singh S, Ahmad S. 1975 – Notes on some rusts from Shimla Hills. Indian Phytopathology 28, 256–260.
- Mitter JH, Tandon RN. 1938 – Fungi of Nainital Part-II. Journal of Indian Botanical Society 17, 177–182.
- Munjal RL, Gill HS. 1962 – Some dematiaceous fungi from India-I. Indian Phytopathology 15, 269–279.
- Padwick GW. 1945 – Notes on Indian fungi-III. Mycological Papers 12, 15 pp.
- Padwick GW. 1946 – Notes on Indian fungi-IV. Mycological Papers 17, 12 pp.
- Padwick GW, Khan A. 1944. Notes on Indian fungi-II. Mycological Papers 10, 17 pp.
- Pandotra VR, Ganguly D. 1962 – Notes on two fungi collected from Kullu Valley, Punjab. Indian Phytopathology 15, 216–217.
- Pandotra VR, Ganguly D. 1964 – Fungi on medicinal and aromatic plants in North West Himalayas I. Mycopathologia et Mycological Applicata 22, 59–68.
- Payak MM. 1965 – *Berberis* as the aecial host of *Puccinia brachypodii* in Shimla Hills, India. Phytopathology 52, 49–54.
- Prasada R. 1948 – Studies on rusts on some of the wild grasses occurring in the neighborhood of Shimla. Indian Journal of Agricultural Science 18, 165–176.
- Ramakrishnan TS. 1952 – Additions to fungi of Madras-XII. Proceedings of Indian Academy of Sciences 35(B), 11–121.
- Ramakrishnan TS, Ramakrishnan K. 1948 – Additions to fungi of Madras- V. Proceedings of Indian Academy of Sciences 28(B), 50–70.
- Sharma RK, Sachan SN. 1994 – New host of rust fungi from Himachal Pradesh. Advances in Plant Sciences 7, 154–158.

- Sydow H. 1938 – Fungi Himalayensis. *Annals of Mycology* 36, 437–442.
- Sydow H, Butler EJ. 1901 – Fungi Indiae Orientalis Pars. I. *Annals of Mycology* 4, 424–445.
- Sydow H, Butler EJ. 1906 – Fungi Indiae Orientalis Pars. I. *Annales Mycologici* 4, 424–445.
- Sydow H, Butler EJ. 1907 – Fungi Indiae Orientalis II. *Annales Mycologici* 5, 485–515.
- Sydow H, Butler EJ. 1911 – Fungi Indiae Orientalis part III. *Annales Mycologici* 9, 372–421.
- Sydow H, Butler EJ. 1912 – Fungi Indiae Orientalis IV. *Annales Mycologici* 10, 243–280.
- Vasudeva RS. 1958 – Report of the division of Mycology and Plant Pathology. *Science Report of Agricultural Research Institute, New Delhi*. 87–101 & 1954–55.