The Journal of Threatened Taxa (JoTT) is dedicated to building evidence for conservation globally by publishing peer-reviewed articles online every month at a reasonably rapid rate at www.threatenedtaxa.org. All articles published in JoTT are registered under Creative Commons Attribution 4.0 International License unless otherwise mentioned. JoTT allows unrestricted use, reproduction, and distribution of articles in any medium by providing adequate credit to the author(s) and the source of publication.

Journal of Threatened Taxa
Building evidence for conservation globally

www.threatenedtaxa.org
ISSN 0974-7907 (Online) | ISSN 0974-7893 (Print)

COMMUNICATION
A checklist of rust fungi from Himachal Pradesh, India

Ajay Kumar Gautam & Shubhi Avasthi

26 November 2019 | Vol. 11 | No. 14 | Pages: 14845–14861
DOI: 10.11609/jott.4238.11.14.14845-14861

For Focus, Scope, Aims, Policies, and Guidelines visit https://threatenedtaxa.org/index.php/JoTT/about/editorialPolicies#custom-0
For Article Submission Guidelines, visit https://threatenedtaxa.org/index.php/JoTT/about/submissions#onlineSubmissions
For Policies against Scientific Misconduct, visit https://threatenedtaxa.org/index.php/JoTT/about/editorialPolicies#custom-2
For reprints, contact <ravi@threatenedtaxa.org>

The opinions expressed by the authors do not reflect the views of the Journal of Threatened Taxa, Wildlife Information Liaison Development Society, Zoo Outreach Organization, or any of the partners. The journal, the publisher, the host, and the partners are not responsible for the accuracy of the political boundaries shown in the maps by the authors.
A Checklist of Rust Fungi from Himachal Pradesh, India

Ajay Kumar Gautam1 & Shubhi Avasthi2

1 School of Agriculture, Abhilashi University, Chail Chowk, Tehsil Chachyot, Mandi, Himachal Pradesh 175028, India.
2 School of Studies in Botany, Jiwaji University, Gwalior, Madhya Pradesh 474001, India.
1a2gautam2006@gmail.com (corresponding author), 2shubh.avasth@gmail.com

Abstract: An updated analysis of the diversity of rust fungi in Himachal Pradesh is provided herein as a product of field surveys, of mycological analysis, and of all forms of published documentation and literature. The results of all forms of analysis revealed that Himachal Pradesh has 167 species of rust fungi belonging to the class Pucciniomycetes. The class is represented by 11 families, 23 genera with 167 species. The Pucciniaceae (96 species) followed by Phragmidiaceae (14 species) are the largest families of rust fungi reported from the state. Rest of the families were found associated with 1–10 species of rust fungi. The rust fungi (19 species) with uncertain placement are placed in incertae sedis. The rust genera reported from Himachal Pradesh so far are Aecidium, Chrysomyxa, Coleosporium, Frommea, Gymnosporangium, Kuehneola, Kweilingia, Melampsora, Monosporidium, Ochrospora, Peridermium, Phakopsora, Phragmidium, Pileolaria, Puccinia, Pucciniastrum, Pucciniostele, Ravenelia, Skierka, Uredinopsis, Ured, Urocystis, and Uromyces.

Keywords: Basidiomycota, checklist, Himachal Pradesh, Pucciniales, Pucciniomycetes.
INTRODUCTION

Rust fungi are highly specialized obligate plant parasites having several unique morphological and microscopic features. These fungi commonly appear as yellow orange or brown powder on a variety of host plants and plant parts. Unlike other plant pathogens, rusts usually affect healthy and vigorously growing plants; the infection is limited to plant parts, such as leaves, petioles, tender shoots, stem, and fruits. The group is considered as one of the most harmful plant pathogens in agriculture, horticulture and forestry. These fungi are of major concern because they act as limiting factors for the successful cultivation, plantation and growth of agricultural crops and forestry plants. A wider diversity and broader host range is exhibited by this fungal group and their infection is not only limited to agricultural crops but also non-agricultural plants including medicinal herbs, shrubs, trees, and even weeds. An estimated 168 rust genera and approximately 7,000 species exist on various plant hosts, more than half of which belong to the genus *Puccinia* (Mohanan 2010).

Rust fungi show unique systematic characteristics among all fungal groups. A single species may produce up to five morphologically and cytologically distinct spore-producing structures, viz., spermagonia, aecia, uredinia, telia, and basidia, in successive stages of reproduction during the infection process. The presence of these successive stages may vary from species to species. To initiate and develop infection, rusts require an average temperature up to 35°C along with 50–60 % relative humidity. The rust infected plants may appear stunted, chlorotic (yellowed), or otherwise discoloured, whereas, disease symptoms includes coloured pustules, witches brooms, stem canker, hypertrophy of the affected tissues or formation of galls (Cummins & Hiratsuka 2003). Unlike other fungi, rusts exhibit one of the most important characteristics of their exceptionally high degree of host specificity.

Among all reported rust fungi, some are among agriculture’s most destructive and devastating pathogens, causing diseases such as wheat stem rust, wheat yellow (stripe) rust, Asian soybean rust, coffee rust and many more. These rust fungi cause annual crop losses in billions every year worldwide. This loss can be greater in developing world where growers are not aware about diseases caused by rust fungi and often cannot afford fungicides. Owing to their economic importance, the rusts have been studied extensively in regular mycological surveys in Himachal Pradesh, but no single-source compiled literature is available. Therefore, this study facilitates the access to scattered Himalayan literature with reference to rust fungi to the students and plant pathologists of national and international community.

STUDY AREA

Himachal Pradesh is one of the northern states of India that lies between 30.377– 32.21 North and 75.74 – 79.07 East. It is a mountainous state with very high mountains to grasslands in plain (Figure 1). Great variations in elevation ranging from about 350m (1,148 ft) to 7,000m (22,966 ft) are found in the state. The variations are also observed in the climatic conditions. Hot and sub-humid tropical conditions were found in the southern tracts while, cold, alpine and glacial conditions in the northern and eastern mountain ranges with more elevation. The variability in rainfall was observed in the range of 1,500–3,000 mm. These variations in geo-climatic conditions of the state lead to greater biodiversity in the state. A total 66.52% of the area is covered with very dense evergreen to deciduous forests types. While, alpine shrub and meadows are found distributed in the west and northeastern Himalaya; alders, birches, rhododendrons, and moist alpine shrubs are regional vegetation. The plant pathogens including bacteria, fungi and viruses are also found due to these changeable geographical and climatic conditions of the state which are quite favourable for their growth and development.

MATERIALS AND METHODS

The information on rust fungi was gathered by investigating the following data sources: (1) mycological survey conducted on rust fungi from Himachal Pradesh during the years 2014 to 2018, and (2) all forms of published documentation and literature (Bilgrami et al. 1991; Jamaluddin et al. 2004). The names of some taxon in the obtained data have been replaced by currently accepted names as they were of out-of-date. The current usage of names was checked using the Index Fungorum (http://www.indexfungorum.org/) to adopt the generic and specific taxonomy in Species Fungorum (http://www.speciesfungorum.org/).

The plant samples found infected with rust fungi were collected during a mycological survey of various localities of Himachal Pradesh. Field observations of rust fungi on host plants and their photographs were
taken in natural conditions. Collected specimens were packed in paper bags and taken to the laboratory for further analysis. A few disease samples were used for morphological analysis of the rust fungi and the rest of the materials were dried for future microscopic studies. The air dried specimens were preserved in standard size herbarium packets and deposited at the Abhilashi University Mycological Herbarium (AUMH).

The microscopic mounts were prepared from fresh samples by brushing the rust powder into a drop of distilled water and lactophenol on microscopic slides, which were covered with cover slip and gently heated. The microscopic slides were analysed for spore dimensions like size, shape and ornamentations.

Both macro- and micro-morphological characters obtained from the laboratory were only used for taxonomic studies of the collected fungi. The fungal specimens were identified and their distribution records were checked by using standard literature (Cummins & Hiratsuka 2003; Mukerji & Manoharachary 2010). Illustrations are photographed under microscope equipped with digital camera.

RESULTS

As per the results obtained in the present study and from all sources of information, Himachal Pradesh has 167 species of rust fungi belonging to 23 genera and 11 families (Table 1). The largest family is Pucciniaceae (95 species) followed by Phragmidiaceae (14 species). Other families were reported to have species of rust fungi up to ten. However, 19 species of rust fungi with uncertain placement are placed in taxonomic group incertae sedis. Aecidium, Chrysomyxa, Coleosporium, Frommea, Gymnosporangium, Kuehneola, Kweilingia, Melampsora, Monosporidium, Ochrospora, Peridermium, Phakopsora, Phragmidium, Pileolaria, Puccinia, Pucciniastrum, Pucciniostele, Ravenelia, Skierka, Uredinopsis, Uredo, Urocystis, and Uromyces are the rust genera reported so far from Himachal Pradesh.

Present studies revealed that 170 plant species belonging to 52 families were found infected with rust fungi throughout the state. Thirty-five hosts of family Poaceae were highest to be found infected with these fungi followed by Ranunculaceae (16), Rosaceae (15), Asteraceae (11), Polygonaceae (7), Fabaceae, Salicaceae, Acanthaceae & Lamiaceae (6 each), Pinnaceae & Apiaceae (5 each), Rubiaceae (4), Saxifragaceae, Cyperaceae & Euphorbiaceae (3 each), and Berberidaceae, Geraniaceae, Linaceae & Zinziberaceae.
Checklist of rust fungi from Himachal Pradesh, a hilly state of northern India.

Table 1. Number of species of rust fungi in the families and genera in Himachal Pradesh.

| Family                | Genera            | Number of species |
|-----------------------|-------------------|-------------------|
| Coleosporiaceae       | Chrysomyxa       | 03                |
|                       | Coleosporium     | 06                |
| Cronartiaceae         | Peridermium      | 06                |
|                       | Uredo            | 07                |
| Melampsoraceae        | Monosporidium    | 02                |
|                       | Phakopsora       | 02                |
|                       | Puccinia         | 01                |
|                       | Kuelleinia       | 01                |
| Phragmidiaceae        | Fromnea          | 01                |
|                       | Kuehneola        | 01                |
|                       | Phragmidium      | 09                |
| Pileariaceae          | Pileolaria       | 02                |
|                       | Skerkia          | 01                |
| Puccinaceae           | Gymnosporangium  | 01                |
|                       | Puccinia         | 80                |
|                       | Uromyces         | 16                |
| Pucciniastreae        | Puccinastreum    | 01                |
|                       | Uredinopsis      | 01                |
| Raveneliaceae         | Ravenelia        | 02                |
| Urocystidaceae        | Urocystis        | 01                |
| Total (10)            | 21               | 148               |
| Incertae sedis        | Aecidium         | 12                |
|                       | Uredo            | 07                |
| Grand Total (11)      | 23               | 167               |

(2 each). The rest of the plant species were reported to be infected with a single rust fungus. The area-wise results revealed that most of the rust fungi (about 127) were reported from Shimla and nearby regions followed by Solan (22), Kullu (18), Kangra (9), Chamba & Mandi (7 each), Lahul & Spiti (4), and Kinnaur & Bilaspur (1 each).

The checklist of rust fungi from Himachal Pradesh, a hilly state of northern India.

Fungi

**Basidiomycota** Whittaker ex Moore

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

**Pucciniales** Clem. & Shear

1. Family: **Coleosporiaceae** Dietel.

**Genus: Chrysomyxa** Unger., Beitr. vergleich. Pathologie: 24 (1840)

Type species: *Chrysomyxa abietis* (Wallr.) Unger (1840)

*Chrysomyxa deformans* (Dict.) Jacz., (Dietel 1890)

On *Pinaceae*—leaves of *Picea morinda*

Distribution: Shimla & Dalhausie

*Chrysomyxa piceae* Barclay, (Barclay 1890)

On *Pinaceae*—leaves of *Picea morinda*

*Chrysomyxa himalensis* Barclay, (Butler 1905)

On *Ericaceae*—leaves of *Rhododendron arboreum*

Distribution: Shimla

**Genus: Coleosporium** Lév., Annls Sci. Nat., Bot., sér. 3 8: 373 (1847)

Type species: *Coleosporium tussilaginis* (Pers.) Lév. (1849)

*Coleosporium barclayense* Bagchee, (Bagchee 1950; Sehgal et al. 1989; Puri 1955)

On *Pinaceae*—Fallen needles of *Pinus roxburghii* and *Pinus excelsa*

Distribution: Kullu and Shimla

*Coleosporium campanulae* (Pers.) Tul., (Barclay 1890; Sehgal et al. 1989)

On *Campanulaceae*—Leaves of *Campanula colorata*, needles of *Pinus roxburghii*

Distribution: Kasauli and Shimla

*Coleosporium clematidis* Barclay, (Barkley 1856; Sydow & Butler 1912)

On *Ranunculaceae*—leaves of *Clematis montana* and *Clematis buchnania*

Distribution: Shimla

*Coleosporium leptoderoidis* (Barclay) P. Syd. & Syd., (Sydow & Butler 1912)

On *Ranunculaceae*—leaves of *Clematis montana*

Distribution: Shimla

*Coleosporium leucanthemi* (Barclay) W. Syd. & Syd., (Sydow & Butler 1912)

On *Ranunculaceae*—leaves of *Clematis montana*

Distribution: Shimla

2. Family: **Cronartiaceae** Dietel.

**Genus: Peridermium** (Link) J.C. Schmidt & Kunze,

Type species: *Peridermium californicum* Arthur & F. Kern (1914)

*Peridermium brevius* (Barclay) Sacc., (Barclay 1890)

On *Pinaceae*—Neeles of *Pinus excelsa*

Distribution: Shimla

*Peridermium cedri* (Barclay) Sacc., (Barclay 1890)

On *Pinaceae*—neelles of *Cedrus libani* var. *deodar*

Distribution: Shimla

*Peridermium malayense* Bagchee, (Sydow & Butler 1901)

On *Pinaceae*—branches of *Pinus longifolia*

Distribution: Shimla
Checklist of rust fungi from Himachal Pradesh

Gautam & Avasthi

Journal of Threatened Taxa | www.threatenedtaxa.org | 26 November 2019 | 11(14): 14845–14861

14849

**Peridermium orientale** Cooke., (Sydow & Butler 1901)
On *Pinaceae—* Needles of *Pinus longifolia*
Distribution: Shimla, Kangra, Kasauli (Solan)

**Peridermium piceae** (Barclay) Sacc., (Sydow & Butler 1901)
On *Pinaceae—* leaves of *Picea morinda*
Distribution: Shimla

**Peridermium thomsonii** (Berk.) Berk., (Cooke 1878)
On *Pinaceae—* leaves of *Picea morinda*
Distribution: Mahasu (Shimla), Kullu

3. **Family: Melampsoraceae** Dietel.

**Genus: Melampsora** Castagne (Image 1)
Type species: *Melampsora euphorbiae* (Ficinus & C. Schub.) Castagne (1843)

*Melampsora ciliata* Barclay, (Barclay 1891, Khan et al. 2004)
On *Salicaceae—* on leaves of *Populus ciliata*
Distribution: Shimla

*Melampsora populnea* (Pers.) P. Karst., (Syn. *Melampsora acicidioides* (DC) Schroet., *Melampsora rostrupii* G. Wagner) (Barclay 1891; Butler & Bisby 1931; Cummins 1943; Sharma & Sharma 2000)
On *Salicaceae—* on leaves of *Populus alba*, *Populus ciliata*
Distribution: Shimla

*Melampsora euphorbiae* (Ficinus & C. Schub.) Castagne, (Syn. *Melampsora helioscopyae* (Pers.) Vint.) (Sydow & Butler 1901)
On *Euphorbiaceae—* Euphorbia pulcherrima Wild. Ex. Klotz. and Euphorbia helioscopya
Distribution: Kangra

*Melampsora hypericorum* (DC.) J. Schröt., (Patil & Nayar 1936)
On *Hypericaceae—* leaves of *Hypericum sp.*
Distribution: Shimla

*Melampsora caprearrum* Thüm., (Syn. *Melampsora loricis-caprearrum* Kleb.) (Sydow & Butler 1907)
On *Salicaceae—* leaves of *Salix daphnoides* and *Salix elegans*
Distribution: Dalhousie (Chamba) and Shimla

*Melampsora lini* (Ehrenb.) Lév., (Mishra 1963b, Mishra & Prasada 1966)
on *Linaceae—* leaves and stem of *Linum mysorenses* and *Linum grandiflorum*.
Distribution: Flowerdale, Shimla

*Melampsora medusae* Thum., (Paul et al. 2004).
On *Salicaceae—* leaves of *Populus deltoides*
Distribution: Kangra

*Melampsora oblonga* Bagchee, (Ranadive et al. 2012).
On *Pinaceae—* leaves of *Pinus excelsa*
Distribution: Mandi (Central H.P.)

*Melampsora salis-albae* Kleb., (Sydow & Butler 1901)
On *Salicaceae—* Leaves of *Salix alba*
Distribution: Suket, Mandi

*Melampsora rostrupii* G. H. Wagner, (Syn. *M. accidioides*, *M. populnea*) (Rehill & Puri 1980)
On *Salicaceae—* leaves of *Populus alba*
Distribution: Shimla.

**Genus: Ochrospora** Dietel.
Type species: *Ochrospora sorbi* (G. Winter) Dietel (Ochrospora sorbi) (Oudem) Diet., (Arthur & Cummins 1933)
On *Ranunculaceae—* Anemone sp.
Distribution: Alwas (Chamba)

![Image 1. Melampsora populnea on Populus alba: A—symptoms | B—urediniospore with paraphyses. © Ajay Kumar Gautam.](image-url)
4. Family: Phakopsoraceae Cummins & Y. Hirats. f.,
Genus: Monosporidium Barclay
Type species: Monosporidium euphorbiae Barclay ex Sacc. (1891)
Monosporidium andraecnes Barclay, (Barclay1890)
On Phyllanthaceae—leaves of Andracne cordifolia,
Distribution: Shimla & Kasuli (Solan)
Monosporidium euphorbiae Barclay ex Sacc., (Barclay 1890)
On Euphorbiaceae—leaves of Euphorbia pilosa
Distribution: Shimla

Genus: Kweilingia Teng
Type species: Kweilingia bambusae (Teng) Teng (1940)
Kweilingia divina (Syd.) Buriticá (Gautam & Avasthi 2018)
On Poaceae—leaves of Dendroclamus strictus
Distribution: Bilaspur

Genus: Phakopsora Dietel
Type species: Phakopsora punctiformis (Barclay & Dietel) Dietel (1898)
Phakopsora cronartiiformis Dietel, (Butler 1912)
On Vitaceae—leaves of Vitis himalayana
Distribution: Nachar, bashahr (Shimla)
Phakopsora punctiformis (Barclay & Dietel) Dietel, (Dietel 1890)
On Rubiaceae—leaves of Galium aparine
Distribution: Shimla

Genus: Pucciniostele Tranzschel & K.L. Kom.
Type species: Pucciniostele clarkiana (Barclay) Tranzschel & K.L. Kom. (1899)
Pucciniostele clarkiana (Barclay) Tranzschel & K.L. Kom., (Barclay 1890)
On Saxifragaceae—leaves of Astilbe rivularis
Distribution: Shimla

5. Family: Phragmidiaceae Corda
Genus: Frommea Arthur
Type species: Frommea obtusa (F. Strauss) Arthur (1917)
Frommeella tormentillae (Fuckel) U. Braun, (syn. Frommea obtusa (Str.) Arth.)
(Godre & Patwardhan 1965)
On Rosaceae—leaves of Potentilla fragariae
Distribution: Shimla

Genus: Kuehneola Magnus
Type species: Kuehneola albida (J.G. Kühn) Magnus (1898)
Kuehneola loeseneriana (Henn.) H.S. Jacks. & Holw., (syn. Puccinia arthraxonis (P. Henn.) Syd., P. Syd. & E.J.
Butler, (Golatkar 1976; Sharma & Sachan 1994)
On Poaceae—Arthroxon prionodes
Distribution: Kasauli Solan (H.P.)

Genus: Phragmidium Link (Image 2)
Type species: Phragmidium mucronatum (Pers.) Schltldl. (1824)
Phragmidium kamtschatkae (H.W. Anderson) Arthur & Cummins, (syn. Pucciniaroseae Barclay; Trolliomyces roseae (Barclay) Ulbrich, Telocha rosea (Barclay) Syd.) (Mundkar 1938; Pandotra & Ganguly 1964; Ulbrich 1939)
On Rosaceae—leaves and branches of Rosa macrophylla
Distribution: Shimla
Phragmidium barclayi Dietel, (Sydow & Butler 1907)
On Rosaceae—leaves of Rubus lasiocarpus
Distribution: Shimla
Phragmidium mucronatum (Pers.) Schltldl., (syn. Phragmidium disciflorum (Tode) James.)(Cooke 1978)
On Rosaceae—Rosa sp.
Distribution: Kalatop forest, Chamba
Phragmidium incompletum Barclay, (Sydow & Butler 1901)
On Rosaceae—leaves of Rubus paniculatus
Distribution: Shimla
Phragmidium kamtschatke (Anders.) Arthur & Cummins, (Pandotra & Gaungly 1964)
On Rosaceae—leaves of Rosa macrophylla
Distribution: Narkanda, Shimla
Phragmidium laceianum Barclay, (Barclay 1891)
On Rosaceae—leaves of Potentilla argyrophylla
Distribution: Narkanda, Bushahr (Shimla), Kullu
Phragmidium nepalense Barclay (Barclay 1891)
On Rosaceae—leaves of Potentilla nepalensis,
Distribution: Mathiana, Shimla
Phragmidium octoloculare Barclay, (Barclay 1891)
On Rosaceae—leaves of Rubus rosaeolius
Distribution: Shimla
Phragmidium quinqueloculare Barclay, (Barclay 1890)
On Rosaceae—leaves of Rubus biflorus
Distribution: Shimla
Phragmidium rose-moschatae Dietel, (Mitter & Tandon 1938)
On Rosaceae—leaves of Rosa moschata
Distribution: Shimla & Kasauli

6. Family: Pileolariaceae Cummins & Y. Hirats.
Genus: Pileolaria Castagne (Image 3)
Type species: Pileolaria terebinthi (DC.) Castagne (1842)
Pileolaria indica Syd., (Sydow 1938)
On Anacardiaceae—leaves of Pistacia integerrima
Distribution: Wangtu, Bushahr (Shimla)
*Pileolaria pistaciae* F. L. Tai & C. T. Wei, (Gautam & Avasthi 2017b)
On Anacardiaceae—leaves of *Pistacia integerrima*
Distribution: Balt (Mandi)

**Genus: Skierka** Racib. (Image 4)
Type species: *Skierka canarii* Racib. (1900)
*Skierka himalayensis* A. K. Gautam & S. Avasthi, (Gautam & Avasthi 2017b)
On Anacardiaceae—leaves of *Pistacia integerrima*
Distribution: Mandi

7. Family: *Pucciniaceae* Chevall.

**Genus: Gymnosporangium** R. Hedw. ex DC.,
Type species: *Gymnosporangium fuscum* DC. (1805)
*Gymnosporangium cunninghamianum* Barclay, (Barclay 1890)
On Rosaceae—leaves of *Pyrus pashia* and *Pyrus vasiocola*
On Cupressaceae—*Cupressus torulosa*
Distribution: Shimla

**Genus: Puccinia** Pers. (Images 5–11)
Type species: *Puccinia graminis* Pers. (1794)
*Puccinia agrostidis* Plowr., (Barclay 1891)
On Ranunculaceae—*Aquilegia vulgaris*

Distribution: Shimla
*Puccinia ahmadiana* Syd., (Sydow 1938)
On Asteraceae—*Pterothea falconeri*
Distribution: Puti Ruhi, Lahul, Kullu Valley of Himachal Pradesh.
*Puccinia porri* (Sowerby) G. Winter, (syn. *Puccinia allii* (DC.) F. Rud.) (Butler & Bisby 1931; Singh & Sharma 1977, Bharat & Gupta 2011)
On Amaryllidaceae—*Allium sativum*
Distribution: Kullu, Shimla
*Puccinia andropogonis* Schwein., (Barclay 1890)
On Poaceae—Andropogon tristis
Distribution: Shimla
*Puccinia graminis* Pers., (syn. *Puccinia anthistiriae* Barclay) (Sydow & Butler 1912)
On Poaceae—*Anthistiria anathera*
Distribution: Shimla
*Puccinia apii* Desm., (Barclay 1890)
On Apiaceae—*Apium graveolens*
Distribution: Shimla
*Puccinia arenariae* (Schumacher) J. Schröt., (Barclay 1891)
On Caryophyllaceae—*Stellaria paniculata*
Distribution: Narkanda (Shimla)
*Puccinia atropuncta* Peck & Clint., (Chona et al. 1956)
On Asteraceae—*Prenanthes brunoniana*
**Checklist of rust fungi from Himachal Pradesh**

**Gautam & Avasthi**

**Distribution:** Shimla

*Puccinia bulbocastani* (A. Cumin) Fuckel., (Bhardwaj & Sharma 1990)

On **Apiaceae**—on *Bunium persicum*

**Distribution:** Solan

*Puccinia bistortae* (F. Strauss.) DC., (Sydow 1938)

On **Polygonaceae**—*Polygonum viviparum*

**Distribution:** Losar, Spiti (Lahul & Spiti)

*Puccinia brachypodii* G.H. Otth., (Payak 1965)

On **Berberidaceae**—*Berberis aristata*

**Distribution:** Shimla

*Puccinia bupleuri* (Opiz) Rudolphi, (syn. *Pucciniabupleuri-falcata* (DC.) G. Wint. (Barclay 1890)

On **Apiaceae**—*Bupleurum falcatum*

**Distribution:** Shimla

*Puccinia calthae* Link, (Arthur & Cummins 1933; Chona et al. 1956)

On **Ranunculaceae**—*Caltha palustris* var. *alba*

**Distribution:** Dharamshala (Kangra); Rohtang pass (Kullu)

*Puccinia caricis* var. *himalayensis* Barclay,(Butler & Bisby 1931; Padwick & Khan 1944)

On **Cyperaceae**—*Carex setigera*

**Distribution:** Shimla

*Puccinia caricis-filicinae* Barclay, (Mitter & Tandon 1938)

On **Cyperaceae**—*Carex filicina*

**Distribution:** Shimla

*Puccinia caricis-nubigenae* Padwick & A. Khan, (Mitter & Tandon 1938)

On **Cyperaceae**—*Carex nubigena*

**Distribution:** Kufri, Shimla

*Puccinia carthami* Corda, (Sydow & Butler 1901)

On **Asteraceae**—*Carthamus oxycantha*

**Distribution:** Kangra

*Puccinia chrysopogoni* Barclay, (Barclay 1890; Sydow &
Checklist of rust fungi from Himachal Pradesh

Gautam & Avasthi

Journal of Threatened Taxa | www.threatenedtaxa.org | 26 November 2019 | 11(14): 14845–14861

Butler 1907)
Oleaceae—Jasminum humile
Poaceae—Chrysopogon gryllus
Distribution: Shimla
Puccinia circaeae Pers., (Barclay 1890)
On Onagraceae—Circaea alpine
Distribution: Shimla
Puccinia collettiana Barclay, (Barclay 1890; Ganguly & Pandotra 1963)

On Rubiaceae—Rubia cordifolia
Distribution Shimla, Kasauli (Solan), Naggar (Kullu)
Puccinia collettiiana Corda, (syn. Puccinia coronata var. avenae P. Syd. & Syd.) (Mishra et al. 1964)
On Poaceae—Avena sativa
Distribution: Shimla
Puccinia eulaliae Barclay, (Barclay 1891)

On Poaceae—Cynodon dactylon
Distribution: Solan
Puccinia dactylidina Bubák, (Sydow & Butler 1912)
On Poaceae—Dactylis glomerata
Distribution: Shimla
Puccinia diascoreae Kom., (Pandotra & Ganguly 1962)
On Dioscoreaceae—Dioscorea deltoidea
Distribution: Manali
Puccinia dutchiel Ellis & Tracy, (Sydow & Butler 1911)
On Poaceae—Andropogon pertusus
Distribution: Kasauli (Solan)
Puccinia ellisi De Toni, (Barclay 1891)
On Apiaceae—Angelica glauca
Distribution: Phagu, Shimla
Puccinia eremuri Kom., (Barclay 1891)
On Xanthorrhoeaceae—Eremurus himalaicus
Distribution: Kullu
Puccinia erianthi Padwick & A. Khan, (Padwick & Khan 1944)
On Poaceae—Erianthus fulvus
Distribution: Shimla
Puccinia eulalae Barclay, (Butler & Bisby 1960)
On Poaceae—Pollinia japonica
Distribution: Reported from Shimla (H.P.) only.
Puccinia excelsa Barclay, (Barclay 1891)
On Lamiaceae—Phlomis bracteosa
Distribution: Mahasu & Huttoo Peak, Shimla
Puccinia fagopyri Barclay, (Barclay 1890)
On Polygonaceae—Fagopyrum esculentum
Distribution: Shimla, Sangla valley (Kinnaur)
Puccinia flavipes Syd. & P. Syd., (Barclay 1890)

On Rosaceae—Fragaria vesca
Distribution: Shimla
Puccinia gentianae (F. Strauss.) Link, (Barclay 1890)
On Gentianaceae—Gentiana kurroo
Distribution: Shimla
Puccinia gerani-sylvatici P. Karst., (Barclay 1890)
On Geraniaceae—Geranium nepalense
Distribution: Shimla
Puccinia striiformis Westend, (syn. Puccinia glumarum (Schw.) Eriks & P. Henn.) (Prasada 1948)
On Poaceae—Brachypodium sylvaticum
Distribution: Shimla
Puccinia graminis Pers., (Barclay 1890a)
On Poaceae—Festuca gigentia
Distribution: Shimla, Kullu
Puccinia graminis-agropyri P.R. Mehta & R. Prasad, (Prasada 1948)
On Poaceae—Agropyron semicostatum
Distribution: Shimla
Puccinia graminis-poaie Erikss. & Henning, (Prasada 1948)
On Poaceae—Poa nemoralis
Distribution: Shimla
Puccinia himalensis (Barclay) Dietel, (Padwick 1946; Sydow & Butler 1906 & 1907)
On Poaceae—Festuca gigentia
Distribution: Shimla
Puccinia himalalensis A.K. Gautam and S. Avasthi, (Gautam & Avasthi 2016a)
On Ranunculaceae—Clematis grata
Distribution: Mandi
Puccinia invenusta Syd. & P. Syd., (Sharma & Sachan 1994)
On Poaceae—Phramites karka
Distribution: Shimla
Puccinia iridis Walker, (Sydow & Butler 1912)
On Iridaceae—Iris florentina
Distribution: Shimla
Puccinia komarovii Tranzschel ex P. Syd. & Syd., (Khanna 1961)
On Balsaminaceae—Impatiens amphorata
Distribution: Shimla
Puccinia leptodermidis Barclay, (Barclay 1890; Sydow & Butler 1912)
On Rubiaceae—Leptodermis lanceolata
Distribution: Shimla, Kasauli (Solan)
Puccinia menthae Pers., (Pandotra & Ganguly 1964; Sydow & Butler 1912; Sydow 1938)
On Lamiaceae—Mentha longifolia
Distribution: Ubsher, Shimla, Kasauli, Kullu
Puccinia minutissima Arthur, (Munjal & Gill 1962)
Image 5. *Puccinia collettiana*: A—habitat of host | B, C—symptoms | D—urediniospores | E—teliospores. © Ajay Kumar Gautam.

Image 6. *Puccinia fagopyri*: A—symptoms | B—urediniospores & teliospores. © Ajay Kumar Gautam.

Image 7. *Puccinia flavipes*: A—symptoms | B—urediniospores. © Ajay Kumar Gautam.
On Poaceae—Saccharum officinarum
Distribution: Manali

Puccinia nepalensis Barclay & Dietel, (Barclay 1890; Ramakrishanan 1952)

On Polygonaceae—Rumex nepalensis
Distribution: Shimla and Kasauli

Puccinia neyraudiae Syd. & P. Syd., (Sharma & Sachan 1994)

On Poaceae—Neyraudia arundinacea
Distribution: Solan

Puccinia nitida (F. Strauss) Barclay, (Sydow & Butler 1912)

On Polygonaceae—Polygonum ampelexicaule
Distribution: Mashobra, Shimla, Rohtaang Pass

Puccinia opizii Bubák, (Arthur & Cunmins 1933)

On Asteraceae—Lactuca decipiens
Distribution: Alwas (Chamba)

Puccinia pacifica Blasdale ex Arthur, (Chona et al. 1956)

On Plantaginaceae—Plantago tibetica
Distribution: Shimla

Puccinia recondita Roberge ex Desm., (syn. Pucciniapersistens Plowr., Pucciniarubigo-vera (DC.) G. Winter) (Arthur & Cummins 1933; Barclay 1890; Jain et al. 1966)

On Ranunculaceae—Aquilegia vulgaris, Thalictrum javanicum, Thalictrum minus
Distribution: Shimla, Dharamshala, Chamba, Kote, Keylog, Kullu

Puccinia pimpinellae (F. Strauss) Link, (Barclay 1890)

On Apiaceae—Pimpinella diversifolia
Distribution: Shimla

Puccinia polliniae Barclay, (Barclay 1890)

On Acanthaceae—Pollinia nuda
Distribution: Shimla

Puccinia pogonatheri Petch, (Sharma & Sachan 1994)

On Poaceae—Pogonatherum paniceum
Distribution: Solan

Puccinia polygoni-amphibii Pers., (Syn. Pucciniapolygonum Alb. & Schw.)Ganguly & Pandotra 1963, Mishra & Sharma 1964)

On Polygonaceae—Polygonum orientale
Distribution: Shimla, Katrain (Kullu)

Puccinia prauniana Barclay, (Barclay 1890)

On Smilacaceae—Smilax aspera
Distribution: Shimla

Puccinia punctata Link, (Barclay 1890)

On Rubiaceae—Galium aparine
Distribution: Shimla

Puccinia purpurea Cooke, (Sharma & Sachan 1994)

On Poaceae—Sorghum halepense
Distribution: Solan

Puccinia pusilla Syd. & P. Syd., (Sharma & Sachan 1994)

On Poaceae—Cappiliopedium assimite
Distribution: Solan

Puccinia recondita var. similensis A.P. Misra, S.T. Ahmad & Sheodh. Singh, (Gupta 1977)

On Ranunculaceae—Thalictrum javanicum,

On Poaceae—Helicotrechon virens
Distribution: Shimla

Puccinia roscaeae Barclay, (Gupta 1977)

On Zingiberaceae—Roscocia alpina, Rosocia procera
Distribution: Shimla

Puccinia saviculae Grev., (Barclay 1890)

On Apiaceae—Savicula europea
Distribution: Shimla

Puccinia saxifragae-cilliatae Barclay, (Barclay 1890)

On Saxifragaceae—Saxifraga ligulata
Distribution: Shimla

Puccinia heucherae (Schweinitz) Dietel, (syn. Puccinia saxifragae-micranthae Barclay) (Barclay 1891)

On Saxifragaceae—leaves of Saxifraga micrantha
Distribution: Bushar & Shimla

Puccinia sonchi Roberge ex Desm., (Sydow 1938)

On Asteraceae—Sonchus sp.
Distribution: Kullu

Puccinia sorgii Schwein., (Annonymous 1950; Mishra 1963a)

On Poaceae—Zea maize

On Oxalidaceae—Oxalis conriculata
Distribution: Mashobra & Shimla

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

On Poaceae—Muehlenbergia huegeli, Bromusjaponicas and Loliumperenne
Distribution: Shimla

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

On Poaceae—Muehlenbergia huegelii
Distribution: Shimla

Puccinia tanaceti DC., (Sharma & Sachan 1994; Bharat 2008)

On Asteraceae—Artemisia nilogirica
Distribution: Solan

Puccinia thlaspeos Ficusin & C. Schub., (Arthur 1934; Arthur & Cummins 1933)

On Brassicaceae—Draba lanceolata
Distribution: Hunan Nallah, Pangi & Chamba

Puccinia tiliaefolia T.S. Ramkr. & Sundaram, (Gautam & Avasthi 2017c)

On Malvaceae—Grewia tilifolia
Distribution: Mandi

Puccinia tricholepidis Syd., (Sydow 1938)
Image 8. *Puccinia himachalensis*: A—symptoms | B—teliospores | C—urediniospores. © Ajay Kumar Gautam.

Image 9. *Puccinia menthae*: A—symptoms | B—urediniospores. © Ajay Kumar Gautam.

Image 10. *Puccinia tiliaefolia*: A—symptoms | B—teliospores. © Ajay Kumar Gautam.
On Asteraceae—Tricholepis elongata
Distribution: Saharan & Bushar

Puccinia trifolii R. Hedw., (Arthur & Cummins 1933)
On Ranunculaceae—Anemone polyanthes
Distribution: Alwas, Chamba

Puccinia tweediana T.S. Ramakr. & K. Ramakr., (Chona & Munjal 1955;
Ramakrishnan & Ramakrishnan 1948)
On Acanthaceae—Dicliptera sp., D. bupleuroides
Distribution: Kullu, Shimla

Puccinia urticae Barclay, (Barclay 1890)
On Urticaceae—Urtica parviflora
Distribution: Shimla & Kasauli

Puccinia ustalis Berk., (Berkeley 1856)
On Ranunculaceae—leaves of Ranunculus hirtellus
Distribution: Mathana, Shimla

Puccinia violae (Schumach.) DC., (Bilgrami 1963)
On Violaceae—Viola serpens.
Distribution: Shimla

Puccinia wattiana Barclay, (Sharma & Sachan 1994)
On Ranunculaceae—Clematis gouriana
Distribution: Shimla

Genus: Uromyces (Link) Unger (Image 12)
Type species: Uredo appendiculata Pers. (1796)
Uromyces trifolii (R. Hedw.) Lév., (Syn. Uromyces flectens
Lagr., Uromyceserviphilus (Grognot) Hotson) (Gautam & avasthi 2017a)
On Fabaceae—leaves of Trifolium repens L.,
Distribution: Chail Chowk, Mandi

Uromyces viciea-fabae (Pers.) J. Schröt. (syn. Uromyces
fabe (Pers.) de Barry. (Kulshrestha et al. 1998)
On Fabaceae—leaves of Vigna radiata (L.)
Distribution: Shimla

Uromyces agropyri Barclay, (Barclay 1891)
On Poaceae —Agropyron sp.
Distribution: Bushahr (Shimla)

Uromyces dactylidis G.H. Otth (Syn. Puccinia lycoctoni
Fuckel) (Sydow & Butler 1907)
On Ranunculaceae—Aconitum lycoctonum
Distribution: Shimla

Uromyces ciceris-arietini (Grognot.) Jacz. & G. Boyer,
(Payak 1962)
On Fabaceae—Trigonella polyerata
Distribution: Shimla

Uromyces appendiculatus (Pers.) Link, (Sydow & Butler
1912)
On Fabaceae—Vigna vexillata
Distribution: Dharamshala

Uromyces macintirianus Barclay, (Sydow & Butler 1938)
On Acanthaceae—leaves of Hemigraphis latebrosa
Distribution: Shimla

Uromyces hobsonii Vize, (Sydow & Butler 1907)
On Oleaceae—leaves of Jasminum grandiflorum
Distribution: Shimla

Uromyces polygoni-avicularis var. polygoni-avicularis
(Pers.) P. Karst., (Sydow 1938)
On Polygonaceae—leaves of Polygonum cogatum
Distribution: Lahul Valley (L&S), Kullu

Uromyces rottboelliae Arthur, (Sydow & Butler 1938)
On Poaceae—Rottboellia speciosa
Distribution: Shimla

Uromyces sommerfeltii Hyl., Jorst. & Nannf., (Barclay
1890)
On Asteraceae—Solidago virgaurea
Distribution: Shimla

Uromyces strobilanthis Barclay, (Mitter & Tandon 1938)
On Acanthaceae—Strobilanthes dalhausianus
Distribution: Shimla

Uromyces valeriana- wallichii (Dietel) Arthur & Cummins, (Arthur & Cummins 1933)
On Caprifoliaceae—leaves of Valeria nauvallichii,
Distribution: Shimla
Uromyces vignae Barclay, (Barclay 1891)
On Fabaceae—Vigna vexillata
Distribution: Shimla
Uromyces vossiae Barclay, (Barclay 1890)
On Poaceae —Vossia speciosa
Distribution: Shimla

Genus: Haplotelium Syd.
Type species: Haplotelium amoenum (Syd. & P. Syd.) Syd. (1922)
Haplotelium ambiens (Cooke) Syd., (syn. Uromyces ambiens Cooke) (Barclay 1891, Sydow 1913)
On Buxaceae—Buxus sempervirens
Distribution: Bushahr (Shimla)

8. Pucciniaceae Gän. ex Leppik 1972
Genus: Pucciniastrum G.H. Otth
Type species: Pucciniastrum epilobii (Pers.) G.H. Otth (1861)
Pucciniastrum agrimoniae (Dietel) Tranzschel, (Sydow & Butler 1901; Sydow & Butler 1912)
On Rosaceae—leaves of Agrimonia eupatoria
Distribution: Shimla

Genus: Uredinopsis Magnus
Type species: Uredinopsis filicina (Niessl) Magnus (1893)
Uredinopsis syngrammes Munjal & J.N. Kapoor., (Munjal & Kapoor 1961)
On Pteridaceae—Leaves of Syngramme fraxiana Bedd.
Distribution: Narkanda

9. Urocystidaceae Begerow, R. Bauer & Oberw.
Genus: Urocystis Rabenh. ex Fuckel
Type species: Urocystis occulta (Wallr.) Rabenh. (1867)
Urocystis sorosporioides Körn. ex Fuckel, (Mundkar & Thirumalachar 1952)

On Ranunculaceae—leaves and stem of Delphinium denudatum
Distribution: Shimla

10. Raveneliaceae Leppik
Genus: Ravenelia Bark.
Type species: Ravenelia glanduliformis Berk. & M.A. Curtis (1874)
Ravenelia mitis Syd. & P. Syd. (Sydow & Sydow 1904-21)
On Fabaceae—leaves of Tephrosia purpurea
Distribution: Solan
Ravenelia tandonii Syd. (Bakshi & Singh)
On Fabaceae—leaves of Acacia catechu
Distribution: Solan.

Incertae sedis
Genus: Aecidium Pers.
Type species: Aecidium berberidis Pers. ex J.F. Gmel. (1792)
Aecidium cunninghamianum Barclay, (Barclay 1891)
on Rosaceae—leaves of Cotoneaster bacillaris Wall.
Distribution: Shimla
Aecidium flavescens Barclay, (Barclay 1891)
on Asteraceae —leaves of Senecio rufinervis DC.
Distribution: Mashobra, Shimla
Aecidium infrequens Barclay, (Sydow & Butler 1912)
on Geraniaceae —leaves of Geranium nepalense
Distribution: Shimla
Aecidium leucospernum DC., (Barclay 1890)
on Ranunculaceae—leaves of Anemone rivularis
Distribution: Shimla
Aecidium lophanthi P. Henn., (Arthur & Cummins 1933)
on Lamiales—leaves of Mentha sp.
Distribution: Chamba
Aecidium montanum E.J. Butler, (Arthur & Cummins 1933)
on Berberidaceae—leaves of Berberis lyceum
Distribution: Kangra
**Checklist of rust fungi from Himachal Pradesh**

**Gautam & A vasthi**

*Journal of Threatened Taxa* | www.threatenedtaxa.org | 26 November 2019 | 11(14): 14845–14861

---

**Aecidium mori** Barclay, (Barclay 1890)
On *Moraceae*—leaves of *Morus alba*
Distribution: Shimla

**Aecidium myriactidis** (Barclay) Syd. & P. Syd., (Barclay 1890)
On *Asteraceae*—leaves of *Myriactis nepalensis*
Distribution: Mashobra (Shimla)

**Aecidium orbiculare** Barclay, (Barclay 1891)
On *Ranunculaceae*—leaves of *Clematis grata*
Distribution: Shimla

**Aecidium peristrophes** Syd. & P. Syd., (Sydow & Butler 1912)
On *Acanthaceae*—leaves of *Peristrophe* sp.
Distribution: Kangra

**Aecidium plectranthi** Barclay, (Barclay 1890)
On *Lamiaceae*—leaves of *Plectranthus coetsa*
Distribution: Shimla

**Aecidium withaniae** Thuem., (Sydow & Butler 1912)
On *Solanaceae*—leaves of *Withania coagulans*
Distribution: Shimla

---

**Genus: Uredo** Pers.

Type species: *Uredo betae* Pers. (1801)

**Uredo apludae** Barclay, (Barclay 1890)
On *Poaceae*—leaves of *Apluda aristata*
Distribution: Shimla

**Uredo duetziae** Barclay, (Butler & Bisby 1960)
On *Hydrangeaceae*—leaves of *Deutzia corymbosa*
Distribution: Shimla

**Uredo lebrookienss** Barclay, (Watt), (Butler & Bisby 1960)
On *Lamiaceae*—leaves of *Colebrookea oppositifolia*,
Distribution: Simla

**Uredo gomphrenae** Barclay, (Sydow & Butler 1907)
On *Amaranthaceae*—leaves & stem of *Gomphrena globosa*
Distribution: Shimla

**Uredo ignobilis** Syd. & P. Syd., (Pedwick & Khan 1944)
On *Poaceae*—leaves of *Sporobolus indicus*
Distribution: Shimla

**Uredo pileae** Barclay, (Barclay 1891)
On *Poaceae*—leaves of *Sporobolus trinervia*
Distribution: Shimla

**Uredo valerianae-wallachii** Dietel, (Barclay 1891)
On *Caprifoliaceae*—leaves of *Valeriana wallachii*,
Distribution: Shimla

---

**DISCUSSION**

The present study provides the checklist of rust fungi from Himachal Pradesh, a northwestern Himalayan State of India. A remarkable diversity of rust fungi have been reported from the state which has an area of 55,673 km². The state exhibits marked variations in climate and vegetation and so far in fungal diversity. The available information about rust fungi from the state is in general meager and there is much scope for exploratory work on the taxonomy, diversity and ecological aspects of these fungi. There are about 167 species, 23 genera belonging to 11 families recorded from this hilly Himalayan state, with great variations in host infected (about 171 plant species belonging to 121 genera and 52 families). This distinguished diversity of rust fungi may be due to the fact that rust fungi tend to prefer humid habitats, which is one of the major characteristic features of the state. Being obligate parasites, rust fungi are associated with spreading and development of nutrient plants and are found in many belts, both on herbaceous plants, and on trees and shrubs.

After compilation of literature it is observed that most of the rust fungi were reported from Shimla and nearby regions. Although, these fungi are also reported from other districts of the state but the scope of exploration of these fungi and their host range is still there.

Two checklists on two major rust genera namely, *Puccinia* (Gautam & Avasthi 2016b) *Uromyces* (Gautam & Avasthi 2017a) have recently been published from this hilly state. Two new species of rust fungi namely *Puccinia himachalenis* (Gautam & Avasthi 2016a) and *Skierka himalayensis* (Gautam & Avasthi 2017b) have been reported from the state which are new to science. Whereas, *Pileolaria pistaciae* (Gautam & Avasthi 2017b), *Kwellingia divina* (Gautam & Avasthi 2018) are the new additions to the mycobiota of the state while, *Puccinia tiliaefolia* (Gautam & Avasthi 2017c) has been rediscovered after 46 years from India. During the literature survey we did not come across any molecular studies conducted on rust fungi from the state. As per greater phytodiversity of the state, studies on the rust fungi are inadequate and there is vast scope to conduct studies and fill the data gaps. Molecular studies of rust fungi are still required besides morphological taxonomy, which will not only help in revision and reassessment of the existing fungal species, but also to find their correct taxonomic position. The knowledge generated by the work is of immense utility as it is a key to revealing the diversity and ecology of rust fungi from Himachal Pradesh Himalaya.
REFERENCES

Ahmad, S.T., H.S. Singh & D.P. Mishra (1969). Additions to wheat rust races in India race 14 & 38 of Puccinia striformis 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 J.C. (1934). Manual of Rusts in United States and Canada. Lafayette, Indiana. 438pp.

Arthur, J.C. & G.D. Cummins (1933). Rusts of North West Himalayas. Mycologia 25: 397–406.

Bagchee (1950). Coleosporium barclayense Bagchee. Indian Forest Records 4(2): 53.

Bakshi, B.K. & S. Singh (1967). Rusts on Indian Forest Trees. Indian Forest Records (NS). Forest Pathology 2: 139–198.

Barclay A. (1890). Descriptive list of Uredineae occurring in the neighborhood of Shimla. Journal Asiatic Society of Bengal 56: 161–165, 350–375.

Barclay A. (1891). Additional Uredineae from the neighborhood of Shimla. Journal Asiatic Society of Bengal 60: 211–230.

Berkeley M.J. (1856). Decades of fungi; Decas 1–62 nos 1–620. Berkeley, M.J. (1890). Fungi of North West Himalayas. Indian Journal of Agricultural Research 20: 107–142.

Bagchee, B.L., R.L. Munjal & J.N. Kapoor (1956).

Chona, B.L. & R.L. Munjal (1956). A new record to rust fungi of North Western Himalayas (Himachal Pradesh), India. Studies in Fungi 3(1): 234–240.

Godre, W.Y. & P.G. Patwardhan (1965). Occurrence of Erysiphe graminis var. tritici in Bombay, Maharashtra. Current Science 34: 89.

Gautam, A.K. & S. Avasthi (2017a). Uromyces trifolii, a new addition to rust fungi of Himachal Pradesh, India with a checklist of Uromyces in India. Plant Pathology & Quarantine 7(1): 1–14.

Gautam, A.K. & S. Avasthi (2017b). Fungi associated with Pistacia integerrima with a description of a new species and one new record from India. Acta Mycologica 52(2): 1100. https://doi.org/10.5586/ am.1100

Gautam, A.K. & S. Avasthi (2017c). Discovery of Puccinia tiliae-foliorum (Pucciniales) in northwestern Himalayas, India. Polish Botanical Journal 62(1): 135–137.

Gautam, A.K. & S. Avasthi (2018). A new record to rust fungi of North Western Himalayas (Himachal Pradesh), India. Studies in Fungi 3(1): 234–240.

Gautam, A.K. & S. Avasthi (2017b). Fungi associated with Pusticia integerrima with a description of a new species and one new record from India. Acta Mycologica 52(2): 1100. https://doi.org/10.5586/ am.1100

Gautham, A.K. & S. Avasthi (2018). A new record to rust fungi of North Western Himalayas (Himachal Pradesh), India. Studies in Fungi 3(1): 234–240.

Khanna, P.C. (1961). New diseases of sugarcane in U.P. India. Current Science 46: 27.

Mohanan, C. (2010). Fungi of medicinal and aromatic plants in North Western Himalayas – I. Mycopathologia et Mycologia Applicata 20: 39–40.

Mundkar, B.B. & M.J. Thirumalachar (1952). Ustilaginales of India. Ustilaginales of India. Mycological Papers 15: 220–223.

Mundkar, B.B. & M.J. Thirumalachar (1952). Ustilaginales of India. Mycological Papers 15: 220–223.

Padwick, G.W. (1945). Notes on Indian fungi-III. Mycological Papers 7(1): 1–14.
Padwick, G.W. (1946). Notes on Indian fungi-IV. Mycological Papers 17: 12 pp.

Padwick, G.W. & A. Khan (1944). Notes on Indian fungi-II. Mycological Papers 10: 17 pp.

Pandotra, V.R. & D. Ganguly (1962). Notes on two fungi collected from Kullu Valley, Punjab. Indian Phytopathology 15: 216–217.

Pandotra, V.R. & D. Ganguly (1964). Fungi on medicinal and aromatic plants in North West Himalayas. Mycopathology et Mycological Applicata 22: 59–68, 106–116.

Patil, J.S. & A.P.B. Nayar (1936). Natural and Induced resistance to shoot rot in the coconut. Proceedings of Indian Academy of Sciences 3(8): 432–437.

Pau, Y.S., V.K. Thakur & C. Gopi (2004). Occurrence of Melampsoraresociaceae Thum in India. Journal of Mycology and Plant Pathology 34: 850–851.

Payak, M.M. (1962). Natural occurrence of gram rusty in uredial stage on Trigonella polycerata L. in Shimla hills. Current Science 31: 433–434.

Payak, M.M. (1965). Berberis as the aecial host of Puccinia brachypodii in Shimla Hills, India. Phytopathology 52: 49–54.

Prasad, 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.

Puri, Y.N. (1955). Rust and wood rotting fungi on some of the Indian Conifers. Forest Bulletin Dehradun 179. Manager of Publication, Government of India Press, Calcutta.

Ramakrishnan, T.S. (1952). Additions to fungi of Madras-XII. Proceedings of Indian Academy of Sciences 35(8): 11–121.

Ramakrishnan, T.S. & K. Ramakrishnan (1948). Additions to fungi of Madras- V. Proceedings of Indian Academy of Sciences 28(8): 50–70.

Ranadive, K., S. Kadbane, S. Mandal, H. Wasesa, P. Jite, V. Ranade & J. Vaidya (2012). Host distribution of Melampsora Cast from India. Journal of Scientific Information (Special issue) 4: 33–40.

Rehill, P.S. & Y.N. Puri (1980). Some important diseases of Populus. Indian Journal of Forestry 3(2): 176–183.

Sehgal, H.S., R.K. Tiwari, S.N. Khan & B.M. Misra (1989). New records of fungi and new host records from India. Indian Forester 115: 228–234.

Sharma, R.C., & S. Sharma (2000). Status and distribution of foliar diseases of poplar in Himachal Pradesh. Indian Phytopathology 53: 57–60.

Sharma, R.K. & S.N. Sachan (1994). New host of rust fungi from Himachal Pradesh. Advances in Plant Sciences 7: 154–158.

Sharma, S., & R.C. Sharma (2002). Prevalence of poplar leaf rust in Himachal Pradesh. Indian Phytopathology 55: 81–83.

Singh, V.M. & Y.R. Sharma (1977). Rust on Garlic FAO. Plant Protection Bulletin 25: 41–42.

Sydow, H (1913). Mycotheca Germanica. Fasc. XXIV: 1151-1200. Annals of Mycology 11: 364–366.

Sydow, H. (1938). Fungi Himalayensis. Annals of Mycology 36: 437–442.

Sydow, H. & E.J. Butler (1901). Fungi Indiae Orientalis Pars. I. Annals of Mycology 4: 424–445.

Sydow, H. & E.J. Butler (1906). Fungi Indiae Orientalis Pars. I. Annales Mycologici 4: 424–445.

Sydow, H. & E.J. Butler (1907). Fungi Indiae Orientalis II. Annales Mycologici 5: 485–515.

Sydow, H. & E.J. Butler (1911). Fungi Indiae Orientalis part III. Annales Mycologici 9: 372–421.

Sydow, H. & E.J. Butler (1912). Fungi Indiae Orientalis IV. Annales Mycologici 10: 243–280.

Sydow, H. & J.H. Mitter (1933). Fungi Indici I. Annals of Mycology 31:84–97.

Sydow, H. & P. Sydow (1904–21). Newae fungorum species-I. Annals of Mycology 2: 162–174.

Ulbrich, E. (1939). New species from Nanga Parbat collected by C. Troll. Fungi. Addendum zu Pucciniaceae. Notizbl. hot. Gart. Bed. 14: 124, 343–344.

Vasudeva, R.S. (1958). Report of the division of Mycology and Plant Pathology. Science Report of Agricultural Research Institute, New Delhi, pp. 87–101 & 1954–55.
The Journal of Threatened Taxa (JoTT) is dedicated to building evidence for conservation globally by publishing peer-reviewed articles online every month at a reasonably rapid rate at www.threatenedtaxa.org. All articles published in JoTT are registered under Creative Commons Attribution 4.0 International License unless otherwise mentioned. JoTT allows unrestricted use, reproduction, and distribution of articles in any medium by providing adequate credit to the author(s) and the source of publication.

Announcement
The Sally Walker Conservation Fund – an appeal for support – P. 14787

Communications
Complementary bat (Mammalia: Chiroptera) survey techniques uncover two new country records for Nigeria – Iroro Tanshi, Anthony Ekata Ogbelbu & Paul Jeremy James Bates, Pp. 14788–14801

Bone fractures in roadkill Northern Tamandua Tamandua mexicana (Mammalia: Pilosa: Myrmecophagidae) in Costa Rica – Randall Arguedas, Elisa C. López & Lizbeth Ovares, Pp. 14802–14807

Barilus tarsol (Teleostei: Cypriniformes: Cyprinidae), a new freshwater fish from the Brahmaputra drainage, India – Kavita Kumari, Manas Hoshalll Munivenkatappa, Archana Sinha, Simanku Borah & Basanta Kumar Das, Pp. 14808–14815

Butterfly diversity throughout Midnapore urban area in West Bengal, India – Suryoj Joyti Biswas, Deburan Patra, Soumyajit Roy, Santosh Kumar Gir, Suman Paul & Asif Hossain, Pp. 14816–14826

Plant and fungi diversity of Devi Pindiyan Valley in Trikuta Hills of northwestern Himalaya, India – Sajan Thakur, Harish Chander Dutt, Bikarma Singh, Yash Pal Sharma, Nawang Tashi, Rajender Singh Charak, Geeta Sharma, Om Prakash Vidyarthi, Tasir Iqbal, Bishander Singh & Kewal Kumar, Pp. 14827–14844

A checklist of rust fungi from Himachal Pradesh, India – Anoop P. Balan, A.J. Robi & S.V. Predeep, Pp. 14886–14890

Notes
Vertebrate prey handling in the Indian Grey Hornbill Ocyeros briostris (Aves: Bucerotiformes: Bucerotidae) – James A. Fitzsimons, Pp. 14891–14894

Impact of cyclone Fani on the breeding success of sandbar-nesting birds along the Mahanadi River in Odisha, India – Subrat Debata, Pp. 14895–14898

First record of the micromoth Ethnia lineatonotella (Moore, 1867) (Lepidoptera: Depressariidae: Ethmiinae) from Bhutan – Jatishwor Singh Irungbam & Meenakshi Jatishwor Irungbam, Pp. 14899–14901

Additional distribution records of the rare Nepal Comma Polygonia c-album agricula (Moore, 1872) (Insecta: Lepidoptera: Nymphalidae) from Rara National Park, Nepal – Sanel Prasad Suwal, Biraj Shrestha, Binita Pandey, Bibek Shrestha, Prithivi Lal Nepal, Kaashi Chandra Rokaya & Bimal Raj Shrestha, Pp. 14902–14905

A new distribution record of the gall midge Octodiplosis bispina Sharma (Diptera: Cecidomyiidae) from the Western Ghats of Tamil Nadu, India – Durai Kannum Vasanthakumar, Radheshyam Murlidhar Sharma & Palanisamy Senthil Kumar, Pp. 14906–14907

New recruitment of staghorn corals in the Gulf of Mannar - the emergence of a resilient coral reef – Koushik Sadhukhan, Ramesh Chatragadda, T. Shanmugaraj & M.V. Ramana Murthy, Pp. 14908–14911

New records of coral diseases in the Persian Gulf Crepidium aphyllum (Orchidaceae), a new record from Bhutan – Pramod R. Lawand, Rajaram V. Gurav & Vinod B. Shimpale, Pp. 14912–14913

Rediagnosis, after over a century, of the endemic climbing vine Argyrea lawii (Convolvulaceae) from the Western Ghats of India – Arjun Adit, Monika Koul & Rajesh Tandon, Pp. 14876–14885

Notes on the extended distribution of Humboldtia bourdillonii (Fabales: Fabaceae), an Endangered tree legume in the Western Ghats, India – Anoop P. Balan, A.J. Robi & S.V. Predeep, Pp. 14886–14890