Indian *Pucciniales*: taxonomic outline with important descriptive notes

Gautam AK¹, Avasthi S², Verma RK³, Devadatha B⁴, Jayawardena RS⁵, Sushma⁶, Ranadive KR⁷, Kashyap PL⁸, Bhadauria R², Prasher IB⁹, Sharma VK³, Niranjana M^{4,10}, Jeewon R¹¹

¹School of Agriculture, Abhilashi University, Mandi, Himachal Pradesh, 175028, India

²School of Studies in Botany, Jiwaji University, Gwalior, Madhya Pradesh, 474011, India

³Department of Plant Pathology, Punjab Agricultural University, Ludhiana, Punjab, 141004, India

⁴Fungal Biotechnology Lab, Department of Biotechnology, School of Life Sciences, Pondicherry University, Kalapet, Pondicherry, 605014, India

⁵Center of Excellence in Fungal Research, Mae Fah Luang University, Chiang Rai, 57100, Thailand

⁶Department of Botany, Dolphin PG College of Science and Agriculture Chunnikalan, Fatehgarh Sahib, Punjab, India

⁷Department of Botany, P.D.E.A. 's Annasaheb Magar Mahavidyalaya, Mahadevnagar, Hadapsar, Pune, Maharashtra, India

⁸ICAR-Indian Institute of Wheat and Barley Research (IIWBR), Karnal, Haryana, India

⁹Department of Botany, Mycology and Plant Pathology Laboratory, Panjab University Chandigarh, 160014, India

¹⁰Department of Botany, Rajiv Gandhi University, Rono Hills, Doimukh, Itanagar, Arunachal Pradesh, 791112, India

¹¹Department of Health Sciences, Faculty of Medicine and Health Sciences, University of Mauritius, Reduit, Mauritius

Gautam AK, Avasthi S, Verma RK, Devadatha B, Jayawardena RS, Sushma, Ranadive KR, Kashyap PL, Bhadauria R, Prasher IB, Sharma VK, Niranjana M, Jeewon R 2021 – Indian *Pucciniales*: taxonomic outline with important descriptive notes. Mycosphere 12(1), 89–162, Doi 10.5943/mycosphere/12/1/2

Abstract

Rusts constitute a major group of the Kingdom Fungi and they are distributed all over the world on a wide range of wild and cultivated plants. It is the largest natural group of plant pathogens including 95% of the subphylum *Pucciniomycotina* and about 8% of all described Fungi. This article provides an overview and outline of rust fungi of India with important descriptive notes. After compilation of available literature on Indian rust fungi from various sources, it was observed that these fungi are distributed in 16 families, 69 genera and 640 species. They belong to *Coleosporiaceae*, *Crossosporaceae*, *Gymnosporangiaceae*, *Melampsoraceae*, *Milesinaceae*, *Ochropsoraceae*, *Phakopsoraceae*, *Phragmidaceae*, *Pileolariaceae*, *Pucciniaceae*, *Pucciniastraceae*, *Raveneliaceae*, *Skierkaceae*, *Sphaerophragmiaceae*, *Tranzscheliaceae* and *Zaghouaniaceae*. There are still many rust fungi with uncertain taxonomic position, and they have been referred to *incertae sedis*. The placement of all fungal genera is provided at the class, order and family-level along with number of species in a genus. Notes for each rust family along with total Indian records and other taxonomic information on transferred genera and species are also presented. A phylogenetic analysis from a combined LSU and ITS dataset for 25 rust genera is presented to provide a better understanding of their phylogeny and evolution.

Key words – India – Phylogeny – *Pucciniomycotina* – rust fungi – Systematics

Introduction

Rust fungi (*Basidiomycota*, *Pucciniales*) are a highly diverse group of obligate biotrophic parasites, distributed in all geographical areas on a wide range of wild and cultivated plants ranging

from ferns, Gymnosperms and Angiosperms (Duplessis et al. 2011). They are called rusts as one of their spore types i.e. the urediniospores and (uredinia) on host surface are often rust coloured. These fungi are unique and fascinating group of organisms possessing diverse structures (spermogonia, two anamorphs, teleomorphs and basidiospores) in their life cycle. Besides having up to five or six morphologically and functionally distinct spore types, many rust fungi exhibit complicated life cycles with variable host plant specificity. Because of their obligate parasitic nature, actively growing rusts survive only on living hosts and produce teliospores towards the end of the growing season. Species of *Pucciniomycotina* show simple life cycle (simple teliosporic yeasts) to the complex elaborate five-stage life cycles of the biotrophic rust fungi, the latter regarded as the most complex organisms in Kingdom Fungi (Lutz et al. 2004). Along with various spore types, some rust fungi require alternation between two exclusive and unrelated host plant taxa to complete their life cycle (heteroecious rust), although others can complete their life cycle on a single host plant (autoecious rust) (Kolmer et al. 2009). Parasitism and host specialization is highly developed in rust fungi (Savile et al. 1971, Duplessis et al. 2011). They constitute one of the major groups of plant pathogenic fungi. *Pucciniales* is the most speciose order in *Pucciniomycotina* and include 95% of the subphylum and ca. 8% of all described Fungi (Kirk et al. 2008).

The rust fungi have a long research history, mostly due to their economic importance in agriculture and forestry, and easily noticeable symptoms (Cummins & Hiratsuka 2003). Taxonomically the rust fungi belong to *Pucciniomycotina*, one of the three subphyla of Basidiomycota. Further, these fungi are placed in class *Pucciniomycetes* and order *Pucciniales*. In some systems of classifications, the rust fungi are placed in the subclass *Heterobasidiomycetes* based on basidial morphology while in other systems, they are with smut fungi in *Teliomycetes* based on their similar basidial characteristics (Talbot 1971, Webster 1980). Different morphological characters have been emphasized in earlier system of rust taxonomy and classifications (Ono & Hennen 1983). Initially, rust fungi were classified into three (or four) families, *Melampsoraceae*, (*Coleosporiaceae*), *Pucciniaceae* and *Zaghouaniaceae* based on the characteristics of basidia and teliospores (Sydow & Sydow 1915, Cunningham 1931). Classification of rust fungi in subfamilies or tribes and morphology of telia in taxonomy was also considered (Sydow & Sydow 1915, Dietel 1928). Use of morphology of spermogonial (0) and aecial (I) stages was emphasized by Hiratsuka & Cummins (1963) and Hiratsuka (1983) in the classification of rust fungi. The morphological characters of telium (Thirumalachar & Cummins 1949) and teliospores (Dietel 1928, Thirumalachar & Cummins 1948, Thirumalachar & Mundkur 1949) played an important role in the taxonomic placement of rust fungi (Alexopoulos 1962). However, with the combination of different character of uredinia, aecia, type of spermogonia and telia, there has been several conflicting taxonomic hypotheses with time and this led to the proposal of 13-family system of classification of rust fungi. Based on telial morphology, three families were accepted: *Melampsoraceae* (sessile teliospores formed in columns in the telium), *Pucciniaceae* (stalked teliospores, produced in a single layer in the telium) and *Coleosporiaceae* (do not form a promycelium but karyogamy and meiosis occur directly within the teliospores that become septate during the germination process). Cummins & Hiratsuka (1983, 2003) proposed 13 families. This was one of the the most accepted systems of rust classification till the incorporation of molecular data in systematic studies.

With the use of modern techniques (molecular studies) along with conventional methods (morphological studies), new taxonomic suggestions have been proposed regarding interrelationships of different groups of fungi. However, the earlier systems of classifications of rust fungi were mainly based on shape, size and other morphological characters of different spores and spore producing structures. Based on recent molecular techniques (DNA sequence data from the large ribosomal subunit) and ultrastructural investigations, it was observed that rusts are distantly related to some of the smuts (Aime et al. 2006, Kijpornyongpan et al. 2018). Subsequently Swann & Taylor (1995a, b) and Swann et al. (2001) proposed the separation of class *Urediniomycetes* (the rust fungi), including the rusts (*Uredinales*), from class *Ustilaginomycetes* (the smut fungi) and class *Hymenomycetes* mushrooms and shelf or bracket fungi) under division *Basidiomycota*. Within the class *Urediniomycetes*, true rusts (*Uredinales*) account for over 95% of the species and more than 75% of

the genera. Several research series on fungal diversity published in recent years provided an updated information on addition, exclusion, correct taxonomic position and transferred taxa of fungi. Aime (2006) examined representative species from the 13 families proposed by Cummins & Hiratsuka (2003) and based on sequence analyses of the 18S and 28S nuclear rDNA regions, three major suborders were proposed *Uredinineae*, *Melampsorineae* and *Mikronegeriineae*. The *Uredinineae* includes species which produce the aecial stage on angiospermous host with pedicellate teliospores. Similarly, *Melampsorineae* comprises heteroecious, mostly macrocyclic rust species producing aecial stage on gymnosperms and producing sessile teliospores. *Mikronegeriineae* accommodates species with aecial stage usually on non-pine gymnosperms and in microcyclic types the teliospores functioned as urediniospores, with short pedicellate or sessile teliospores. He et al. (2019) presented notes, outline and divergence times of *Basidiomycota*. They differentiated *Urediniomycetes* from *Basidiomycetes*, as the nuclear membrane partially degrades during mitosis (semiopen pleuromitosis) in some *Urediniomycetes* while mitosis in basidiomycetes proceeds with preservation of the nuclear membrane (intranuclear pleuromitosis). They also differentiated rusts and smuts as non-basidiomata forming members of *Basidiomycota*, which comprises *Pucciniomycotina* and *Ustilaginomycotina*, respectively. They included eight families, *Coleosporiaceae*, *Mikronegeriaceae*, *Phakopsoraceae*, *Phragmidiaceae*, *Pileolariaceae*, *Pucciniaceae*, *Raveneliaceae* and *Sphaerophragmiaceae* in order *Pucciniales*, class *Pucciniomycetes* and subphylum *Pucciniomycotina* in their phylogenetic studies. However, they also presented the estimated number for taxa in *Basidiomycota*, of which, order *Pucciniales* possesses 15 families, 162 genera and 8105 species. Recently, Wijayawardene et al. (2020) outlined the kingdom Fungi up to genus level. They also presented 15 families (138 genera) under the order *Pucciniales*, class *Pucciniomycetes* and phylum *Basidiomycota*. It is interesting to mention here that the majority of *Pucciniomycotina* species (ca. 7500 of nearly 8500) belong to a single order *Pucciniales* that cause rust diseases in numerous plants (He et al. 2019, Wijayawardene et al. 2020, Aime & McTaggart 2020). The recent higher-rank classification for rust fungi is provided by Aime & McTaggart (2020), wherein they proposed the addition of four new suborders and seven new families, with some amendments in existing families. The classification of *Pucciniales* now comprises seven suborders and 18 families.

To understand the status of research on rust fungi in India, we have started this part here with the beginning of Indian mycological research. Here foreign visiting scientists or emigrant experts in the 18th and 19th centuries carried out most of the research. This started with the mycological studies initiated by K.R. Kirtikar in late 19th century who collected and identified numerous fungi. Although the special credit to initiate mycological research in India goes to A. Barclay and E.J. Butler because of their contribution to initiate and organize research on mycology and plant pathology in India. After the establishment of the Imperial Agricultural Research Institute at Pusa (Bihar) during the year 1905 with the generous grant of 30,000 pounds from an American philanthropist, Mr. Henry Phipps, mycological research in India gained momentum. With the earlier efforts of E.J. Butler, the first imperial mycologists to the then British Government of India, a firm foundation of mycology and plant pathology was laid in this country and he is aptly referred to as the Father of Indian Mycology (Subramanian 1986). This research continued with the passage of time and involvement of many more mycologists. With the advancement in mycological research, B.B. Mundkur and M.J. Thirumalachar laid down a pioneer contribution in the studies of rust and smut fungi as *Ustilaginales* of India (Mundkar & Thirumalachar 1952). Foundation of the Indian Phytopathological Society was also laid down by B. B. Mundkur along with S.R. Bose, both served as its earliest presidents. K.C. Mehta (1940) studied the problem of the recurrence of the wheat rust in plains of India. They mainly focused on cereal rust of India. Balchandra Bhavanishankar Mundkur and Mandayam Jeersannidhi Thirumalachar in 1952 jointly published a consolidated list of Indian *Ustilaginales*. Similarly, Thirumalachar & Mundkar (1950) published a very useful appendix of genera of rust fungi. Simultaneously, Hans Sydow, a German mycologist, son of Paul Sydow also contributed a lot in understanding the Himalayan mycoflora including rust fungi. Similarly, George Baker Cummins, A. Barclay and Joseph Charles Arthur investigated the rusts occurring near North Western Himalayas. D.P. Mishra along with other mycologists also investigated rust fungi of agricultural crops in India.

Several other mycologists contributed significantly to the development of research on rust fungi in India on a regional basis. Pioneering work of C. Mohanan cannot be neglected as modern mycologists. He worked on biodiversity of plant pathogenic fungi of the Western Ghats and published a book entitled “Rust Fungi of Kerala, India”. Some names worth mentioning are Ramesh Chand Sharma, Sanjeev Sharma, R.K. Sharma, S.N. Sachan and Ajay Kumar Gautam, who actively worked in the past and are still engaged in studies of various aspects of rust fungi of Himachal Pradesh. Dr. E.J. Butler & G.R. Bisby compiled a monograph “The Fungi of India”, in 1931. The fungi of India series have been revised from time to time and updated by several workers. However, the contribution of great Indian mycologists K.D. Bagchee, T.S. Ramakrishnan, J.H. Mitter, K.J. Narsimhan, S.N. Das Gupta, R.N. Tandon, R. Prasad, T.S. Sadasivan, C.V. Subramaniam and many more cannot be ignored. The taxonomic research on rust fungi in India has been based primarily on morphology of certain spore stages. Only a few studies published recently have employed modern tools and techniques for identification of rust fungi. Several institutes like Indian Type Culture Collection (ITCC) New Delhi; National Fungal Culture Collection of India (NFCCI) Pune, Maharashtra; CSIR-IMTECH Chandigarh, NBAIM Mau and many more are actively carrying research on fungal taxonomy and other related aspects and providing facilities for molecular characterisation of fungi including rust fungi in India. A major scientific breakthrough of the Indian Council of Agricultural Research (ICAR) scientists lead to the decoding of genomes of 15 strains of wheat rust fungus *Puccinia triticina*. Herbarium Cryptogamae Indiae Orientalis (HCIO) has a rich collection of rusts, smuts, powdery mildews and meliiales fungi and has more than 3500 type specimens (Maheswari et al. 2012). HCIO documented a comprehensive checklist of *Puccinia* species of India along with herbarium photographs and brief description (Kamil et al. 2013). Similarly, “Rust fungi of Kerala, India” (Mohanani 2010); First checklist of rust fungi in the genus *Puccinia* from Himachal Pradesh, India” (Gautam & Avasthi 2016a); and “A checklist of rust fungi from Himachal Pradesh, India” (Gautam & Avasthi 2019) are the recent compilations of rust fungi from India. In subsequent years, a plethora of articles on *Pucciniales* (*Uredinales*) has been published, which has added a lot to understanding this group of fungi, thus it is essential and pragmatic to compile it into a single document. Therefore, we are starting a series of publications on rust fungal diversity from India, and this first paper provides basic information and the latest trends related to taxonomic outline of rust fungi of India with important descriptive notes.

Materials & Methods

Layout of the paper

A brief description of each genus up to its higher taxonomic rank related with rust fungi of India is provided. During the listing of genera, their species, and other higher taxonomic ranks into a single outline, all generic names are listed from previously published literature pertaining to rust fungi of India. The detailed literature in reference to Indian rust fungi is summarised in the present study under the heading “literature used during the study of rust fungi”. The names of some species have been replaced by currently accepted names after consultation of MycoBank (www.mycobank.org/) and Species Fungorum (www.speciesfungorum.org) websites and this has been indicated in such cases. For general outline of Indian rust fungi, we adopted He et al. (2019) and Wijayawardene et al. (2020). Aime & McTaggart (2020) was followed to provide a higher-rank classification of rust fungi. To confirm their scientific entity where some generic/species names have been updated with currently accepted name, more literature on rust fungi was consulted (Cummins & Hiratsuka 2003, Aime 2006, Aime et al. 2018, Aime & McTaggart 2020. After complete verification, accepted taxa of rust fungi of *Basidiomycota* up to species level are presented in detailed. The existing and currently accepted names of various genera and species of rust fungi are provided as a separate section in this manuscript.

Phylogenetic analyses

Most of the rust fungi reported from India were characterized mainly based on the

morphological characters of uredia and telia or other successive stages observed on collected samples. However, rust fungi reported from India lack molecular studies.

Based on earlier studies on Indian rust fungi, a checklist was prepared and the DNA sequence data from the LSU and ITS rDNA regions available for same rust fungi reported from other countries were downloaded from GenBank and through published literature (Maier et al. 2003, Aime 2006, Aime et al. 2006, Aime & McTaggart 2020). Individual nucleotide sequences of LSU and ITS were aligned distinctly using MAFFT 7 (<http://mafft.cbrc.jp/alignment/server/>) (Kato & Standley 2013) and then manual checking and editing where necessary in BioEdit v.7.0.9 (Hall 1999). The ITS sequences of taxa containing weak aligned portions, incomplete data, missing sequence data and gaps were removed. The separate aligned gene regions of LSU and ITS were combined in BioEdit. The combined multigene sequence alignment was converted to PHYLIP format (.phy) using ALTER (alignment trans-formation environment: (<http://sing.eiuvigo.es/ALTER/>; 2021) for randomized accelerated maximum likelihood (RAXML) analysis. The aligned LSU and ITS single gene datasets and a concatenated dataset of LSU and ITS genes were analyzed with maximum likelihood using the RAXML-HPC2 on XSEDE (8.2.8) (Stamatakis et al. 2008, Stamatakis 2014) in the CIPRES Science Gateway platform (Miller et al. 2010) using GTR+I+G model of evolution. Maximum Likelihood bootstrap values greater than 70% were given above each node. Phylogenetic trees were visualized with FigTree v1.4.0 program (Rambaut 2012) and reorganized in Microsoft power point (2016).

Table 1 GenBank and voucher/culture collection accession numbers of species included in the phylogenetic study

Taxon	Voucher/culture	GenBank accession Numbers		References
		ITS	LSU	
<i>Cerotelium fici</i>	LAH20019AM	--	MK135779	Ishaq et al. (unpublished)
<i>Chrysomyxa pirolae</i>	190CHP_PCG_DU2		GU049555	Feau et al. (2011)
<i>Coleosporium asterum</i>	MCA3077	--	MG907226	Aime et al. (2018)
<i>Coleosporium bletiae</i>	BSC1	--	MN108162	Zhou (unpublished)
<i>Coleosporium campanulae</i>	--	--	KP017565	Tian et al. (unpublished)
<i>Coleosporium campanulae</i>	LB09265/ZT_Myc_58002	KY810467	--	Beenken et al. (2017)
<i>Coleosporium inulae</i>	U717	--	MG907223	Aime et al. (2018)
<i>Coleosporium inulae</i>	LB09168/ZT_Myc_57996	KY810470	--	Beenken et al. (2017)
<i>Coleosporium ipomoeae</i>	JRH 485	MF769644	--	McTaggart & Aime (2018)
<i>Coleosporium ipomoeae</i>	R232	--	EU851160	Zuluaga et al. (2011)
<i>Coleosporium senecionis</i>	LB08877/ZT_Myc_57995	KY810472	--	
<i>Coleosporium senecionis</i>	PDD 98309	--	KJ716348	Beenken et al. (2017)
<i>Coleosporium xanthoxyli</i>	KUS-F30013	--	MK530184	Shin et al. (2019)
<i>Cronartium quercuum</i>	CqvGa-1	L76495	--	Vogler & Bruns (1998)
<i>Cronartium ribicola</i>	--	KX963430	--	Kaitera et al. (2017)
			AF426240	Maier et al. (2003)
<i>Crossospora ziziphi</i>	BPI 877877	--	MG744558	Souza et al. (2018)
<i>Gymnosporangium clavariiforme</i>	LD 1019	HM114220	--	Dervis et al. (2011)
<i>Gymnosporangium clavariiforme</i>	HMAS:24626	--	KU342766	Zhao et al. (2016)
<i>Gymnosporangium confusum</i>	LD 1021	HM114219	--	Dervis et al. (2011)
<i>Gymnosporangium confusum</i>	20140808B H22	--	KP261043	Fernandez & Alvarado (2016)
<i>Hyalopsora polypodii</i>	BPI 893256	KY798367	--	Demers & Castlebury (unpublished)
<i>Hyalopsora polypodii</i>	DB 1681	--	AY512852	Begerow et al. (unpublished)

Table 1 Continued.

Taxon	Voucher/culture	GenBank accession Numbers		References
		ITS	LSU	
<i>Kernkampella breyniae</i>	BRIP:56909	--	KJ862346	McTaggart et al. (2015)
<i>Kweilingia divina</i>	MCA3493	--	MG907215	Aime et al. (2018)
<i>Leucotelium pruni-persicae</i>	--	AB097450	--	Osaki (unpublished)
<i>Maravalia pterocarpi</i>	HNCM1	KU301795	--	Wang et al. (2016)
<i>Melampsora caprearum</i>	GE14_3_2	KY649193	--	Piskur (unpublished)
<i>Melampsora caprearum</i>	NYS-F-003819	--	KU550033	Zhao (unpublished)
<i>Melampsora epitea</i>	--	--	DQ354564	Aime (2006)
<i>Melampsora epitea</i>	1046MEE-SA-QC.1	GQ479218	--	Vialle (unpublished)
<i>Melampsora euphorbiae</i>	--	EF192199	--	Aime (unpublished)
<i>Melampsora euphorbiae</i>	BPI 863501	--	DQ437504	Aime et al. (2006)
<i>Melampsora hypericorum</i>	BPI 893298	--	KY798351	Demers & Castlebury (unpublished)
<i>Melampsora hypericorum</i>	PDD 97325	KJ716353	--	Padamsee & McKenzie (2014)
<i>Melampsora populnea</i>	892MPO-PTA-FR3.1	EU808037	--	Feau et al. (2009)
<i>Melampsora populnea</i>	--	--	AY444786	Pei et al. (2005)
<i>Melampsora salicis-albae</i>	HMAAC4068 HMAAC4068	--	MK372199	Wang (unpublished)
<i>Melampsora salicis-albae</i>	13125 F	FJ455128	--	Eslami et al. (unpublished)
<i>Melampsoridium betulinum</i>	KR-M-0048135	--	MK302187	Bubner et al. (2019)
<i>Melampsoridium betulinum</i>	H 6034375	KF031552	--	McKenzie et al. (2013)
<i>Melampsoridium hiratsukanum</i>	421	KC313888	--	Blomquist et al. (2014)
<i>Melampsoridium hiratsukanum</i>	KR-M-0048149	--	MK302188	Bubner et al. (2019)
<i>Milesina exigua</i>	KR-M-0050247	MH908478	MK302211	Bubner et al. (2019)
<i>Milesina polypodii</i>	KR-M-0043190	--	MK302190	Bubner et al. (2019)
<i>Nyssopsora thwaitesii</i>	AMH:9528	KF550283	--	Baiswar et al. (2014)
<i>Ochropsora ariae</i>	KR-M-42604	KX228773	KX228778	Scholler et al. (2019)
<i>Phakopsora apoda</i>	PDD 72076	MG461668	MG461668	Demers & Castlebury (unpublished)
<i>Phakopsora cingens</i>	BRIP:55628	--	KP729474	Maier et al. (2016)
<i>Phakopsora meibomia</i>	Brazil 82-1	AF333501	--	Frederick et al. (2002)
<i>Phakopsora meibomia</i>	R188	--	EU851164	Zuluaga et al. (2011)
<i>Phakopsora phyllanthi</i>	83	KF528025	--	Beenken (2014)
<i>Phakopsora phyllanthi</i>	BPI 843632	--	KY764084	Demers et al. (unpublished)
<i>Phakopsora ziziphi-vulgaris</i>	HMJAU8595	MK296536	MK296506	Ji (unpublished)
<i>Phragmidium barclayi</i>	HMAS-67281	--	MG669117	Liu et al. (2018)
<i>Phragmidium brevipedicellatum</i>	HMUT100463	--	KU059170	Xu et al. (unpublished)
<i>Phragmidium butleri</i>	HMAS-67841	--	MG669118	Liu et al. (2018)
<i>Phragmidium fragariae</i>	--	--	AF426217	Maier et al. (2003)
<i>Phragmidium mucronatum</i>	TFS01	--	KJ867552	El-Deeb (unpublished)
<i>Phragmidium potentillae</i>	BRIP:60089	--	KT199403	McTaggart et al. (2016b)

Table 1 Continued.

Taxon	Voucher/culture	GenBank accession Numbers		References
		ITS	LSU	
<i>Phragmidium potentillae</i>	HMJAU8609	MK296538	--	Ji (unpublished)
<i>Phragmidium rosae-moschatae</i>	BPI 893257	--	KY798368	Demers & Castlebury (unpublished)
<i>Pileolaria pistaciae</i>	--	MG860928	KY314266	Ishaq et al. (2020)
<i>Puccinia actaeae-agropyri</i>	TUB 14959	--	DQ917746	Maier et al. (2007)
<i>Puccinia antirrhini</i>	BPI 910208	--	KY764090	Demers et al. (unpublished)
<i>Puccinia arenariae</i>	BPI 893275		KY798385	Demers et al. (unpublished)
<i>Puccinia argentata</i>	IMI 502182	--	KC433402	Tanner et al. (unpublished)
<i>Puccinia bistortae</i>	TUB 14964	--	DQ917697	Maier et al. (2007)
<i>Puccinia brachypodii</i>	HSZ0975	GQ457303	--	Jin et al. (2010)
<i>Puccinia brachypodii</i>	BRIP 59466	--	KX999868	Marin-Felix et al. (2017)
<i>Puccinia bupleuri</i>	BPI 910217	--	KY764100	Demers et al. (unpublished)
<i>Puccinia canaliculata</i>	U-77	HQ412647		Deadman et al. (2011)
<i>Puccinia carthami</i>	SAF 1	AF064822		Berthier-Schaad (unpublished)
<i>Puccinia carthami</i>	--		AY787782	Deadman et al. (2005)
<i>Puccinia cenchri</i>	BPI055581	--	KY575080	Demers & Castlebury (unpublished)
<i>Puccinia chloridis-incompletae</i>	HSZ1393	KM096427	KM096427	Mahadevakumar (unpublished)
<i>Puccinia chrysanthemi</i>	HSZ2154	KX369039	--	Szabo & Nguyen (unpublished)
<i>Puccinia chrysanthemi</i>	R79F	--	HQ201322	Alaei (unpublished)
<i>Puccinia circaeae</i>	TUB 14969	--	DQ917716	Maier et al. (2007)
<i>Puccinia coronata</i>	--	--	DQ354526	Aime et al. (2006)
<i>Puccinia crepidis-japonicae</i>	BPI 893282	--	KY798360	Demers & Castlebury (unpublished)
<i>Puccinia cyperi</i>	BRIP 60997	KU296885	KU296885	McTaggart et al. (2016a)
<i>Puccinia dactylidina</i>	PUR F15426	JX533546	JX533546	Liu et al. (2013)
<i>Puccinia dioicae</i>	DAR 77052	EF635897	--	Morin et al. (2009)
<i>Puccinia drabae</i>	R209-16555	EU014054	EU014055	Alaei et al. (2009)
<i>Puccinia ferruginosa</i>	IBA7553	--	AB190901	Engkhaninun et al. (unpublished)
<i>Puccinia ferruginosa</i>	TSH-R6237	AB188126	--	Engkhaninun et al. (2005)
<i>Puccinia graminis</i>	72_2	--	JQ688991	Berlin et al. (2012)
<i>Puccinia heterospora</i>	BPI 893307	KY798362	--	Demers & Castlebury (unpublished)
<i>Puccinia heterospora</i>	BRIP 60937	--	KU296886	McTaggart et al. (2016a)
<i>Puccinia heucherae</i>	RHS5296/05	--	DQ359702	Henricot et al. (2007)
<i>Puccinia hieracii</i>	DAOM 240969	--	HQ317515	Liu et al. (2015)
<i>Puccinia hordei</i>	PDD:101656	--	KX985762	Padamsee & McKenzie (2017)
<i>Puccinia hydrocotyles</i>	--	--	GU936635	Zuluaga et al. (2011)
<i>Puccinia iridis</i>	KUS-F23394	--	MK446720	Choi et al. (2019)
<i>Puccinia iridis</i>	KUS-F30180	MK446718		Choi et al. (2019)
<i>Puccinia kuehnii</i>	BPI 881011	--	HQ666891	Saumtally et al. (2011)

Table 1 Continued.

Taxon	Voucher/culture	GenBank accession Numbers		References
		ITS	LSU	
<i>Puccinia kuehnii</i>	090687	GU564421	--	Glynn et al. (2010)
<i>Puccinia lantanae</i>	R190	--	EU851144	Zuluaga et al. (2011)
<i>Puccinia lateritia</i>	BPI 910249	--	KY764134	Demers et al. (unpublished)
<i>Puccinia liberta</i>	BRIP 59686	--	KX999881	Marin-Felix et al. (2017)
<i>Puccinia linkii</i>	DAOM:242721	KM851040	--	Mulvey & Hambleton (2015)
<i>uccinia linkii</i>	DAOM:243230	--	KM851041	Mulvey & Hambleton (2015)
<i>Puccinia malvacearum</i>	AFTOL-ID 1629	EF561641	--	Matheny & Hibbett (unpublished)
<i>Puccinia malvacearum</i>	U1384	--	MG907249	Aime et al. (2018)
<i>Puccinia melanocephala</i>	PM_NayMex_Xalsco	MG564638	--	Bermudez et al. (unpublished)
<i>Puccinia melanocephala</i>	PM_ColMex_CE_Tecoman	--	MG564636	Bermudez et al. (unpublished)
<i>Puccinia menthae</i>	BPI 910255	KY764141	--	Demers et al. (unpublished)
<i>Puccinia menthae</i>	BPI 871110		DQ354513	Aime et al. (2006)
<i>Puccinia nakanishikii</i>	BPI 910261	KY764147	--	Demers et al. (unpublished)
<i>Puccinia nakanishikii</i>	--	--	GU058002	Dixon et al. (2010)
<i>Puccinia nepalensis</i>	BA66	--	KX014746	Ali et al. (2017)
<i>Puccinia nepalensis</i>	BA651	KX225481	--	Ali et al. 2017)
<i>Puccinia nitida</i>	BPI 843472	--	KY764148	Demers et al. (unpublished)
<i>Puccinia oahuensis</i>	BPI087481	--	KY575092	Demers & Castlebury (unpublished)
<i>Puccinia obscura</i>	KR14322	--	FJ669234	Scholler et al. (2011)
<i>Puccinia obscura</i>	--	AF468042	--	Weber et al. (2003)
<i>Puccinia ocimi</i>	BPI 910262	KY764149	KY764149	Demers et al. (unpublished)
<i>Puccinia operta</i>	BPI142436		KY575095	Demers & Castlebury (unpublished)
<i>Puccinia oxalidis</i>	KUS-F27920	MH325473	--	Lee et al. (2019)
<i>Puccinia oxalidis</i>	BPI 893310	--	KY798348	Demers & Castlebury (unpublished)
<i>Puccinia paspali</i>	BPI841180	--	KY575098	Demers & Castlebury (unpublished)
<i>Puccinia peradeniyae</i>	BPI 089014	KX190906	KX190906	Demers et al. (2017)
<i>Puccinia pimpinellae</i>	--	GU058023	GU058023	Dixon et al. (2010)
<i>Puccinia polygoni-amphibii</i>	BPI 893289	--	KY798381	Demers & Castlebury (unpublished)
<i>Puccinia polysora</i>	--	HM467909	GU058024	Yu et al. (unpublished)
<i>Puccinia porri</i>	22-16	KY492366	--	Ristic et al. (unpublished)
<i>Puccinia recondita</i>	BPI 910319	--	KY798399	Demers & Castlebury (unpublished)
<i>Puccinia rufipes</i>	--	AJ406071	--	Virtudazo et al. (2001)
<i>Puccinia scirpi</i>	BRIP 61027	KX999892	KX999892	Marin-Felix et al. (2017)
<i>Puccinia striiformis</i>	HSZ1834	GQ457306	--	Jin et al. (2010)
<i>Puccinia striiformis</i>	HSZ1828	--	GQ457304	Jin et al. (2010)
<i>Puccinia substriata</i>	--	GU058028	--	Dixon et al. (2010)

Table 1 Continued.

Taxon	Voucher/culture	GenBank accession Numbers		References
		ITS	LSU	
<i>Puccinia substriata</i>	BPI106260		KY575101	Demers & Castlebury (unpublished)
<i>Puccinia tanacetii</i>	R221	HQ201323	HQ201324	Alaei (unpublished)
<i>Puccinia thlaspeos</i>	--	L76177		Roy et al. (1998)
<i>Puccinia thlaspeos</i>	--	L76183		Roy et al. (1998)
<i>Puccinia turgida</i>	NA224	MH144383	--	Otálora & Berndt (2018)
<i>Puccinia turgida</i>	NA223	MH144382		Otálora & Berndt (2018)
<i>Puccinia versicolor</i>	U902	--	MG907252	Aime et al. (2018)
<i>Puccinia violae</i>	BPI 842321	DQ354509	--	Aime (2006)
<i>Puccinia violae</i>	--	--	GU058029	Dixon et al. (2010)
<i>Puccinia xanthii</i>	BRIP48819	EU659694	--	Seier et al. (2009)
<i>Puccinia xanthii</i>	BRIP 56946		KX999896	Marin-Felix et al. (2017)
<i>Pucciniastrum coryli</i>	TSH-R4237 (IBA8641)	AB221419	--	Liang et al. (2006)
<i>Ravenelia acaciae-arabicae</i>	PREM61853	--	MN072675	Ebinghaus et al. (2020)
<i>Ravenelia acaciae-pennatulae</i>	U115	--	MG907213	Aime et al. (2018)
<i>Ravenelia acaciicola</i>	PREM61861	--	MN072683	Ebinghaus et al. (2020)
<i>Ravenelia evansii</i>	PREM61209	MG945959	--	Ebinghaus et al. (2018)
<i>Ravenelia evansii</i>	PREM61028	--	MG945996	Ebinghaus et al. (2018)
<i>Tranzschelia discolor</i>	U-884	DQ995341	--	Deadman et al. (2007)
<i>Tranzschelia discolor</i>	BRIP 57662	--	KR994891	Doungsa-Ard (unpublished)
<i>Tranzschelia pruni-spinosae</i>	KR-M-0002755	--	KX228774	Scholler et al. (2019)
<i>Uromyces aloes</i>	2020-6-28-0005	MT136509	--	Bily et al. (unpublished)
<i>Uromyces aloes</i>	WM 3290	--	DQ917740	Maier et al. (2007)
<i>Uromyces ciceris-arietini</i>	--	GU058030	--	Dixon et al. (2010)
<i>Uromyces ciceris-arietini</i>		--	GQ914998	Stuteville et al. (2010)
<i>Uromyces clignyi</i>	DAOM 192217	HM131364	--	Liu & Hambleton (2013)
<i>Uromyces commelinae</i>	JW100	KF982855	--	Kwon & Kim (2014)
<i>Uromyces coronatus</i>	DAOM 32991	HM131365	--	Liu & Hambleton (2013)
<i>Uromyces coronatus</i>	BPI 910293		KY764191	Demers et al. (unpublished)
<i>Uromyces dactylidis</i>	PRC:705	KM667955	--	Hrabetova et al. (2015)
<i>Uromyces dactylidis</i>	TUB 14997	--	DQ917745	Maier et al. (2007)
<i>Uromyces dolicholi</i>	DAOM 116149	HQ317563	HQ317563	Liu et al. (2015)
<i>Uromyces eragrostidis</i>	DAOM 106767	HQ317561	--	Liu et al. (2015)
<i>Uromyces eragrostidis</i>	BPI004474	--	KY575113	Demers & Castlebury (unpublished)
<i>Uromyces euphorbiae</i>	PUR N11621	KT750329	--	Roskopf et al. (unpublished)
<i>Uromyces euphorbiae</i>	BPI 863673	--	KT750330	Roskopf et al. (unpublished)
<i>Uromyces geranii</i>	BRIP 60100	--	KX999898	Marin-Felix et al. (2017)
<i>Uromyces hedysari-obscuri</i>	DAOM 189699	HQ317573	--	Liu et al. (2015)
<i>Uromyces hedysari-obscuri</i>	DAOM 223015	--	HQ317572	Liu et al. (2015)
<i>Uromyces lespedezae-procumbentis</i>	BPI 910294	KY764193	KY764193	Demers et al. (unpublished)

Table 1 Continued.

Taxon	Voucher/culture	GenBank accession Numbers		References
		ITS	LSU	
<i>Uromyces minor</i>	MVAP50000151	MK045314	MK045314	Blomquist (unpublished)
<i>Uromyces muscari</i>	DAOM 75626	HQ317552	HQ317552	Liu et al. (2015)
<i>Uromyces orientalis</i>	BRIP 60934	KX999899	KX999899	Marin-Felix et al. (2017)
<i>Uromyces peglerae</i>	BPI843311		KY575116	Demers & Castlebury (unpublished)
<i>Uromyces pisi-sativi</i>	--	DQ521591	--	Sagliocco et al. (unpublished)
<i>Uromyces pisi-sativi</i>	BRIP 60151	--	KX999900	Marin-Felix et al. (2017)
<i>Uromyces polygoni-avicularis</i>	DAOM 181565		HQ317558	Liu et al. (2015)
<i>Uromyces rumicis</i>	PDD:93529	KX985763	--	Padamsee & McKenzie (2017)
<i>Uromyces rumicis</i>	BPI 910298		KY764197	Demers et al. (unpublished)
<i>Uromyces setariae-italicae</i>	BPI863744	KY575068		Demers & Castlebury (unpublished)
<i>Uromyces setariae-italicae</i>	BPI863750	--	KY575069	Demers & Castlebury (unpublished)
<i>Uromyces striatus</i>	U-675	HQ412651	--	Deadman et al. (2011)
<i>Uromyces striatus</i>	DAOM 240966	--	HQ317512	Liu et al. (2015)
<i>Uromyces strobilanthidis</i>	BPI 893253	--	KY798375	Demers & Castlebury (unpublished)
<i>Uromyces tenuicutis</i>	BRIP 60012	--	KX999904	Marin-Felix et al. (2017)
<i>Uromyces trifolii</i>	--	--	GU936634	Zuluaga et al. (2011)
<i>Uromyces viciae-fabae</i>	--	AB115665	--	Chung et al. (2004)
<i>Uromyces viciae-fabae</i>		--	AF426199	Maier et al. (2003)
<i>Uromyces vignae</i>	H92019	AB115731	--	Chung et al. (2004)
<i>Uromyces vignae</i>	BRIP 60213	--	KX999906	Marin-Felix et al. (2017)
<i>Taphrina pruni</i>	CBS 358.35	MH855700	MH867219	Vu et al. 2019)

Genus-wise literature of Indian rust fungi

Angiopsora: Bagchee & Singh 1960, Bahadur & Sinha 1967, Ramakrishnan 1950, Ramakrishnan & Sundaram 1954b, Thirumalachar & Mundkar 1951, Vaheeduddin 1955. **Arthuria:** Gokhle & Patel 1953. **Bubakia:** Butler & Bisby 1931, Mundkar 1938, 1943, Ramakrishnan & Ramakrishnan 1950a. **Calidion:** Ramakrishnan 1950. **Chaconia:** Butler & Bisby 1931, Mishra et al. 1976, Patel et al. 1949, Patil & Thirumalachar 1971, Patil 1966a, Ramakrishnan 1950, Singh 1966. **Ceropsora:** Bakshi & Singh 1960. **Cerotelium:** Ahmad 1981, Arthur 1917, Bakshi et al. 1972, Butler 1914, Chowdhary 1948, Jain et al. 1966, Joshi & Vashiist 1959, Nagraj et al. 1971, Patil & Thirumalachar 1971, Patil 1966a, Pawar & Kulkarni 1973, Payak 1949, Ramachar et al. 1978, Ramakrishnan 1952, Rangaswamy et al. 1968, Sathe 1972b, Sydow & Mitter 1935, Thite & Patil 1970, Vasudeva 1962, Venkatakrishaiya 1958, Wakhloo 1962, Yadav 1963a, Yadav & Thirumalachar 1955. **Chrysocelis:** Ramakrishnan & Ramakrishnan 1949. **Chrysomyxa:** Bakshi & Singh 1972, Barclay 1890a, Butler 1906, 1910, Dietal 1890, Puri 1955, Sydow & Butler 1901, Ulbitch 1938. **Coleosporium:** Anonymous 1950, Arthur 1934, Bagchee 1950b, Bakshi et al. 1972, Barclay 1890b, Berkeley 1856, Butler & Bisby 1931, Cummins 1943, Dewan & Kar 1974, Fleming 1874, Goswami & Singh 1973, Hafeezkhan 1928b, Kamal et al. 1979, Mitter & Tandon 1932a, b, Patil & Thirumalachar 1971, Patil 1966a, Prasada 1951, Puri 1955, Sanwal 1951b, Sydow 1922, Sydow & Mitter 1933, Sydow et al. 1937, Sydow & Butler 1901, Sydow et al. 1907, Sydow et al. 1912, Wani & Thirumalachar 1969, Yadav 1964a, Yadav & Thirumalachar 1955. **Corbulopsora:** Thirumalachar 1947. **Cronartium:** Anonymous 1950, Bagchee 1933, 1950a, b, c, Bakshi et al. 1972,

Butler & Bisby 1931, Goswami & Singh 1973, Hafeezkhan 1928a, Puri 1955. **Crossopsora**: Chavan & Bakare 1974, Malviya & Jain 1981, Mundkar & Thirumalachar 1945, Mundkar & Thirumalachar 1952, Patil & Thirumalachar 1971, Patil 1966a, Ramakrishnan & Soumini 1946a, Sunderam 1961, Sydow et al. 1912, Yadav 1963b. **Cystopsora**: Ramakrishnan & Sundaram 1952a, Rangaswamy et al. 1968, Sharma 1977. **Dasturella**: Butler & Bisby 1931, Mishra & Nema 1976, Mundkar & Kheshwala 1943, Nema & Mishra 1965, Patel et al. 1949, 1951b, Patil & Thirumalachar 1971, Patil 1966a, Rangaswamy et al. 1968, Sathe 1965a, Thirumalachar et al. 1956, Thirumalachar & Gopalkrishnan 1947, Yadav 1964a. **Didymopsorella**: Rangaswamy et al. 1968, Thirumalachar 1950a, 1951, Thirumalachar & Mundkar 1950. **Diorchidium**: Sydow et al. 1907, Yadav 1953. **Elateraecium**: Thirumalachar et al. 1966. **Endophyllum**: Arthur 1934, Cummins 1943, Gokhle et al. 1955, Singh & Jalan 1965, Nagraj et al. 1971, Patil 1966a, Thirumalachar & Govindu 1954, Thirumalachar & Narsimhan 1950b. **Gambleola**: Butler 1906, Sydow & Butler 1901, Sydow et al. 1907. **Goplana**: Ramakrishnan & Ramakrishnan 1949. **Gymnopuccinia**: Ramakrishnan 1951c, Thite & Patil 1970. **Gymnosporangium**: Arthur 1934, Arthur & Cummins 1936a, Barclay 1890d, Butler 1906, Cummins 1943, Sydow 1938, Sydow & Butler 1901. **Hamasporea**: Goswami & Singh 1973, Massee 1892, Ramakrishnan & Sundaram 1954a. **Hapalophragmium**: Jain et al. 1966, Mishra 1969, Ramakrishnan & Ramakrishnan 1948a, Thirumalachar 1950c. **Hemileia**: Ananth & Chokanna 1961, Cooke 1876b, Krishnamurthy & Rangaswamy 1947, Massee 1906, Nagraj et al. 1971, Parndekar 1964, Patil & Thirumalachar 1971, Patil 1977, 1966a, Ramakrishnan 1957b, Ramakrishnan & Soumini 1946b, Rangaswamy et al. 1968, Sydow & Mitter 1933, Sydow & Butler 1901, Thirumalachar 1947, Thirumalachar 1950b, Thirumalachar & Narsimhan 1947, Thite & Patil 1970, Yadav 1963b. **Hyalopsora**: Anonymous 1936, Arthur 1934, Chona & Munjal 1955, Munjal & Kapoor 1961, Sydow 1938. **Kernella**: Thirumalachar & Mundkar 1949. **Kernkampella**: Rajendren 1970, Bhagyanarayana & Ramachar 1985. **Kuehneola**: Chavan 1975, Malviya & Jain 1981, Patil 1966a, Thite & Patil 1970, Yadav 1963b, Bhagyanarayana & Rao 1995, Hosagoudar 1985. **Kweilingia**: Bakshi et al. 1972, Gautam & Avasthi 2018. **Leucotelium**: Sydow 1939, Sydow et al. 1912, Nema & Mishra 1965. **Macabuna**: Kamal et al. 1979. **Maravalia**: Ahmad 1981, Arthur & Cummins 1936b, Butler & Bisby 1931, Patil & Thirumalachar 1971, Patil 1966a, Thirumalachar 1949a, Yadav & Thirumalachar 1955. **Masseeëlla**: Joshi & Vashiist 1959, Mundkar & Thirumalachar 1952, Patel et al. 1949, Patil 1966a, Patwardhan 1964, Ramakrishnan 1957a, Sharma 1975, Thirumalachar 1943b, c. **Melampsora**: Agarwal et al. 1959, Ajrekar 1912, Bagchee 1950b, Bagchee & Singh 1960, Bakshi & Singh 1961, Barclay 1891, Butler 1905, 1918, Butler & Bisby 1931, 1960, Chavan & Bakare 1977, Cooke 1876b, Cummins 1943, Jain et al. 1966, Kala & Gaur 1983a, Kaul 1959a, b, Kern & Thurston 1944, Lele 1952, Manocharachary et al. 1976, Mcrae 1917, Mishra 1969, 1963a, Mishra & Prasad 1966, Pandotra 1966, Pandotra & Ganguly 1964b, Parndekar 1964, Patil & Thirumalachar 1971, Patil 1966a, Payak 1949, Puri 1955, Ramachar & Bhagyanarayana 1977a, b, Ramakrishnan & Ramakrishnan 1949, Rangaswamy et al. 1968, Ravindra Nath & Narahari Reddy 1964, Srivastava 1982, Sydow & Butler 1901, Sydow et al. 1907, Sydow et al. 1912, Thirumalachar 1941b, Vasudeva 1948, 1949, 1950a, b. **Melampsoridium**: Bakshi et al. 1972, Narayan & Kamal 1985, Patil 1966a, Sathe 1966a, Singh & Pandey 1972. **Milesina**: Anonymous 1959a, Bagchee & Singh 1960. **Monosporidium**: Barclay 1890c, Parndekar 1964, Patil 1966a, Sydow et al. 1912, Gokhle & Patel 1951. **Neophysopella**: Mundkar 1943, Vaheeduddin 1955, Bagchee & Singh 1960. **Nyssopsora**: Mundkar & Thirumalachar 1952, Nagachan & Goswami 1985, Rangaswamy et al. 1968, Roy 1948. **Ochropsora**: Arthur & Cummins 1936a. **Olivea**: Bakshi et al. 1972, Butler & Bisby 1931, Pandotra & Ganguly 1964b, Patil 1966a. **Peridermium**: Anonymous 1950, Bakshi & Singh 1972, Barclay 1890b, Butler & Bisby 1931, Champion 1922, Cooke 1878b, Hafeezkhan 1928a, Mitter & Tandon 1932a, Puri 1955, Sydow & Butler 1901, Berkeley 1856, Cooke 1877. **Peridiopsora**: Sathe 1969b. **Phakopsora**: Bahekar 1966, Butler 1912, Butler & Bisby 1931, Dietal 1890, Jhooty et al. 1977, Kala & Gaur 1983a, Mundkar 1943, Nagraj et al. 1971, Patel et al. 1985, Patil & Thirumalachar 1971, Patil 1977, Ramachar et al. 1978, Ramakrishnan & Subramanian 1952, Ramakrishnan 1951c, Ramakrishnan 1952, 1955a, 1956, Ramakrishnan & Ramakrishnan 1950a, Ramakrishnan et al. 1952, Ramakrishnan & Sundaram 1954b, 1955a, b, Rangaswamy et al. 1968, Sathe 1972a, Sharma & Jain

1981, Sydow 1938, Sydow et al. 1907, Sydow et al. 1912, Thirumalachar 1947, Uppal et al. 1935, Yadav 1963a, 1964a, Yadav & Thirumalachar 1955. **Phragmidiella**: Patel et al. 1949, Patil 1966a, Thirumalachar & Mundkar 1949. **Phragmidium**: Barclay 1890b, Barclay 1891, Bhattacharya & Baruah 1953, Cooke 1878a, b, Goswami & Singh 1973, Kala & Gaur 1983a, Mitter & Tandon 1932a, b, Mundkar 1938, Pandotra & Ganguly 1964b, Ramakrishnan & Sundaram 1953a, Sydow 1938, Sydow & Mitter 1935, Sydow et al. 1907, Sydow et al. 1911a, b. **Physopella**: Agarwal et al. 1964, Khanna & Chandra 1975, Malviya & Jain 1981, Patil & Thirumalachar 1971, Ramachar 1966, Ramachar & Bhagyanarayana 1976, Sathe 1965d, Subramaniam & Ramakrishnan 1956. **Pileolaria**: Sydow 1938, Gautam & Avasthi 2017c. **Prospodium**: Bagyanarayana & Ravinder 1995, Bagyanarayana et al. 1998. **Puccinia**: Agarwal et al. 1959, 1981, Ahmad 1977, Ahmad & Singh 1969, Ahmad et al. 1969, Anonymous 1950, Arthur 1934, Arthur & Cummins 1936a, Bagchee & Singh 1960, Balasubramanian 1973, Barclay 1890a, b, e, f, 1891, Berkeley 1856, Butler 1905, 1918, Butler & Bisby 1931, 1960, Butler & Hayman 1906, Chavan 1975, Chavan & Bakare 1974, Chavan & Bakare 1977, Chavan & Patil 1972, Chona et al. 1958, Chona & Munjal 1950, 1955, 1956, Chona et al. 1956, Chowdhary 1948, Cooke 1876a, b, Cooke 1878a, Cummins 1943, Cummins 1953, Dalela 1956, Dalela & Sinha 1964, Damle 1943, Darr & Shah 1980, Deoraj 1980, Dietal 1890, Dube 1958, Fleming 1874, Ganguly & Pandotra 1962, 1963, Gautam & Avasthi 2016b, Gautam & Avasthi 2017a, Gopinathnair 1972, Goswami 1974, Goswami & Singh 1973, Goyal et al. 1971, Gupta 1977, Gupta & Shukla 1955, Jadhav & Somani 1978a, b, Jain et al. 1966, Joshi & Lele 1984, Joshi & Merchand 1963, Joshi & Payak 1963, Joshi 1958, Joshi & Vashiist 1959, Kala & Gaur 1983a, b, Kamal et al. 1979, Kanaujia 1978, Kanaujia & Kishore 1981, Kanadswamy & Vijyalakshmi 1959, Kaul 1959b, Khanna 1961, Khosla et al. 1975, Khulbe & Verma 1978, Kolte & Awasthi 1979, Konger & Baruah 1958, Kumar et al. 1975, Malviya & Jain 1981, Mcrae 1917, Mehta 1934, Mishra et al. 1964, 1965, 1968, Mishra 1969, Mishra & Nema 1976, Mishra et al. 1976, Mishra & Mishra 1975, Mishra 1963b, Mishra & Lele 1963, Mishra & Sharma 1963, 1964, Mishra et al. 1975, Mitter & Tandon 1930, 1932a, b, 1937, Mundkar 1938, Mundkar & Ahmad 1946, Mundkar & Thirumalachar 1952, Mutkekar et al. 1968, Munshi 1976, Nema & Agarwal 1960, Nema & Mishra 1965, Padwick 1945a, b, Padwick & Khan 1944, Pandotra 1966, Pandotra & Ganguly 1962, Pandotra & Ganguly 1964a, b, Pandotra & Sastry 1969a, b, Parndekar 1964, Patel et al. 1949, 1950, Patil & Thirumalachar 1964, Patil & Thirumalachar 1971, Patil 1966a, Patil & Date 1980, Payak 1949, 1965, Payak & Khanna 1970, Payak & Mishra 1963, Payak & Renfro 1966, Prasad 1948, Prasada 1951, Rebenhorst 1878, Sharma & Shankar 1979, Rajendran 1966, Ramachar 1965, Ramachar et al. 1978, Ramachar & Bhagyanarayana 1976, Ramachar & Cummins 1965, Ramakrishna & Subbayya 1973, Ramakrishnan 1950, Ramakrishnan 1952, 1955b, 1956, Ramakrishnan & Narasimhalu 1941, Ramakrishnan & Ramakrishnan 1946, Ramakrishnan & Ramakrishnan 1947, 1948a, b, Ramakrishnan & Ramakrishnan 1949, 1950b, c, Ramakrishnan et al. 1952a, b, Ramakrishnan & Sundaram 1952b, 1953b, 1954a, b, 1955a, 1956a, b, Rangaswamy et al. 1968, Roy 1964, 1968, Roy & Gupta 1959, Sachan et al. 1980, Sahni & Chona 1965, Salam & Ramachar 1955, Sathe 1965b, 1969a, 1971, Shanmugam et al. 1972, Sharma & Mukerji 1972, Sharma 1975, Sharma et al. 1979, Sharma & Singh 1964, Sharma 1957, Sharma et al. 1973, Shinde & More 1975, Shukla & Singh 1976, Siddiqui 1971, 1972, 1973, Singh & Kamal 1985, Singh & Sharma 1977, Singh 1962, Mishra et al. 1965, Mishra 1969, Sinha & Kapooria 1966, Sohi et al. 1967, Somani 1979, Soumini 1949, Srivastava 1979a, c, 1980, 1982, Subramaniam & Ramakrishnan 1956, Sunderam 1956, 1963, Sunderam et al. 1966, Sydow 1913, 1914, 1922, 1938, 1939, Sydow & Mitter 1935, Sydow et al. 1937, Sydow & Butler 1901, Sydow et al. 1907, Sydow et al. 1911a, b, Sydow et al. 1912, Thirumalachar 1941a, 1945, Thirumalachar 1947, 1949a, b, Thirumalachar & Mundkar 1951, Thirumalachar et al. 1943, Tilak & Rao 1968, Ulbitch 1938, Unni & Philip 1974, Uppal et al. 1935, Vasudeva 1948, 1949, 1950a, b, 1957, 1958, Wakhloo 1962, Yadav 1953, 1963b, 1964a, Yadav & Yadav 1965, Yadav et al. 1975. **Pucciniastrum**: Bakshi et al. 1972, Patil 1966a. **Pucciniosira**: Arthur 1934, Cummins 1943. **Pucciniostele**: Barclay 1891, Sydow et al. 1912. **Ramakrishnan**: Ramachar & Bhagyanarayana 1979. **Ravenelia**: Berkeley 1839, Butler & Bisby 1931, Chavan & Bakare 1974, Cooke 1880a, b, Jain et al. 1966, Kapoor & Agarwal 1972, 1974, Mishra 1969, Mishra et al. 1976,

Mundkar & Prasad 1938, Narasimhan & Thirumalachar 1961, Patil & Thirumalachar 1971, Patil 1977, Patil & Thite 1978, Patil 1966a, b, Patil & Date 1977, Pavgi & Singh 1969, Petch 1912, Ramakrishnan 1952, 1957a, Ramakrishnan & Ramakrishnan 1948b, Ramakrishnan & Sundaram 1952b, Rangaswamy et al. 1968, Roy 1964, Salam & Ramachar 1956, Sanwal 1951a, Sathe 1965c, Siddiqui 1957, Sydow 1913, Sydow & Mitter 1933, Sydow & Butler 1901, Sydow et al. 1907, Sydow et al. 1912, Tyagi & Prasad 1972, 1978, Yadav 1963b, Yadav & Thirumalachar 1955. **Roestelia**: Barclay 1891, Arthur & Cummins 1936a, Mitter & Tandon 1932a, 1937, Sydow et al. 1907. **Scopella**: Butler & Bisby 1931, Cummins 1950, Mundkar & Thirumalachar 1952, Narayan & Kamal 1985, Parndekar 1964, Patil & Thirumalachar 1971, Payak 1949, Solanki et al. 1985, Thirumalachar 1950c, Thirumalachar & Mundkar 1951. **Skierka**: Chavan 1968, Gautam & Avasthi 2017c. **Sphaerophragmium**: Cooke 1880a. **Stakmania**: Sathe 1966c. **Trachyspora**: Arthur 1934, Padwick & Merh 1943. **Tranzschelia**: Patel et al. 1949, Waraitch & Khatri 1976, 1977. **Trochodium**: Gharse 1944, Patil & Thirumalachar 1971, Patil 1966a, Thirumalachar 1942a. **Uredinopsis**: Anonymous 1936, Munjal & Kapoor 1961, Patil 1966a, Puri 1955, Ramakrishnan & Ramakrishnan 1950b. **Uredopeltis**: Ramachar et al. 1978, Sathe 1965e. **Uromyces**: Agarwal et al. 1959, Ahmad 1941, Ajrekar 1912, Ajrekar & Tonapy 1923, Anonymous 1950, 1954, Arthur 1934, Arthur & Cummins 1936a, Asthana 1952, Bahadur & Sinha 1967, Barclay 1890a, 1891, Basuchaudhary & Singh 1971, Behera & Mukerji 1974, Butler & Bisby 1931, 1960, Chaudhari 1958, Chavan 1975, Chavan & Bakare 1973a, b, Chavan & Bakare 1974, Chavan & Bakare 1977, Cooke 1876a, Cummins 1943, Dietal 1890, Dube 1958, Dube et al. 1979, Dublith & Singh 1977, Gautam & Avasthi 2017b, Gerdemann & Bakshi 1976, Jain et al. 1966, Joshi & Reddy 1958, Joshi & Reddy 1959, Joshi 1958, Kapooria & Sinha 1966, Manocharachary 1975, Mathur 1967, Mathur & Singh 1964, Mishra 1969, Mishra & Khare 1969, Mishra & Nema 1976, Mishra et al. 1976, Mitter & Tandon 1930, 1932b, More & Moniz 1964, Nagachan & Verma 1984, Narasimhan & Thirumalachar 1964, Nema & Agarwal 1960, Nema & Mishra 1965, Padwick & Khan 1944, Padwick & Merh 1943, Pandotra 1966, Pandotra & Sastry 1969a, Parndekar 1964, Patel et al. 1949, Patil & Thirumalachar 1968, Patil & Thirumalachar 1962, Patil & Thirumalachar 1971, Patil 1966a, Patil & Date 1980, Pavgi & Upadhyay 1966, Payak 1949, 1953, 1962, Ponappa 1969, Prasad et al. 1962, Rebenhorst 1878, Ramachar et al. 1978, Ramakrishnan & Subramanian 1952, Ramakrishnan 1951b, Ramakrishnan 1952, Ramakrishnan & Ramakrishnan 1948b, Ramakrishnan & Rangaswamy 1948, Ramakrishnan & Shrinivasan 1950, Ramakrishnan et al. 1952a, b, Ramakrishnan & Sundaram 1955a, Rangaswamy et al. 1968, Rolla & Addala 1963, Sachan et al. 1980, Saini & Chand 1984, Saksena 1956, 1930, Sokhi & Sohi 1976, Srivastava 1979b, Sunderam 1964, Sydow 1913, 1922, 1938, Sydow & Mitter 1935, Sydow et al. 1937, Sydow & Butler 1901, Sydow et al. 1907, Sydow et al. 1912, Thite & Patil 1970, Ulbitch 1938, Uppal et al. 1935, Vasudeva 1948, 1949, 1950a, b, Yadav 1963b, Yadav & Thirumalachar 1955. **Xenostele**: Ramakrishnan 1951a. **Zaghouania**: Butler & Bisby 1931.

***Pucciniales* genera incertae sedis**

Aecidium: Ajrekar 1936, Arthur & Cummins 1936a, Bagchee & Singh 1960, Barclay 1890a, b, 1891, Bhagat & Kelkar 1974, Butler & Bisby 1931, 1960, Chavan & Bakare 1973a, b, 1974, Chavan & Patil 1972, Cooke 1878a, Cummins 1943, Goswami 1972, Goswami & Bhattacharjee 1973, Gupta & Gupta 1985, Hennings 1900, Hosagaudar 1984, Kamal & Singh 1981, Kamal et al. 1979, Mishra et al. 1976, Mitter & Tandon 1932a, b, Mundkar 1938, Mundkar & Thirumalachar 1952, Pandotra & Ganguly 1964b, Pandotra & Sastry 1969b, Patel et al. 1949, Patil & Thirumalachar 1971, Prasad et al. 1962, Ramachar 1956, Ramakrishnan 1959, 1960, Ramakrishnan & Ramakrishnan 1946, 1948a, 1949, Ramakrishnan et al. 1952a, b, Ramakrishnan & Sundaram 1953a, b, Rangaswamy et al. 1968, Salam & Ramachar 1955, 1956, Sathe 1965c, 1966b, Singh & Kamal 1985, Sunderam & Rao 1950, Sydow 1913, Sydow 1914, Sydow & Mitter 1933, Sydow & Mitter 1935, Sydow & Sydow 1904a, 1911, 1912a, b, Sydow 1921, Sydow & Sydow 1917, Sydow & Butler 1901, Sydow et al. 1907, Sydow et al. 1912, Thirumalachar 1947, Thirumalachar 1950c, Thirumalachar & Narsimhan 1950a, Thite & Patil 1970, Ulbitch 1938, Uppal et al. 1935, Yadav 1956b, Yadav & Saran 1985. **Phragmotelium**: Thirumalachar 1942b, Thirumalachar et al. 1943. **Tunicopsora** Suj. Singh & P.C.

Pandey: Bakshi et al. 1972. ***Uraecium***: Ramakrishnan 1965, Ramakrishnan & Ramakrishnan 1948b. ***Uredo***: Anonymous 1959b, Bagchee & Singh 1960, Barclay 1890b, 1891, Berkeley 1839, Butler & Bisby 1931, 1960, Chavan 1975, Chavan & Bakare 1973a, b, 1974, Chavan & Bhambure 1975, Cooke 1876b, 1879, Kamal et al. 1979, Kanaujia & Kishore 1981, Kapoor & Agarwal 1974, Laundon & Ponappa 1966, Nagraj et al. 1971, Padwick 1945a, b, Padwick & Khan 1944, Pandotra 1966, Patel et al. 1951a, Patil 1977, Patil & Thite 1978, Rahalkar 1977, Ramachar et al. 1978, Ramakrishnan 1951a, 1952, 1956, 1957a, Ramakrishnan & Ramakrishnan 1948a, Ramakrishnan & Ramakrishnan 1949, Ramakrishnan et al. 1952a, Ramakrishnan & Sundaram 1953b, Rangaswamy et al. 1968, Sathe & Rahalkar 1976, Sunderam 1961, Sydow & Mitter 1935, Sydow et al. 1937, Sydow & Sydow 1904b, 1924, Sydow & Butler 1901, Sydow et al. 1912, Thirumalachar 1947, Thirumalachar 1950c, Vaheeduddin 1955, Yadav 1964b.

Results

Accepted taxa of rust fungi of *Basidiomycota* up to genus are summarized in Table 1 while, the species of each genus are mentioned in detailed outline of the fungi reported from India. The rust fungi of India comprised of 640 species and 69 genera belonging to 16 families. Highest numbers of species were reported in *Pucciniaceae* (393) followed by *Raveneliaceae* (61), *Phakopsoraceae* (50), *Coleosporiaceae* (32), *Phragmidiaceae* (27), *Pucciniastraceae* (19), *Melampsoraceae* (18), *Crossopsoraceae* (14), *Zaghouaniaceae* (13), *Gymnosporangiaceae* (7), *Milesiaceae* (5), *Skierkaceae* (3), *Tranzscheliaceae* (3), *Pileolariaceae* (2), *Ochropsoraceae* (1), *Sphaerophragmiaceae* (1). Similarly, when comparing the rust genera, highest number of species of rust fungi was found *Puccinia* (279), followed by *Uromyces* (89), *Ravenelia* (33), *Phakospora* (25), *Coleosporium* (19), *Phragmidium* (18), *Melampsora* (17) and *Maravalia* (11). Many taxa of rust fungi with uncertain taxonomic position are placed in *incertae sedis*. Similarly, the generic names have been transferred to new genera, but either their types or records from India still need to be revised. Such genera and their species are discussed in notes of Indian rust genera section of this manuscript.

Outline of rust fungi reported from India

The information presented in the outline is arranged as phylum followed by subphylum, class, order, family, genus and species.

Taxonomy

Basidiomycota R.T. Moore

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

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

Pucciniales Clem. & Shear

1. *Coleosporiaceae* Dietel, In: Engler & Prantl, Nat. Pflanzenfam., Teil. I (Leipzig) 1: 548. 1900.
emend. Aime & McTaggart

Coleosporium Lév. (19)

Coleosporium asterum (Dietel) Syd. & P. Syd.

Coleosporium barclayense Bagchee

Coleosporium bletiae Dietel

Coleosporium campanulae (Pers.) Tul.

Coleosporium clematidis Barclay

Coleosporium datiscae Tranzschel

Coleosporium inulae Rabenh.

Coleosporium ipomoeae (Schwein.) Burrill

Coleosporium himalayense Durrieu

Coleosporium leptodermidis (Barclay) P. Syd. & Syd.

Coleosporium mitteri Syd.
Coleosporium myriactidis Syd.
Coleosporium oldenlandiae E.J. Butler
Coleosporium perillae P. Syd.
Coleosporium plectranthi Barclay
Coleosporium satyrii Mundk. & Thirum.
Coleosporium senecionis (Pers.) Fr.
Coleosporium sidae Sanwal
Coleosporium xanthoxyli Dietel & P. Syd. (1898)

***Chrysomyxa* Unger (7)**

Chrysomyxa deformans (Dietel) Jacz.
Chrysomyxa dietelii Syd. & P. Syd.
Chrysomyxa himalensis Barclay
Chrysomyxa piceae Barclay
Chrysomyxa pirolae (DC.) Rostr.
Chrysomyxa vitis E.J. Butler
Chrysomyxa himalayensis Singh, Khan & Mishra

***Cronartium* Fr. (4)**

Cronartium fici T.S. Ramakr. & K. Ramakr.
Cronartium himalayense Bagchee
Cronartium quercuum (Berk.) Miyabe ex Shirai
Cronartium ribicola J.C. Fisch.

***Goplana* Racib. (1)**

Goplana indica T.S. Ramakr. & K. Ramakr.

***Stakmania* Kamat & Sathe (1)**

Stakmania indica Kamat & Sathe

2. *Crossoporidae* Aime & McTaggart, In: Fungal Systematics and Evolution 7: 21–47. 2020

***Angiopsora* Mains (2)**

Angiopsora cyrtococci T.S. Ramakr. & Sundaram
Angiopsora apoda (Har. & Pat.) Aime & McTaggart

***Crossopsora* Syd. & P. Syd. (3)**

Crossopsora premnae (Petch) Syd. & P. Syd.
Crossopsora premnae-tomentosae T.S. Ramakr. & Soumini
Crossopsora symphorematis Sundaram
Crossopsora ziziphi (Syd., P. Syd. & E.J. Butler) Syd. & P. Syd.

***Dasturella* Mundk. & Khesw. (3)**

Dasturella bambusina Mundk. & Khesw.
Dasturella boswelliae Patel, Payak & N.B. Kulk.
Dasturella oxytenantherae Sathe

***Kweilingia* Teng (2)**

Kweilingia bagchii (Suj. Singh & P.C. Pandey) Buriticá
Kweilingia divina (Syd.) Buriticá

***Neophysopella* Jing X. Ji & Kakish. (3)**

Neophysopella ampelopsidis (Dietel & P. Syd.) Jing X. Ji & Kakish.
Neophysopella meliosmae (Kusano) Jing X. Ji & Kakish.
Neophysopella meliosmae-myrianthae (Henn. & Shirai) Jing X. Ji & Kakish.

***Physopella* (2)**

Physopella artocarpi (Berk. & Broome) Arthur
Physopella vernoniae (T.S. Ramakr.) Ramachar & Bhagyan.

3. Gymnosporangiaceae P. Zhou & L. Cai, Persoonia 45: 79. 2020. emend. Aime & McTaggart

Peridiopsora Kamat & Sathe (1)

Peridiopsora adelocaryi Kamat & Sathe

Gymnosporangium R. Hedw. ex DC. (3)

Gymnosporangium clavariiforme (Wulfen) DC.

Gymnosporangium confusum Plowr.

Gymnosporangium cunninghamianum Barclay

Roestelia Rebent. (3)

Roestelia distorta (Arthur & Cummins) F. Kern

Roestelia cunninghamianum (Barclay) F. Kern

Roestelia patula (Syd. & P. Syd.) F. Kern

4. Melampsoraceae Dietel, in Engler & Prantl, Nat. Pflanzenfam., Teil. I (Leipzig) 1: 38. 1897

Ceropsora B.K. Bakshi & Suj. Singh (1)

Ceropsora piceae (Barclay) B.K. Bakshi & Suj. Singh

Melampsora Castagne (17)

Melampsora caprearum Thüm.

Melampsora ciliata Barclay

Melampsora damnosa (Sacc.) Lind.

Melampsora epitea Thüm.

Melampsora eucalypti Rabenh.

Melampsora euphorbiae (Ficinus & C. Schub.) Castagne

Melampsora euphorbiae-geniculatae F. Kern & Thurst.

Melampsora geniculatae Ramachar & Bhagyan.

Melampsora hypericorum (DC.) J. Schröt.

Melampsora lini (Ehrenb.) Lév.

Melampsora mundkurii Thirum.

Melampsora oblonga Bagchee

Melampsora populnea (Pers.) P. Karst.

Melampsora salicis-albae Kleb.

Melampsora salicis-wallichianae Ulbr.

Melampsora sancti-johannis Barclay

Melampsora stereospermi T.S. Ramakr. & K. Ramakr.

Melampsora yoshinagai Henn.

Melampsora caprearum Thüm.

5. Milesinaceae Aime & McTaggart, In: Fungal Systematics and Evolution 7: 21–47. 2020

Milesina Magnus (3)

Milesina coniogrammes Hirats. f.

Milesina exigua Faull

Milesina polypodii (F.B. White) Aime & Rossman

Uredinopsis Magnus (2)

Uredinopsis macrosperma (Cooke) Magnus

Uredinopsis syngrammes Munjal & J.N. Kapoor

6. Ochropsoraceae (Arthur) Aime & McTaggart, In: Fungal Systematics and Evolution 7: 21–47. 2020

Ochropsora Dietel (1)

Ochropsora ariae (Fuckel) Ramsb.

7. Phakopsoraceae Cummins & Y. Hirats., Illustr. Gen. Rust Fungi, rev. Edn (St. Paul): 13. 1983. emend. Aime & McTaggart

- Arthuria** Jackson (2)
Arthuria glochidii Gokhale, Patel & Thirum.
Arthuria tylophorae T.S. Ramakr.
- Bubakia** Arthur (1)
Bubakia indica T.S. Ramakr. & K. Ramakr.
- Cerotelium** Arthur (7)
Cerotelium bauhiniae Thirum. & Yadav
Cerotelium fici (Castagne) Arthur
Cerotelium kirganeliae Thirum. & Yadav
Cerotelium peregrinum (P. Syd. & Syd. & E.J. Butler) Arthur
Cerotelium terminaliae-paniculatae Nag Raj, Govindu & Thirum.
Cerotelium trichosanthis (Petch) Nag Raj, Govindu & Thirum.
Cerotelium wagatae Thirum. & Gopalkr.
- Macabuna** Buriticá & J.F. Hennen (1)
Macabuna ziziphi (Pat.) Buriticá & J.F. Hennen
- Monosporidium** Barclay (3)
Monosporidium andrachnes Barclay ex Sacc.
Monosporidium euphorbiae Barclay ex Sacc.
Monosporidium pavettae (Gokhale & Patel) Buriticá
- Masseella** Dietel (6)
Masseella breyniae Thirum.
Masseella capparis (Hobson bis ex Cooke) Dietel
Masseella flueggeae Syd.
Masseella narasimhanii Thirum.
Masseella putranjivae T.S. Ramakr.
Masseella terminaliae Patw.
- Phakopsora** Dietel (25)
Phakopsora apludae M.S. Patil
Phakopsora artemisiae Hirats. f.
Phakopsora caseariae Yadav
Phakopsora chorisandrae T.S. Ramakr. & G.S. Reddy
Phakopsora cingens (Syd. & P. Syd.) Hirats.
Phakopsora cronartiiformis Dietel
Phakopsora desmium (Berk. & Broome) Cummins
Phakopsora elephantopodis Hirats
Phakopsora elettariae (Racib.) Cummins
Phakopsora erythrinae Gäum.
Phakopsora fici-elasticae T.S. Ramakr.
Phakopsora formosana Syd. & P. Syd.
Phakopsora incompleta (Syd. & P. Syd.) Cummins
Phakopsora kirganeliae T.S. Ramakr. & K. Ramakr.
Phakopsora mangalorica T.S. Ramakr. & Sundaram
Phakopsora meibomia (Arthur) Arthur
Phakopsora pachyrhizi Syd. & P. Syd.
Phakopsora odinae Mundk.
Phakopsora pachyrhizi Syd. & P. Syd.
Phakopsora parasnathii Yadav & Thirum.
Phakopsora phyllanthi Dietel
Phakopsora punctiformis (Barclay & Dietel) Dietel
Phakopsora sterculiae Nag Raj, Govindu & Thirum.
Phakopsora zingiberis T.S. Ramakr.
Phakopsora ziziphi-vulgaris Dietel

***Phragmidiella* Henn. (3)**

Phragmidiella aliena (Syd., P. Syd. & E.J. Butler) Buriticá & J.F. Hennen

Phragmidiella heterophragmatis (Mundk. & Thirum.) Thirum. & Mundk.

Phragmidiella holwayi (H.S. Jacks.) Buriticá

***Pucciniostele* Tranzschel & K.L. Kom. (1)**

Pucciniostele clarkiana (Barclay) Tranzschel & K.L. Kom.

***Uredopeltis* Henn. (1)**

Uredopeltis chevalieri J. Walker & R.G. Shivas

8. *Phragmidiaceae* Corda Icon. fung. (Prague) 1: 6. 1837

***Hamaspora* Körn. (2)**

Hamaspora longissima (Thüm.) Körn.

Hamaspora rubi-sieboldii (Kawagoe) Dietel

***Kuehneola* Magnus (6)**

Kuehneola grewiae (Mundk. & Thirum.) Thirum.

Kuehneola loeseneriana (Henn.) H.S. Jacks. & Holw.

Kuehneola flacourtiae (Mundk. & Thirum.) Thirum.

Kuehneola ramacharii Bagyan. & K.N. Rao

Kuehneola spondiadis Hosag.

Kuehneola ziziphi (T.S. Ramakr. & Subram.) Thirum.

***Phragmidium* Link (18)**

Phragmidium assamense Syd. & P. Syd.

Phragmidium barclayi Dietel

Phragmidium brevipedicellatum Hirats. f.

Phragmidium bulbosum (Fr.) Schltdl.

Phragmidium butleri Syd. & P. Syd.

Phragmidium egenulum Syd., P. Syd. & E.J. Butler

Phragmidium fragariae (Rabenh.) Ces.

Phragmidium kamtschatkae (H.W. Anderson) Arthur & Cummins

Phragmidium mucronatum (Pers.) Schltdl.

Phragmidium orientale Syd. & P. Syd.

Phragmidium potentillae (Pers.) P. Karst.

Phragmidium rosae-moschatae Dietel

Phragmidium incompletum Barclay

Phragmidium laceianum Barclay

Phragmidium malvacearum Bert.

Phragmidium nepalense Barclay

Phragmidium octoloculare Barclay

Phragmidium quinqueloculare Barclay

***Trachyspora* Fuckel (1)**

Trachyspora alchemillae (Pers.) Fuckel

9. *Pileolariaceae* (Arthur) Cummins & Y. Hirats., Illustr. Gen. Rust Fungi, rev. Edn (St. Paul): 14. 1983. *emend.* Aime & McTaggart

***Pileolaria* Castagne (2)**

Pileolaria indica Syd.

Pileolaria pistaciae F.L. Tai & C.T. Wei

10. *Pucciniastraceae* Gäum. ex Leppik, Ann. bot. fenn. 9: 139. 1972. *emend.* Aime & McTaggart

***Hyalopsora* Magnus (2)**

Hyalopsora orientalis Chona & Munjal

Hyalopsora polypodii (Pers.) Magnus

Melampsoridium Kleb. (4)

Melampsoridium betulinum (Pers.) Kleb.

Melampsoridium hiratsukanum S. Ito ex Hirats. f.

Melampsoridium indicum Sathe

Melampsoridium inerme Suj. Singh & P.C. Pandey

Pucciniastrum G.H. Oth (6)

Pucciniastrum aceris Syd.

Pucciniastrum agrimoniae (Dietel) Tranzschel

Pucciniastrum celastri Syd. & P. Syd.

Pucciniastrum coriariae Dietel

Pucciniastrum coryli Kom.

Pucciniastrum gaultheriae Syd. & P. Syd.

Peridermium (Link) J.C. Schmidt & Kunze (7)

Peridermium brevius Barclay

Peridermium cedri Barclay

Peridermium ephedrae Cooke

Peridermium himalayense Bagchee

Peridermium orientale Cooke

Peridermium piceae Barclay

Peridermium thomsonii Berk.

11. Pucciniaceae Chevall., Fl. gén. env. Paris (Paris) 1: 413. 1826. emend. Aime & McTaggart

Caeoma Link (4)

Caeoma himalayense Suj. Singh, S.N. Khan & B.M. Misra

Caeoma scopariae K.N. Rao

Caeoma euphorbiae-geniculatae Ramachar & Bhagyan.

Caeoma indicum Rajendren

Chrysocelis Lagerh. & Dietel (1)

Chrysocelis butleri (Dietel, Syd. & P. Syd.) G.F. Laundon

Corbulopsora Cummins (1)

Corbulopsora cumminsii Thirum.

Endophyllum Lév. (8)

Endophyllum cassiae Nag Raj, Govindu & Thirum.

Endophyllum cassiae (Bres.) F. Stevens & Mendiola

Endophyllum elaeagni-latifoliae (Petch) Gokhale, Thirum. & Patel

Endophyllum emiliae-sonchifoliae Nag Raj, Govindu & Thirum.

Endophyllum heliotropii Thirum. & Naras.

Endophyllum kaernbachii (Henn.) F. Stevens & Mendiola

Endophyllum maheshwarii Hard. Singh & Jalan

Endophyllum macowanianum (Thüm.) Pole-Evans

Endophyllum spilanthi Thirum. & Govindu

Gambleola Massee (1)

Gambleola cornuta Massee

Hapalophragmium Syd. & P. Syd. (4)

Hapalophragmium anamalaiense T.S. Ramakr. & K. Ramakr.

Hapalophragmium mysorensense Thirum.

Hapalophragmium ponderosum Syd., P. Syd. & E.J. Butler

Hapalophragmium tandonii Mitter

Kernella Thirum. (1)

Kernella lauricola (Thirum.) Thirum.

Puccinia Pers. (279)

Puccinia acanthospermi Henn.

Puccinia acrophila Peck
Puccinia actaeae-agropyri E. Fisch.
Puccinia adjuncta Mitter
Puccinia aggregata Syd. & P. Syd.
Puccinia agrostidis Plowr.
Puccinia ahmadiana Syd.
Puccinia ainsliaeae P. Syd. & Syd.
Puccinia altii Rud.
Puccinia amphiphididis Doidge
Puccinia angelicae (Schumach.) Fuckel
Puccinia anodae P. Syd. & Syd.
Puccinia antirrhini Dietel & Holw.
Puccinia apii Desm.
Puccinia apludae Syd. & P. Syd.
Puccinia arachidis Speg.
Puccinia arenariae (Schumach.) J. Schröt.
Puccinia argentata (Schultz) G. Winter
Puccinia aristidae Tracy
Puccinia aristidicola Henn.
Puccinia arthraxonis-ciliaris Cummins
Puccinia arundinellae Barclay
Puccinia asterum (Schwein.) F. Kern
Puccinia atropuncta Peck & Clinton
Puccinia azanzae Yadav
Puccinia baradensis P.B. Chavan & U.V. Kulk.
Puccinia barbeyi (Roum.) Magnus
Puccinia behenis G.H. Oth
Puccinia belamcandae Dietel
Puccinia bellurensis Thirum.
Puccinia betae-bengalensis Mundk. & Thirum.
Puccinia bistortae (F. Strauss) DC.
Puccinia blepharidis Henn.
Puccinia bottomleyae Doidge
Puccinia brachypodii G.H. Oth
Puccinia bulbostylidis Doidge
Puccinia bupleuri F. Rudolphi
Puccinia butleri Syd. & P. Syd.
Puccinia cacao McAlpine
Puccinia caheunsis Ell. & Ev.
Puccinia calcitrapae var. *filicinae* Barclay
Puccinia calcitrapae DC.
Puccinia calosperma Syd., P. Syd. & E.J. Butler
Puccinia calthae Link
Puccinia caricis-filicinae Barclay
Puccinia caricis-nubigenae Padwick & A. Khan
Puccinia cenchri Dietel & Holw.
Puccinia cephalandrae-indicae Syd. & P. Syd.
Puccinia chaerophylli Purton
Puccinia chloridis-incompletae T.S. Ramakr., Sriniv. & Sundaram
Puccinia chrysanthemi Roze
Puccinia circaeae Pers.
Puccinia citrina P. Syd. & Syd.

Puccinia citrulli Syd., P. Syd. & E.J. Butler
Puccinia citrullina Raghun. & K. Ramakr. ex Hosag. & Raghun.
Puccinia collettiana Barclay
Puccinia conclusa Thüm.
Puccinia congesta Berk. & Broome
Puccinia coronata Corda
Puccinia courtoisiae (Syd. & P. Syd.) Syd.
Puccinia crepidis-japonicae (Lindr.) Dietel
Puccinia crepidis-sibiricae Lindr.
Puccinia cressae Lagerh.
Puccinia ctenolepidis Ramachar & Bagyan.
Puccinia curculiginis Racib.
Puccinia curcuma T.S. Ramakr. & Sundaram
Puccinia cynodontis Lacroix ex Desm.
Puccinia cyperi Arthur
Puccinia cyperi-tagetiformis (Henn.) F. Kern
Puccinia dactylidina Bubák
Puccinia deodikarii K.R.G. Nair
Puccinia desertorum Syd. & P. Syd.
Puccinia digitariae Ramachar & George
Puccinia digitariae-biformis P.B. Chavan & Hosag.
Puccinia digitariae-vestitae Ramachar & Cummins
Puccinia dioicae Magnus
Puccinia dioscoreae Kom.
Puccinia dovrensis A. Blytt
Puccinia drabae F. Rudolphi
Puccinia droogensis E.J. Butler
Puccinia abutilonis Berk. & Broome
Puccinia aristidae var. *chaetariae* Cummins & S.M. Husain
Puccinia bulbocastani (A. Cumino) Fuckel
Puccinia canaliculata (Schwein.) Lagerh.
Puccinia centaureae H. Mart.
Puccinia chrysopogoni Barclay
Puccinia coronata f.sp. *avenae* P. Syd. & Syd.
Puccinia dissiliens Cooke
Puccinia duthiei Ellis & Tracy
Puccinia ellisii De Toni
Puccinia elytrariae Henn.
Puccinia engleriana Henn.
Puccinia enteropogonis P. Syd. & Syd.
Puccinia eragrostidis Petch
Puccinia eremuri Kom.
Puccinia erianthi Padwick & A. Khan
Puccinia eulaliae Barclay
Puccinia eutela Syd.
Puccinia exhauriens Thüm.
Puccinia expallens Syd. & P. Syd.
Puccinia echinopis DC.
Puccinia excelsa Barclay
Puccinia fagopyri Barclay
Puccinia fagopyricola Jørst.
Puccinia ferruginosa P. Syd. & Syd.

Puccinia festucae Plowr.
Puccinia fimbristylidis Arthur
Puccinia fimbristylidis-ferrugineae Ramachar, Bhagyan. & A. Kumar
Puccinia flaccida Berk. & Broome
Puccinia flavipes Syd. & P. Syd.
Puccinia fuirenicola Arthur
Puccinia fusca G. Winter
Puccinia garnotiae T.S. Ramakr. & Sundaram
Puccinia gentianae (F. Strauss) Link
Puccinia geranii-silvatici P. Karst.
Puccinia gerberae Pole-Evans
Puccinia gouaniae Holw.
Puccinia gracilentia Syd., P. Syd. & E.J. Butler
Puccinia graminis f. *avenae* Erikss. & Henning
Puccinia graminis Pers.
Puccinia graminis f. *agropyri* P.R. Mehta & R. Prasad
Puccinia graminis f. *poae* Erikss. & Henning
Puccinia graminis f. *tritici* Erikss. & Henning
Puccinia gymnopetali-wightii T.S. Ramakr., Sriniv. & Sundaram
Puccinia helianthi Schwein.
Puccinia heraclei Grev.
Puccinia heracleicola Cummins
Puccinia herqueri
Puccinia heterospora Berk. & M.A. Curtis
Puccinia heucherae (Schwein.) Dietel
Puccinia hieracii (Röhl.) H. Mart.
Puccinia himachalensis A.K. Gautam & S. Avasthi
Puccinia holboelliae-latifoliae Cummins
Puccinia hookeri P. Syd. & Syd.
Puccinia hordei G.H. Otth
Puccinia hyderabadensis Bagyan. & Ravinder
Puccinia hydrocotyles (Mont.) Cooke
Puccinia hypoxidis McAlpine
Puccinia inayatii Syd. & P. Syd.
Puccinia insidiosa Berk.
Puccinia intermixta Peck
Puccinia invenusta Syd. & P. Syd.
Puccinia investita Schwein.
Puccinia iridis Wallr.
Puccinia isachnes Petch
Puccinia jagopyri Barclay
Puccinia jasminicola T.S. Ramakr. & K. Ramakr.
Puccinia joerstadii S. Ahmad
Puccinia kalchbrenneri De Toni
Puccinia kenmorensis Cummins
Puccinia kraussiana Cooke
Puccinia kuehnii (W. Krüger) E.J. Butler
Puccinia kunthiana T.S. Ramakr., Sriniv. & Sundaram
Puccinia lantanae Farl.
Puccinia lateripes Berk. & Ravenel
Puccinia lateritia Berk. & M.A. Curtis
Puccinia launaeae Maire

Puccinia leiocarpa Thirum.
Puccinia leonotidicola Henn.
Puccinia leucadis P. Syd. & Syd.
Puccinia leucophaea Syd., P. Syd. & E.J. Butler
Puccinia leveillei Mont.
Puccinia levis (Sacc. & Bizz.) Magnus
Puccinia libani Magnus
Puccinia liberta F. Kern
Puccinia ligustici Ellis & Everh.
Puccinia linkii Klotzsch
Puccinia lithospermi Ellis & Kellerm.
Puccinia longirostris Kom
Puccinia luculenta (Syd. & P. Syd.) T.S. Ramakr. & K. Ramakr.
Puccinia macrorhynchi Rabenh.
Puccinia malvacearum Bertero ex Mont.
Puccinia melanocephala Syd. & P. Syd.
Puccinia melasmiioides Tranzschel
Puccinia menthae Pers.
Puccinia merrillii Henn.
Puccinia microspora Dietel
Puccinia minutissima Arthur
Puccinia monticola Kom.
Puccinia mysorensis Syd.
Puccinia melothriicola Syd. & P. Syd.
Puccinia nakanishikii Dietel
Puccinia nepalensis Barclay & Dietel
Puccinia neyraudiae Syd. & P. Syd.
Puccinia nitida Barclay
Puccinia oahuensis Ellis & Everh.
Puccinia obscura J. Schröt.
Puccinia ocimi Doidge
Puccinia oligocarpa Syd., P. Syd. & E.J. Butler
Puccinia operculinae T.S. Ramakr. & Sundaram
Puccinia operta Mundk. & Thirum.
Puccinia opizii Bubák
Puccinia oplismeni Syd. & P. Syd.
Puccinia oreogeta Syd.
Puccinia oryzopsidis Syd., P. Syd. & E.J. Butler
Puccinia ottochloae T.S. Ramakr.
Puccinia oxalidis Dietel & Ellis
Puccinia pachypes Syd. & P. Syd.
Puccinia pacifica Blasdale ex Arthur
Puccinia padwickii Cummins
Puccinia panici-montani Fujik. ex Ramachar & Cummins
Puccinia paspali Tracy & Earle
Puccinia pectiniformis T.S. Ramakr., Sriniv. & Sundaram
Puccinia peradeniyae Demers & Castl.
Puccinia peraffinis Syd. & P. Syd.
Puccinia phragmitis (Schumach.) Tul.
Puccinia phyllocladiae Cooke
Puccinia phyllostachydis Kusano
Puccinia pieridiz Hazel.

Puccinia pimpinellae (F. Strauss) Link
Puccinia plicata Kom.
Puccinia pogonatheri Petch
Puccinia pollinae Barclay
Puccinia pollinae-quadrinervis Dietel
Puccinia polygoni-amphibii Pers.
Puccinia polygoni-weyrichii Miyabe
Puccinia polysora Underw.
Puccinia porri (Sowerby) G. Winter
Puccinia praecox Bubák
Puccinia prainiana Barclay
Puccinia prenanthis-purpureae (DC.) Lindr.
Puccinia princeps Syd. & P. Syd.
Puccinia propinqua Syd., P. Syd. & E.J. Butler
Puccinia prostii Moug.
Puccinia pseudocesatii Cummins
Puccinia pulverulenta Grev.
Puccinia pulvinata Rabenh.
Puccinia punctata Link
Puccinia purpurea Cooke
Puccinia pusilla Syd. & P. Syd.
Puccinia recondita Roberge ex Desm.
Puccinia ribis DC.
Puccinia recondita var. *simlensis* A.P. Misra, S.T. Ahmad & Sheodh. Singh
Puccinia ribis-caricis Kleb.
Puccinia rhynchosporae Syd. & P. Syd.
Puccinia romagnoliana Maire & Sacc.
Puccinia roscoae Barclay
Puccinia rostrata Cooke
Puccinia rottboelliae P. Syd. & Syd.
Puccinia ruelliae Lagerh.
Puccinia rufipes Dietel
Puccinia sacchari Patel, Kamat & Y.A. Padhye
Puccinia sonchi Roberge ex Desm.
Puccinia satarensis P.B. Chavan & Bakare
Puccinia saussureae Thüm.
Puccinia saviculae Grev.
Puccinia saxifragae-ciliatae Barclay
Puccinia schedonnardi Kellerm. & Swingle
Puccinia schirajewskii Tranzschel
Puccinia scirpi DC.
Puccinia senecionis-scandentis Lindr.
Puccinia shiraiana P. Syd.
Puccinia silvaticella Arthur & Cummins
Puccinia solanacearum Sacc. & P. Syd.
Puccinia solani-giganteae T.S. Ramakr. & K. Ramakr.
Puccinia solmsii (Kuntze) Sacc. & P. Syd.
Puccinia sorghi Schwein.
Puccinia spongiosa Berk. & Broome
Puccinia stenotaphricola J. Walker
Puccinia striiformis Westend.
Puccinia striiformis f. *muehlenbergii*

- Puccinia suaveolens* (Pers.) Rostr.
Puccinia substriata Ellis & Barthol.
Puccinia swertiae G. Winter
Puccinia tanacetii DC.
Puccinia terminaliae T.S. Ramakr. & Sundaram
Puccinia thlaspeos Ficus & C. Schub.
Puccinia thomasiana T.S. Ramakr. & K. Ramakr.
Puccinia thunbergiae Cooke
Puccinia thwaitesii Berk.
Puccinia tiliaefolia T.S. Ramakr. & Sundaram
Puccinia tragiae Cooke
Puccinia tricholepidis Syd.
Puccinia trollii P. Karst.
Puccinia turgida P. Syd. & Syd.
Puccinia tweediana T.S. Ramakr. & K. Ramakr.
Puccinia unica var. *chica* Cummins & S.M. Husain
Puccinia urticae Barclay
Puccinia ustalis Berk.
Puccinia verruca Thüm.
Puccinia vernoniae-monosis T.S. Ramakr. & K. Ramakr.
Puccinia versicolor Dietel & Holw.
Puccinia violae (Schumach.) DC.
Puccinia volutarellae Thirum.
Puccinia wangikarii Somani
Puccinia wattiana Barclay
Puccinia weyrehii Miyabe
Puccinia woodii (Kalchbr. & Cooke) P. Syd. & Syd.
Puccinia xanthii Schwein.
Puccinia xanthocarpi R.Y. Roy & P.C. Gupta
Puccinia xanthopoda Syd. & P. Syd.
Puccinia xanthosperma Syd. & P. Syd.
Puccinia zingiberis T.S. Ramakr.
- Pucciniosira*** Lagerh (1)
Pucciniosira tuberculata (Ellis & Kellerm.) Buriticá & J.F. Hennen
- Ramakrishnania*** Ramachar & Bhagyan. (1)
Ramakrishnania ixorae Ramachar & Bhagyan.
- Trochodinium*** Syd. & P. Syd. (2)
Trochodinium ajrekarii Gharse
Trochodinium sampathense Thirum.
- Uromyces*** (Link) Unger (89)
Uromyces achrous Syd. & P. Syd.
Uromyces aconiti Fuckel
Uromyces acori T.S. Ramakr. & Rangaswami
Uromyces agropyri Barclay
Uromyces aloes (Cooke) Magnus
Uromyces ambiens Cooke
Uromyces amphiphis-insculptae T.S. Ramakr., Sriniv. & Sundaram
Uromyces andropogonis Tracy
Uromyces andropogonis-annulati Syd., P. Syd. & E.J. Butler
Uromyces anotidis-monospermatis T.S. Ramakr. & Sundaram
Uromyces anthyllidis (Grev.) J. Schröt.
Uromyces apludae Syd., P. Syd. & E.J. Butler

Uromyces appendiculatus (Pers.) Link
Uromyces behenis (DC.) Unger
Uromyces bidentis Lagerh.
Uromyces blainvilleae Berk.
Uromyces callicarpae (Petch) Fujik. ex S. Ito
Uromyces capitatus Syd. & P. Syd.
Uromyces ciceris-arietini (Grognot) Jacz. & G. Boyer
Uromyces clignyi Pat. & Har.
Uromyces clivalis Mitter
Uromyces commelinae Cooke
Uromyces coronatus Yoshin.
Uromyces dactylidis G.H. Otth
Uromyces decoratus Syd. & P. Syd.
Uromyces dolicholi Arthur
Uromyces eragrostidis Tracy
Uromyces eriochloae (Syd. & P. Syd.) Syd., P. Syd. & E.J. Butler
Uromyces euphorbiae Cooke & Peck
Uromyces fritillariae Thüm.
Uromyces geranii (DC.) G.H. Otth & Wartm.
Uromyces haussknechtii Tranzschel
Uromyces hedysari-obscuri (DC.) Carestia & Picc.
Uromyces heterogeneous Cooke
Uromyces hobsonii Vize
Uromyces hyderabadensis Ramachar, K.N. Rao & Bagyan.
Uromyces indigoferae f.sp. tinctoriae L.M. Joshi & A.R. Reddy
Uromyces ignobilis (Syd. & P. Syd.) Arthur
Uromyces inayatii Syd. & P. Syd.
Uromyces indicus Pat.
Uromyces indigoferae Dietel & Holw.
Uromyces lapponicus Lagerh.
Uromyces lespedezae-procumbentis (Schwein.) Lagerh.
Uromyces lespedezae-sericeae S. Ahmad
Uromyces lineolatus (Desm.) J. Schröt.
Uromyces loculiformis T.S. Ramakr. & K. Ramakr.
Uromyces macintirianus Barclay
Uromyces minor J. Schröt.
Uromyces mucunae Rabenh.
Uromyces muscari (Duby) Niessl
Uromyces mussooriensis Syd. & P. Syd.
Uromyces nilagiricus T.S. Ramakr. & K. Ramakr.
Uromyces orientalis Syd. & P. Syd.
Uromyces orthosiphonis T.S. Ramakr. & Sriniv.
Uromyces ottochloae Ramakr. T.S.
Uromyces panici-sanguinalis Rangel
Uromyces pavgii R.N. Goswami & Ngachan
Uromyces peglerae Pole-Evans
Uromyces pianhyensis Henn.
Uromyces pisi-sativi (Pers.) Liro
Uromyces polygona-avicularis (Pers.) G.H. Otth
Uromyces pontederiicola Speg.
Uromyces poonensis W.D. More & Moniz
Uromyces proeminens (DC.) Lév.

Uromyces pseudarthriae Cooke
Uromyces ramacharii Ravinder & Bagyan.
Uromyces rottboelliae Arthur
Uromyces rugulosus Pat.
Uromyces rumicis (Schumach.) G. Winter
Uromyces satarensis P.B. Chavan & Bakare
Uromyces schoenanthi Syd. & P. Syd.
Uromyces setariae-italicae Yoshino
Uromyces sommerfeltii Hyl., Jørst. & Nannf.
Uromyces spagazzinii (De Toni) Arthur
Uromyces sphaeropleus Cooke
Uromyces sporgoni Clint & Peck. subsp. *asiaticus*
Uromyces striatus J. Schröt.
Uromyces strobilanthis Barclay
Uromyces superfluus P. Syd. & Syd.
Uromyces tenuiculis McAlpine
Uromyces triandrae T.S. Ramakr. & Sriniv.
Uromyces trichoneurae Doidge
Uromyces trifolii (R. Hedw.) Lév.
Uromyces trigonellae Pass.
Uromyces tripogonicola Payak & Thirum.
Uromyces trollii-caroli Ulbr.
Uromyces valerianae (Schumach.) Fuckel
Uromyces valerianae-wallichii (Dietel) Arthur & Cummins
Uromyces vestergrenii P. Syd. & Syd.
Uromyces viciae-fabae (Pers.) J. Schröt.
Uromyces vignae Barclay
Uromyces vossiae Barclay
Uromyces wedeliae-biflorae Boedijn
Uromyces wellingtonicus T.S. Ramakr. & K. Ramakr.
Xenostele Syd. & P. Syd. (1)
Xenostele litseae (Pat.) Syd. & P. Syd.

12. Raveneliaceae Leppik, Ann. bot. fenn. 9: 139. 1972. *emend.* Aime & McTaggart

Chaconia Juel (1)
Chaconia butleri (Syd. & P. Syd.) Mains
Didymopsorella Thirum. (1)
Didymopsorella macrospora (Mundk. & Thirum.) Thirum.
Diorchidium Kalchbr. (3)
Diorchidium levigatum Syd., P. Syd. & E.J. Butler
Diorchidium orientale Syd., P. Syd. & E.J. Butler
Diorchidium tricholaenae Syd. & P. Syd.
Gymnopuccinia K. Ramakr. (1)
Gymnopuccinia pulneyensis K. Ramakr.
Kernkampella Rajendren (6)
Kernkampella breyniae (Syd. & P. Syd.) Rajendren
Kernkampella breyniae-patentis (Mundk. & Thirum.) Rajendren
Kernkampella coimbatorensis (T.S. Ramakr. & Sundaram) G.F. Laundon
Kernkampella emblicae (Syd. & P. Syd.) G.F. Laundon
Kernkampella kirganeliae (Mundk. & Thirum.) G.F. Laundon
Kernkampella phyllanthi (Mundk. & Thirum.) G.F. Laundon

Maravalia Arthur (11)

- Maravalia achroa* (Syd.) Arthur & Cummins
- Maravalia aulica* (Syd.) Y. Ono
- Maravalia ascotela* (Syd.) Mains
- Maravalia echinulata* (Niessl ex Rabenh.) Y. Ono
- Maravalia fici* (Mundk. & Thirum.) Y. Ono
- Maravalia gentilis* (Syd.) Y. Ono
- Maravalia ichnocarpi* (Barclay) Sathe
- Maravalia millettiae* Yadav & Thirum.
- Maravalia milletticola* Y. Ono & J.F. Hennen
- Maravalia mimusops* (Cooke) Y. Ono
- Maravalia pterocarpi* (Thirum.) Thirum.

Scopella Mains (1)

- Scopella dalbergiae* (T.S. Ramakr. & K. Ramakr.) Ragunathan & K. Ramakr.

Olivea Arthur (3)

- Olivea colebrookiana* Thirum. & Yadav
- Olivea isonandrae* Hosag.
- Olivea tectonae* (Racib.) Thirum.

Ravenelia Berk. (33)

- Ravenelia acaciae-arabicae* Mundk. & Thirum.
- Ravenelia acaciae-caesia* Tyagi & S.S. Prasad
- Ravenelia acaciae-concinnae* Mundk. & Thirum.
- Ravenelia acaciae-intsia* B.V. Patil & Thirum.
- Ravenelia acaciae-pennatulae* Dietel
- Ravenelia acaciae-pennatulae* Dietel
- Ravenelia acaciae-sumae* Thirum. & Mundk.
- Ravenelia acaciae-senegalae* Sanwal
- Ravenelia acaciicola* Sanwal
- Ravenelia aculeifera* Berk.
- Ravenelia ajmerensis* Sanwal
- Ravenelia albiziae-amarae* Bacc.
- Ravenelia burmanica* Thaug
- Ravenelia cassiicola* G.F. Atk.
- Ravenelia clemensae* Syd.
- Ravenelia deformis* Tyagi & S.S. Prasad
- Ravenelia tephrosiicola* (Henn.) Hirats. f.
- Ravenelia esculenta* Naras. & Thirum.
- Ravenelia evansii* Syd. & P. Syd.
- Ravenelia fragrans* Long
- Ravenelia hansfordii* Cummins
- Ravenelia hobsonii* Cooke
- Ravenelia indica* Berk.
- Ravenelia japonica* Dietel & P. Syd.
- Ravenelia karadensis* P.B. Chavan & U.V. Kulk.
- Ravenelia mitis* Syd. & P. Syd.
- Ravenelia mitteri* Syd.
- Ravenelia odoratissima* Tyagi & S.S. Prasad
- Ravenelia ornata* Syd. & P. Syd.
- Ravenelia parasnathii* Yadav
- Ravenelia radhanagarensis* Patil
- Ravenelia satarensis* P.B. Chavan & U.V. Kulk.
- Ravenelia sayeedii* M.A. Salam & Ramachar

Ravenelia sessilis Berk.
Ravenelia spicigerae B.V. Patil & Thirum.
Ravenelia stictica Berk. & Broome
Ravenelia sumatii S.D. Patil & Date
Ravenelia tandonii Syd.
Ravenelia taslimii Mundk.
Ravenelia versatilis (Peck) Dietel

***Prospodium* Arthur (2)**

Prospodium erebia (Syd. & P. Syd.) Bagyan. & Ravinder
Prospodium tirumalense Bagyan., Ravinder & P. Ramesh

13. *Skierkaceae* (Arthur) Aime & McTaggart, Fungal Systematics and Evolution 7: 21–47, 2020.

***Skierka* Racib. (3)**

Skierka agallochae Racib.
Skierka himalayensis A.K. Gautam & S. Avasthi
Skierka toddaliae (Petch) Hirats.

14. *Sphaerophragmiaceae* Cummins & Y. Hirats., Illustr. Gen. Rust Fungi, rev. Edn (St. Paul): 15. 1983. emend. Aime & McTaggart

***Sphaerophragmium* Magnus (1)**

Sphaerophragmium acaciae (Cooke) Magnus

15. *Tranzscheliaceae* (Arthur) Aime & McTaggart, Fungal Systematics and Evolution 7: 21–47, 2020

***Leucotelium* Tranzschel (1)**

Leucotelium pruni-persicae (Hori) Tranzschel

***Tranzschelia* Arthur (2)**

Tranzschelia discolor (Fuckel) Tranzschel & M.A. Litv.
Tranzschelia pruni-spinosae (Pers.) Dietel

16. *Zaghouaniaceae* P. Syd. & Syd., Monogr. Uredin. (Lipsiae) 3(3): 586. 1915. *emend.* Aime & McTaggart

***Cystopsora* E.J. Butler (1)**

Cystopsora antidesmatis T.S. Ramakr. & Sundaram

***Elateraecium* Thirum., F. Kern & B.V. Patil (1)**

Elateraecium salaciicola Thirum., F. Kern & B.V. Patil

***Hemileia* Berk. & Broome (10)**

Hemileia canthii Berk. & Broome
Hemileia gardeniae-thunbergiae (Henn.) Maubl. & Roger
Hemileia holarrhenae Syd. & P. Syd.
Hemileia indica Massee
Hemileia jasmini C.S. Krishnam. & Rangaswami
Hemileia mysorensis Thirum. & Gopalakrishn.
Hemileia pavetticola Maubl. & Roger
Hemileia thomasii Thirum. & Naras.
Hemileia vastatrix Berk. & Broome
Hemileia wrightiae (Racib.) Racib.

***Zaghouania* Pat. (1)**

Zaghouania oleae (E.J. Butler) Cummins

***Pucciniales* genera incertae sedis**

Aecidium Vuill.

Aecidium adhatodae Syd. & P. Syd.
Aecidium aechmantherae Syd. & P. Syd.
Aecidium ajugae Syd. & P. Syd.
Aecidium anaphalidis-leptophyllae T.S. Ramakr., Sriniv. & Sundaram
Aecidium argyreiae Berk. & Broome
Aecidium brasiliense Dietel
Aecidium callianthum Syd.
Aecidium campanulae Pandotra & K.S.M. Sastry
Aecidium carviae Sathe
Aecidium cassiae-torae P.B. Chavan & Bakare
Aecidium cinnamomi Racib.
Aecidium cleomes Ellis & H.W. Anderson
Aecidium clerodendri Henn.
Aecidium colchici-aurei Ulbr.
Aecidium crassocephali Wakef. & Hansf.
Aecidium crini Kalchbr.
Aecidium crypticum Kalchbr. & Cooke
Aecidium cuspidatum T.S. Ramakr., Sriniv. & Sundaram
Aecidium delphinii Barthol.
Aecidium deutziae Dietel
Aecidium dichrocephalae Henn.
Aecidium diospyri A.L. Sm.
Aecidium distinctum Arthur & Cummins
Aecidium elaeocarpi-tuberculati Hosag.
Aecidium esculentum Barclay
Aecidium flavescens Barclay
Aecidium garciniae Sundaram & A.V. Rao
Aecidium girardiniae Syd. & P. Syd.
Aecidium gymnematis T.S. Ramakr. & Sundaram
Aecidium hartwegiae Thüm.
Aecidium hedyotidis Syd.
Aecidium hemidesmi Syd. & P. Syd.
Aecidium hemigraphidis B.V. Patil & Thirum.
Aecidium infrequens Barclay
Aecidium innatum Syd., P. Syd. & E.J. Butler
Aecidium inquitosense P. Henn.
Aecidium kamatii Sathe
Aecidium latifolium Masee
Aecidium leae M.A. Salam & Ramachar
Aecidium lepidagathis Syd. & P. Syd.
Aecidium leucadinum Mitter
Aecidium lophanthi Henn.
Aecidium lophopetali Wakef.
Aecidium marsdeniae T.S. Ramakr. & K. Ramakr.
Aecidium melaleucum Syd. & P. Syd.
Aecidium meliosmae-wightii T.S. Ramakr., Sriniv. & Sundaram
Aecidium memecyli Thirum.
Aecidium microrhynchi Henn.
Aecidium miliare Berk. & Broome
Aecidium montanum E.J. Butler
Aecidium mori Barclay
Aecidium morobeanum Cummins

Aecidium myriactidis (Barclay) P. Syd. & Syd.
Aecidium nummulare Berk.
Aecidium ocimi Henn.
Aecidium orbiculare Barclay
Aecidium osmanthi Syd., P. Syd. & E.J. Butler
Aecidium painavuense Hosag.
Aecidium paramignya Racib.
Aecidium pavoniae-odoratae T.S. Ramakr., Sriniv. & Sundaram
Aecidium peristrophes Syd. & P. Syd.
Aecidium petchii Sacc. & Trotter
Aecidium plectranthicola Cummins
Aecidium plectroniae Cooke
Aecidium ponderosum Syd. & P. Syd.
Aecidium poonense Sathe
Aecidium pulneyense T.S. Ramakr. & Sriniv.
Aecidium pupaliae Prasad, L.C. Sharma & R.D. Singh
Aecidium pygei Syd. & P. Syd.
Aecidium quintum Syd. & P. Syd.
Aecidium randiae Henn.
Aecidium rhododendri Barclay
Aecidium rhynchosiae Bagyan. & Ramachar
Aecidium rhytismoideum Berk. & Broome
Aecidium salamii G.F. Laundon
Aecidium satarense P.B. Chavan & S.K. Patil
Aecidium saussureae Johanson
Aecidium scutellariae Syd. & P. Syd.
Aecidium sinhagadense Sathe
Aecidium solani Mont.
Aecidium spilanthi T.S. Ramakr. & Sundaram
Aecidium stewartianum Cummins
Aecidium stewartii Arthur & Cummin
Aecidium stranvaesiae Syd. & P. Syd.
Aecidium strobilanthi Barclay
Aecidium tandonii Mitter
Aecidium terminaliae T.S. Ramakr. & K. Ramakr.
Aecidium travancoricum T.S. Ramakr.
Aecidium tricholepidis P.B. Chavan & Bakare
Aecidium tubulosum Pat. & Gaillard
Aecidium urceolatum Cooke
Aecidium urgineae Henn. & Pole-Evans
Aecidium vangueriae Cooke
Aecidium verbenae Speg.
Aecidium vernoniae-cinereae Petch
Aecidium walayarens T.S. Ramakr. & Sundaram
Aecidium withaniae Thüm.

***Nyssopsora* Arthur**

Nyssopsora cedrelae (Hori) Tranzschel
Nyssopsora thirumalacharii R.N. Goswami & Ngachan
Nyssopsora thwaitesii (Berk. & Broome) Syd.

***Phragmotelium* Syd.**

Phragmotelium burmanicum (Syd. & P. Syd.) Syd.
Phragmidium mysorens (Thirum. & Mundk.) B. Ali & Berndt

Tunicopsora Suj. Singh & P.C. Pandey

Tunicopsora bagchii Suj. Singh & P.C. Pandey

Uraecium Arthur

Uraecium nothopegiae T.S. Ramakr. & K. Ramakr.

Uredo Pers.

Uredo acaciae-concinnae Kapoor bis & D.K. Agarwal

Uredo acalyphae-fruticosae T.S. Ramakr., Sriniv. & Sundaram

Uredo allmaniae P.B. Chavan & U.V. Kulk.

Uredo alpestris J. Schröt.

Uredo amomi Petch

Uredo apludae Barclay

Uredo arachidis Lagerh.

Uredo brachylepidis T.S. Ramakr. & Sundaram

Uredo cajani Syd. & P. Syd.

Uredo carissae Thirum.

Uredo carissae-occidentalis Chavan & Kulkurni

Uredo cassiae K.N. Rao

Uredo cassiae-occidentalis T.S. Ramakr.

Uredo celastri Arthur & Cummins

Uredo celastri-paniculatae T.S. Ramakr. & Sundaram

Uredo chasaliae Petch

Uredo citri Vaheed.

Uredo davaoensis Syd. & P. Syd.

Uredo dalbergiae-latifoliae Hosag. & N.C. Nair

Uredo deutziae Barclay

Uredo dioscoreae Henn.

Uredo dioscoreae-sativae Syd. & P. Syd.

Uredo echinulata (Niessl.) Syd.

Uredo ehretiae Barclay

Uredo elephantopodis Petch

Uredo elettariae Thirum.

Uredo emiliae-scabrae T.S. Ramakr. & Sundaram

Uredo exasperata (Cooke) Sacc.

Uredo garugae Sundaram

Uredo gayanae J.C. Lindq.

Uredo gharsei Sathe & Rahalkar

Uredo gomphrenae Barclay

Uredo hygrophilicola G.F. Laundon & Ponnappa

Uredo hyperici-mysorensis Petch

Uredo khandalensis Sathe & Rahalkar

Uredo launeae-coromandelicae Chavan & Bakare

Uredo lipocarphae Syd. & P. Syd.

Uredo malabarica T.S. Ramakr. & K. Ramakr.

Uredo mannanurensis K.N. Rao

Uredo microspora (Vize) Sacc.

Uredo mundkurii P.B. Chavan

Uredo myriactidis Sundaram

Uredo neilgherriensis T.S. Ramakr.

Uredo niterogensis Rangel

Uredo ochnae K.N. Rao

Uredo ophiorrhizae Petch

Uredo ophiuri Syd., P. Syd. & E.J. Butler

Uredo paederiae Syd. & P. Syd.
Uredo pallidula Cooke & Massee
Uredo panacis Syd. & P. Syd.
Uredo paspali Pandotra
Uredo paspali-scrobiculati Syd. & P. Syd.
Uredo phyllanthi-niruris M.S. Patil
Uredo pileae Barclay
Uredo pouzolziae Syd. & P. Syd.
Uredo pterocarpi T.S. Ramakr.
Uredo punctoidea Cooke
Uredo ravennae Maire
Uredo rhinacanthi T.S. Ramakr. & Sundaram
Uredo rottboelliae Dietel
Uredo shuteriae T.S. Ramakr.
Uredo sesbaniae Henn.
Uredo setariae-tomentosae Ramachar, Bhagyan. & A. Kumar
Uredo sissoo Syd., P. Syd. & E.J. Butler
Uredo spinulosa (Cooke) Sacc.
Uredo tephrosiae Rabenh.
Uredo terminaliae Henn.
Uredo terminaliae-paniculatae T.S. Ramakr. & K. Ramakr.
Uredo thelypteridis Yadav
Uredo thelypteridis var. *thelypteridis* Yadav
Uredo verecunda Syd.
Uredo victoriae Cummins

Phylogenetic analysis

The phylogenetic analyses based on the combined LSU and ITS rDNA sequence dataset comprised 189 taxa including various genera from 13 families belonging to Pucciniales were assessed with *Taphrina pruni* CBS 358.35 as an outgroup taxon. RAxML analysis of the combined dataset produced the best tree with a final ML optimization likelihood value of -34581.032655. The genera from different families included in the phylogenetic analyses are *Coleosporiaceae*, *Cronartiaceae*, *Crossopsoraceae*, *Melampsoraceae*, *Milesinaceae*, *Ochropsoraceae*, *Phakopsoraceae*, *Phragmidiaceae*, *Pileolariaceae*, *Pucciniastraceae*, *Pucciniaceae*, *Raveneliaceae* and *Tranzscheliaceae*. The genera *Coleosporium*, *Chrysomyxa* clustered together in *Coleosporiaceae* clade with significant support from ML 93% and *Cronartia* formed a distinct clade sharing a sister group relationship with *Coleosporium* and *Chrysomyxa*. The *Melampsoraceae* clade is supported by taxa from *Melampsora* with significant support from ML 100%. The *Pucciniastraceae* clade consists of taxa from *Hyalospora*, *Melampsoridium* and *Pucciniastrum* and *Milesinaceae* includes *Milesina*. The genera *Ravenelia*, *Kernkampella* clustered in a *Raveneliaceae* clade and *Maravalia* formed a distinct lineage. While *Nyssopsora* belonging to Uredinineae *incertae sedis* formed a different lineage. The *Tranzschelia* includes *Tranzschelia* and *Leucotelium* and *Ochropsoraceae* comprises *Ochropsora*. The *Phakopsoraceae* includes *Cerotelium* and *Phakopsora* in a monophyletic clade. The *Crossopsoraceae* clade comprises *Angiopsora*, *Crossopsora* and *Kweilingia*. The *Phragmidiaceae* includes taxa from *Phragmidium* in monophyletic clade with significant support from ML 94%. The *Gymnosporangiaceae* comprised *Gymnosporangium* in a monophyletic clade with significant support from ML 96%. The *Pucciniaceae* includes polyphyletic taxa from *Puccinia* and *Uromyces*.

Notes of Indian rust genera

After going through the available literature on Indian rust fungi, it is now clear that identification of these fungi has primarily been based on morphological characters. Few studies are

reported to use modern tools and molecular based techniques (specifically DNA-based) in their taxonomy. But with the use of all modern molecular methodologies, a number of alterations in existing system of classification of rust fungi has been proposed by Cummins & Hiratsuka (2003). Number of changes as proposed recently in classification of rust fungi (Aime 2006, Aime & McTaggart 2020), has led to the introduction of many new families as well as transfer of many genera and species. Keeping in view all the proposed changes, this outline of Indian *Pucciniales* incorporates updated changes. Of the 18 families of rust fungi, 16 are reported from India, consists 69 genera and 640 species. Most of the genera and species of Indian collections still required DNA based identification. Therefore, a brief description of each rust family along with total number of genera as well as species reported from India and their host families are provided in this section. In addition, a brief note, where further studies on Indian collections are urgently required to resolve their taxonomic uncertainty is also provided.

Phylum – *Basidiomycota* R. T. Moore, Bot. Mar.23: 371 (1980).

Synonyms – *Basidiomycota* Bold, Morph. Pl.: 7, 198 (1958), nomen invalidum

Basidiomycota is the second largest phyla of kingdom Fungi which shares 97% of all fungal species along with phylum *Ascomycota* (Wijayawardene et al. 2017, 2018, 2020, Niskanen et al. 2018). The fungi included in *Basidiomycota* possess basidia as meiosporocysts in the sexual life stage. The hyphae appeared to have single-layered wall (which actually is multi-layered) are divided by septa into mononucleate, binucleate, or multinucleate segments. The septal pore is generally closed, however, in some cases barrel-like thickening is present on both sides. Chemotaxonomy, formation of urease, siderochromes, and the type of ubiquinone system also differentiate basidiomycetous fungi from ascomycetes. In addition, the guanine-cytosine content of the total DNA exceeds 50% in basidiomycetous species. The updated outline of *Basidiomycota* includes four subphyla, 18 classes, 68 orders, 241 families, 1928 genera and 41270 species, of which rust fungi are included in subphylum *Pucciniomycotina* (He et al. 2019, Wijayawardene et al. 2020).

Subphylum: *Pucciniomycotina* R. Bauer, Begerow, J.P. Samp., M. Weiß & Oberw., Mycol. Progr.5: 45 (2006).

Equivalent to *Urediniomycetes* (Swann & Taylor 1995b, Kirk et al. 2001, Swann et al. 2001).

Pucciniomycotina is a diverse group of fungi, including rusts, yeasts, smut-like and jelly-like fungi. It is the sister to the *Ustilaginomycotina* and *Agaricomycotina*, forming the basal lineage of *Basidiomycota*. Species of *Pucciniomycotina* studied so far lack dolipores (septal pore swellings) and septal pore caps. Absence of the predominant cell wall sugar, mannose (Prillinger et al. 1993) and disc like spindle pole bodies (McLaughlin et al. 1995, Wells 1994), distinguishes them from most other *Basidiomycota*. These fungi show very simple to complex life cycle, considered as most complex organisms (Lutz et al. 2004). Most described species are predominantly phytopathogens but also include asymptomatic members. Subphylum *Pucciniomycotina* is estimated to have 10 classes, 22 orders, 49 families, 270 genera, and 8653 species with rust fungi placed in class *Pucciniomycetes* (He et al. 2019, Wijayawardene et al. 2020).

Class: *Pucciniomycetes* R. Bauer, Begerow, J.P. Samp., M. Weiss & Oberw., Mycol. Progr. 5: 48 (2006).

Equivalent to *Urediniomycetidae* (Swann et al. 2001).

Pucciniomycetes is a diverse class of subphylum *Pucciniomycotina*. It is one of the major classes of basidiomycete fungi containing about 8000 species (Kirk et al. 2008). Based on rDNA phylogenetic studies, rust fungi and their closest relatives in *Pucciniomycetes* are reported to have ambiguous phylogenetic positions within the *Pucciniomycotina* (Aime et al. 2006). All species of *Pucciniomycetes* are dikaryotic (containing two haploid nuclei per cell) except for *Septobasidiales*, which are monokaryotic (containing a single haploid nucleus per cell). Lack of clamp connections in their hyphae (Bauer et al. 2006) is another characteristic feature of these fungi. Production of asexual spores, especially among rusts, is often well developed (Bruckart et al. 2010). Sexual reproduction takes place via the formation of basidiospores. This class contains 5 orders, 20 families, 180 genera,

and 8016 species. Majority of the fungal species in *Pucciniomycetes* are parasitic in nature. *Pucciniales* is the most species-rich group of the *Pucciniomycetes* with over 95% of the species and 75% of the genera placed in this order, the plant parasitic rust fungi.

Order: ***Pucciniales*** Clem. & Shear, Gen. Fungi (2nd edn): 147 (1931).

Equivalent to *Uredinales*.

Exemplar genera: *Puccinia* Pers. 1801, *Uromyces* (Link) Unger 1832.

The *Pucciniales* is one of the largest and major orders in *Basidiomycota* (class *Pucciniomycetes*). This order mainly contains many important plant pathogens popularly known as rusts. These fungi are obligate plant parasites occurring on ferns, gymnosperms and angiosperms. They have been studied in detailed as many of the most devastating plant diseases in agricultural crops are caused by the members of *Pucciniales*. Morphologically, the species of *Pucciniales* are characterized by their rusty appearance on infected host parts such as leaves, petioles, tender shoots, stems, fruits, etc. and named for the typically rusty coloration of their urediniospores. These obligate parasites have highly complex life cycles with up to five spore stages and two unrelated hosts (Cummins & Hiratsuka 2003). Of 7800 described species, *Pucciniales* constitutes 25% of all known species in *Basidiomycota* and ca. 8% of all described Fungi (Kirk et al. 2008). The *Pucciniales* is estimated to have 15 families, ca. 150 genera and ca. 7,800 species, and is considered as the most speciose order of fungi (Kirk et al. 2008, Wijayawardene et al. (2020). Recently, a higher-rank classification for rust fungi, with notes on genera was provided by Aime & McTaggart (2020). They have proposed four new suborders and seven new families based on the evaluation of 80 % of accepted genera including type species wherever possible, and three DNA loci. As per this classification, *Pucciniales* now comprises seven suborders as *Araucariomycetinae*, *Melampsorineae*, *Mikronegeriineae*, *Raveneliineae*, *Rogerpeteroniineae*, *Skierkineae*, and *Uredinineae*. There are now 18 families *Araucariomycetaceae*, *Coleosporiaceae*, *Crossosporaceae*, *Gymnosporangiaceae*, *Melampsoraceae*, *Milesinaceae*, *Ochropsoraceae*, *Phakopsoraceae*, *Phragmidiaceae*, *Pileolariaceae*, *Pucciniaceae*, *Pucciniastraceae*, *Raveneliaceae*, *Rogerpeteroniaceae*, *Skierkaceae*, *Sphaerophragmiaceae*, *Tranzscheliaceae*, and *Zaghouaniaceae* (Aime & McTaggart 2020). Therefore, we followed Aime & McTaggart (2020) to present updated information on genera and species in each family. The numbers of genera and species of rust fungi were presented as per Wijayawardene et al. (2020). The distinct characteristics of various spore stages (telia, teliospores, uredinia, urediniospores, aecia, aeciospores, spermogonia and basidia) for each family are summarized in this section. The notes on rust families reported from India are described here in this section of manuscript.

Coleosporiaceae Dietel, In: Engler & Prantl, Nat. Pflanzenfam., Teil. I (Leipzig) 1: 548. 1900.
emend. Aime & McTaggart

Type genus – ***Coleosporium*** Lév., Ann. Sci. Nat. Bot. III, Ser. 8: 373. 1847

The species of family *Coleosporiaceae* bear large, bladder-like aecia covered with well-developed peridium and have catenulate, verrucose aeciospores. Uredinia with rudimentary peridium or none and urediniospores are formed in chain with verrucose echinulate ornamentation on surface. The germ pores are mostly obscure and scattered. The teliospores are formed one by one (catenulate, pseudocatenulate or in a single layer) in erumpent, hard, waxy or gelatinous, pulvinate or columnar telia under the epidermis of the host plant. The teliospores are generally unicellular, thin walled and sessile with non-differentiated germ pores. The spermogonia are of Group I (type 2 or 3) (but Group II, type 9 in *Cronartium*). Most of the species are heteroecious and macrocyclic, with aecial stage on needle, buds and cones of conifers (Cummins & Hiratsuka 2003, Aime & McTaggart 2020).

Genera reported in India – *Coleosporium* (19), *Chrysomyxa* (7), *Cronartium* (4), *Goplana* (1), *Stakmania* (1) total 32 species.

Host families – *Asteraceae*, *Campanulaceae*, *Ericaceae*, *Gentianaceae*, *Grossulariaceae*, *Lamiaceae*, *Lauraceae*, *Moraceae*, *Phyllanthaceae*, *Pinaceae*, *Ranunculaceae*.

Figure 1 – Maximum likelihood phylogeny of Indian rust fungi based on two concatenated loci (LSU and ITS) of taxa from Pucciniales. Bootstrap support values for maximum likelihood equal to or

greater than 70% are given above each branch respectively. Outgroup taxon is *Taphrina pruni* CBS 358.35.

Figure 1 – Continued.

Notes – Two species of rust genus *Stakmania* (*S. formosana* and *S. indica*) were reported from India. Among the two, *S. formosana* Syd. & P. Syd. has been transferred to *Phakopsora formosana* while, *S. indica* Kamat & Sathe remains unchanged (Index Fungorum 2020). Hence, this species has been retained in this family.

Crossopsoraceae Aime & McTaggart, In: Fungal Systematics and Evolution 7: 21–47. 2020

Fig. 9

Type genus – *Crossopsora* Syd. & P. Syd., Annls mycol. 16(3/6): 243. 1919.

Crossopsoraceae is characterized by producing Group VI (type 7) spermogonia and aecidium-type aecia wherever known. Uredinia are of malupa-type and usually paraphysate. The teliospores produced by these fungi are 1-celled, compact and often produced in catenulate chains of a few to many cells. These spores germinate externally, with or without dormancy. The fungi in this family are mostly identified from the sporothallus (uredinial, and telial) stages. The genus *Neophysopella* in this family is macrocyclic and heteroecious in nature (Aime & McTaggart 2020) and considered the same for other genus/species also. A total of 7 genera have been included in this family, of which, six genera being reported from India.

Genera reported in India – *Angiopsora* (2), *Crossopsora* (3), *Dasturella* (3), *Kweilingia* (2), *Neophysopella* (2), *Physopella* (2); total 14 species.

Host families – *Poaceae*, *Rhamnaceae* *Verbenaceae*.

Notes – Two Indian records of the genus *Physopella* i.e. *P. artocarpi* (Berk. & Broome) Arthur and *P. vernoniae* (T.S. Ramakr.) Ramachar & Bhagyan are solely based on morphs. Since the genus *Physopella* has now been changed to *Neophysopella*, these two Indian records are still unchanged (Index Fungorum 2020). Hence, we retained this species in this family and proposed DNA based studies to resolve its taxonomic position.

Gymnosporangiaceae P. Zhou & L. Cai, Persoonia 45: 79. 2020. *emend.* Aime & McTaggart

Type genus – *Gymnosporangium* R. Hedw. ex DC., In: Lamarck & de Candolle, Fl. franç., Edn 3 (Paris) 2: 216. 1805.

The family *Gymnosporangiaceae* consists of Group V (type 4) Spermogonia, bounded with well developed peripheral flexuous hyphae. Aecia *Roestelia*-type, subepidermal, with well-developed peridia (*Gymnosporangium*) or less frequently aecidium-type (*Gymnotelium*). Aeciospores catenulate, with intercalary cells. Urediniospores borne singly on pedicels in Uredo-type, subepidermal Uredinia. Telia subepidermal, erumpent consists mostly 2-celled teliospores, borne singly on gelatinising pedicels without dormancy via external basidia. Life cycle mostly demicyclic and heteroecious (Zhao et al. 2020, Aime & McTaggart 2020).

Genera reported in India – *Peridiopsora* (1) *Gymnosporangium* (3) *Roestelia* (3)

Host families – *Boraginaceae*, *Cupressaceae*, *Rosaceae*.

Notes – Based on puccinioid character of 2-celled, pedicellate teliospores, the genus name *Gymnosporangium* has been conserved against the older name *Roestelia* Rebent. (Aime et al. 2018b). Hence, the genus *Roestelia* has now been transferred to *Gymnosporangium*. Because of lack of molecular data, Indian records of this genus reported as *Roestelia distorta* (Arthur & Cummins) F. Kern, *Roestelia cunninghamianum* (Barclay) F. Kern and *Roestelia patula* (Syd. & P. Syd.) F. Kern are still unchanged (Index Fungorum 2020).

Melampsoraceae Dietel, in Engler & Prantl, Nat. Pflanzenfam., Teil. I (Leipzig) 1: 38. 1897.

Figs 2, 7, 9

Type genus – *Melampsora* Castagne, Obs. Plantes Acotylédonées Fam. Urédinié 2: 18. 1843.

Melampsoraceae is characterized by aecia without peridium or rudimentary if present with catenulate and verrucose aeciospores. Uredinia contain abundant paraphyses (sometimes rudimentary peridium also) and echinulate urediniospores with scattered or bizonate germ pores and borne singly. Telia are embedded (subepidermal or rarely subcuticular) containing unicellular, sessile, pigmented teliospores with one germ pore. Germination external or semi-external (*Ceropsora*). The basidium is external and spermogonia are of Group I (Type 2 or 3). These fungi are mostly macrocyclic and inhabit two different unrelated hosts or same host to produce all spore stages. Most of the species are heteroecious and macrocyclic; however, the species of *Ceropsora* are microcyclic. Total 100 species of *Melampsora* have been reported globally (He et al. 2019, Wijayawardene et al. 2020), of which only 17 species have been reported so far in India.

Genera reported in India – *Ceropsora* (1), *Melampsora* (17); total 18 species.

Host families – *Euphorbiaceae*, *Hypericaceae*, *Linaceae*, *Pinaceae*, *Salicaceae*.

Notes – The type species of the genus *Ceropsora* (*C. picea*) infecting *Picea* sp. was reported from India (Bakshi & Singh 1960). It was placed in family Coleosporiaceae (Cummins & Hiratsuka 2003, Wijayawardene et al. 2020). The telia of two species of *Ceropsora* viz., *C. picea* and *C. weirii* contain some thin-walled sterile cells on the sides (been interpreted as remnants of a peridermium). Teliospores of the genus are subtended by adherent crusts of sterile basal cells in the beginning that separate at dispersal stage (Bakshi & Singh 1960, Crane et al. 2000). Aime & McTaggart (2020) proposed the inclusion of the genus *Ceropsora* in to this family.

Figure 2 – Rust fungi *Melampsora* sp. A-B *Euphorbia helioscopia*. C-D *Populus* sp.

Milesinaceae Aime & McTaggart, In: Fungal Systematics and Evolution 7: 21–47. 2020

Type genus – *Milesina* Magnus, Ber. Deutsch. Bot. Ges. 27: 325. 1909.

Two important characters, production of colourless urediniospores in species that infect ferns and production of aecia (milesia-type) in species that infect *Ericaceae* differentiate this family from *Melampsorineae*. The important characters of this family include production of Group I (mostly type 1, also type 2 and 3) Spermogonia and colourless sori. Although urediniospores of *Naohidemyces* are orange in colour. The presence of peridermium-type aecia (milesia-type in *Naohidemyces*); milesia-type uredinia; 1- to many-celled, barely differentiated, sometimes laterally adherent teliospores with dormant germination are found. These fungi are mostly macrocyclic and heteroecious in nature. They produce sporothalli on ferns (except *Naohidemyces* on *Ericaceae*), and gametothalli on *Pinaceae*.

Genera reported in India – *Milesina* (3), *Uredinopsis* (2); total 5 species

Host families – *Dryopteridaceae*, *Pteridaceae*.

Note – This is newly proposed family by Aime & McTaggart (2020). Out of 4 genera included in this family (Aime & McTaggart 2020), two genera namely, *Milesina* and *Uredinopsis* are reported from India. Aime et al. (2018) recommended the protection of the name *Milesina* Magnus over *Milesia* F.B. White, but they do not found the type species of both the genera congeneric and recommended retaining both the genera. In India, the molecular studies on *Milesina* and *Uredinopsis* are also required to demonstrate their correct taxonomic position.

Ochropsoraceae (Arthur) Aime & McTaggart, In: Fungal Systematics and Evolution 7: 21–47. 2020
Type genus – *Ochropsora* Dietel, Ber. Dtsch. Bot. Ges. 13: 401. 1895.

The family *Ochropsoraceae* contains Group VI (type 7) spermogonia. Aecia are of aecidium-type, these states systemic in nature and overwintering as mycelium. Uredinia are of malupa-type. The genera of this family produce 1-cell deep telia forming crusts, which are at first subepidermal, then erumpent. Teliospores germinate without dormancy, either internally (*Ochropsora*) or externally (*Aplopsora*). These fungi are macrocyclic and heteroecious in nature.

Genera reported in India – *Ochropsora* (1); total 1 species

Host families – *Ranunculaceae*.

Note – Aime & McTaggart (2020) proposed *Ochropsoraceae* as new family. The rust genera *Aplopsora* and *Ochropsora* included in this family were previously treated within the *Chaconiaceae* (Cummins & Hiratsuka 2003). Of these, *Ochropsora* (*Ochropsora ariae* (Fuckel) Ramsb.) was also reported from India. However, only morphotaxonomic studies are available for this record, and molecular studies can be helpful to establish the correct taxonomic position.

Phakopsoraceae Cummins & Y. Hirats., Illustr. Gen. Rust Fungi, rev. Edn (St. Paul): 13. 1983.
emend. Aime & McTaggart

Type genus – *Phakopsora* Dietel, Ber. Deutsch. Bot. Ges. 13: 333. 1895.

The genera of *Phakopsoraceae* show both heteroecious and autoecious (species of *Bubakia*, *Masseëlla* and *Nothoravenelia*) mode of life cycle on various hosts but not host restricted. Spermogonia are of Group IV (type 7). The aecia are caecoma-type (some *Masseëlla* with aecidium-type) with aeciospores either verrucose or echinulate, borne singly or in chains. Uredinia lecythea or uredo-type consisting echinulate urediniospores, mostly borne singly (catenulate in *Arthuria*) with scattered germ pores or obscure. Both erumpent and embedded types of telia are found which contain 1-celled, sessile, catenulate or irregularly arranged teliospores with mostly 1 germ pore in each cell. The majority of *Phakopsora* and *Uredopeltis* species are only known from the sporothallus (uredinial, and telial) stages (Cummins & Hiratsuka 2003, Aime & McTaggart 2020). This family comprises 15 genera and 209 species (Wijayawardene et al. 2020). Aime & McTaggart (2020) in recent treatment included 12 genera in this family, 10 being reported from India.

Genera reported in India – *Arthuria* (2), *Bubakia* (1), *Cerotelium* (7), *Macabuna* (1), *Monosporidium* (3), *Masseëlla* (6), *Phakopsora* (25), *Phragmidiella* (3), *Pucciniostele* (1), *Uredopeltis* (1); total 50 species.

Host families – *Bignoniaceae*, *Burseraceae*, *Combretaceae*, *Euphorbiaceae*, *Fabaceae*, *Phyllanthaceae*, *Putranjivaceae*, *Rhamnaceae*, *Rubiaceae*, *Salicaceae*, *Saxifragaceae* and *Vitaceae*.

Notes – The rust genus *Bubakia* has now been transferred to *Phakopsora* (Index Fungorum 2021). It is often treated as a synonym of *Phakopsora* (Cummins & Hiratsuka 2003). But, Aime & McTaggart (2020) found a distinct lineage of the *Bubakia argentinensis* within *Phakopsoraceae* and similar characteristics and hosts with type, *B. crotonis*. Hence, they proposed *Bubakia* for these species. However, the only India record of *Bubakia indica* T.S. Ramakr. & K. Ramakr. still requires molecular studies, as it was identified based on morphology only. The genus *Masseëlla* is also placed within this family (Aime & McTaggart 2020), although previously treated as *incertae sedis* within *Pucciniales* (Cummins & Hiratsuka 2003).

Phragmidiaceae Corda Icon. fung. (Prague) 1: 6. 1837

Figs 3, 9

Type genus – *Phragmidium* Link, Mag. Ges. Naturfr. Freunde Berlin 7: 30. 1816.

Phragmidiaceae is characterized by forming spermogonia Group IV (type 6, 8, 10 or 11). The aecia variable, caeoma-, petersonia- or uredo-type and are formed with or without peridium. Aeciospores are verrucose or echinulate aeciospores borne in chains or singly on pedicels with few or no paraphyses. Uredinia lecythea or uredo-type, thin-walled, with incurved paraphyses consisting of echinulate urediniospores borne singly and have scattered germ pores. Telia erumpent, with or without paraphyses, with teliospores born on short pedicels, 3- to several cells (by transverse septa) with 1 or more apical germ pore in each cell. Basidium is external. Life cycle is mainly of autoecious type. Wijayawardene et al. (2020) documented 13 genera and 178 species in this family; however, Aime & McTaggart (2020) included only 9 genera.

Genera reported in India – *Hamaspora* (2), *Kuehneola* (6), *Phragmidium* (18), *Trachyspora* (1); total 27 species.

Host families – *Poaceae*, *Rosaceae*.

Notes – Of the 9 genera included in this family, only 4 genera and 27 species have been reported in India. *Phragmidiaceae* species are confined almost exclusively to the *Rosoideae* subfamily of *Rosaceae* (Aime 2006).

Figure 3 – A-B *Phragmidium* sp. on *Rosa* sp.

Pileolariaceae (Arthur) Cummins & Y. Hirats., *Illustr. Gen. Rust Fungi*, rev. Edn (St. Paul): 14. 1983. *emend.* Aime & McTaggart

Figs 4A, 9

Type genus – *Pileolaria* Castagne, *Obs. Plantes Acotylédonées Fam. Urédinées* 1: 22. 1842.

The genera of the family are characterized by forming spermogonia Group VI (type 7). Aecia (uredo-type) with or without peridium contains reticulate, ridged, verrucose, spirally marked aeciospores borne singly and germ pores zonate. Uredia (uredo-type) are similar to aecia except not accompanied by spermogonia. Telia erumpent and having unicellular teliospores 1-celled, borne one or few on each pedicel with one germ pore per spore. Basidium is external. Species are mostly macrocyclic and autoecious. The genera of this family mostly inhabit members of *Anacardiaceae* (Cummins & Hiratsuka 2003, Aime & McTaggart 2020).

Genera reported in India – *Pileolaria* (2); total 2 species.

Host family – *Anacardiaceae*.

Notes – Four genera and 43 species have been documented in this family (Wijayawardene et al. 2020), of which two genera, *Pileolaria* and *Skierka* were reported from India. However, Aime & McTaggart (2020) included only the genus i.e. *Pileolaria* and proposed the placement of *Skierka* within another family. A total 25 species of *Pileolaria* are recorded worldwide (Index Fungorum 2021). The two Indian records (*P. indica* Syd. and *P. pistaciae* F.L. Tai & C.T. Wei) require further molecular studies.

Figure 4 – Rust fungi. A *Pileolaria* sp. on *Pistacia* sp. B *Skierka* sp. on *Pistacia* sp.

Pucciniastraceae Gäum. ex Leppik, Ann. bot. fenn. 9: 139. 1972. ***emend.*** Aime & McTaggart

Type genus – *Pucciniastrum* G.H. Otth, Mitt. Naturforsch. Ges. Bern 1861: 71. 1861.

Pucciniastraceae members are heteroecious and mostly macrocyclic. Spermogonia and aecia produced on conifers; uredinia and telia often on ferns. Spermogonia are of Group I (type 2 or 3). Aecia with well developed peridium and contain catenulate aeciospores. Uredinia are formed with cellular peridium and ostiolar opening and contain pedicellate or non pedicellate, echinulate urediniospores, borne singly and possess obscure, scattered or bizonate germ pores. Telia are not well differentiated i.e. either subepidermal or intradermal, not erumpent, composed of unicellular or multicellular, sessile teliospores having obscure or 1 germ pore per cell. Basidia are external (Cummins & Hiratsuka 2003, Aime & McTaggart 2020). The family was reported to contain 10 genera and 210 species (Wijayawardene et al. 2020). The recent higher rank classification for rust fungi proposed the inclusion of only six genera in this family (Aime & McTaggart 2020), of which four were recorded from India.

Genera reported in India – *Hyalopsora* (2), *Melampsoridium* (4), *Peridermium* (7), *Pucciniastrum* (6); total 19 species.

Host families – *Betulaceae*, *Celastraceae*, *Coriariaceae* *Magnoliaceae*, *Phyllanthaceae*, *Pinaceae*, *Pteridaceae*, *Rosaceae*, *Sapindaceae*.

Notes – As per the proposal to conserve the name of rust fungi (Aime et al. 2018), the sexual name *Melampsorella* has been conserved over *Peridermium*. However, the Indian records of *Peridermium* are devoid of any molecular studies and are still unchanged (Index Fungorum 2021).

Pucciniaceae Chevall., Fl. gén. env. Paris (Paris) 1: 413. 1826. ***emend.*** Aime & McTaggart

Figs 5, 6, 7, 8

Type genus – *Puccinia* Pers., Synopsis methodica fungorum: 225. 1801.

Pucciniaceae is a largest family that infects nearly all the major angiospermous orders. They are destructive phytopathogens infecting mainly cereals such as wheat. Spermogonia belong to Group V (type 4). Aecidia are with or without a peridium and have verrucose aeciospores borne singly, or in chain (catenulate). Uredinia with palisade like peridium contain echinulate urediniospores borne singly and have many germ pores. The most important distinguishing character is that these fungi having stalked teliospores borne singly or united in telia with or without paraphyses. In some cases, palisade like peridium or separation of telia into locules by stromatoid paraphyses is also observed.

Teliospores are mostly 1 or 2 (rarely more) celled with one germ pore in each cell and germination mostly by external basidium (sometimes internal). The genera are mostly heteroecious exhibiting four spore stages usually upon two or more distinct hosts followed by an independent promycelial stage upon germination of the teliospores. The largest two genera are *Puccinia*, with two-celled teliospores, and *Uromyces* where they are one-celled. This is the most speciose family of the *Pucciniales*, and contains 21 genera and over 4961 species (Wijayawardene et al. 2020). Aime & McTaggart (2020) proposed the inclusion of 23 genera and 9 more genera likely to include in this family. Total 12 genera with 393 species have been recorded in India.

Genera reported in India – *Caeoma* (4), *Chrysocelis* (1), *Corbulopsora* (1), *Endophyllum* (8), *Gambleola* (1), *Hapalophragmium* (4), *Kernella* (1), *Puccinia* (279), *Puccinosira* (1), *Ramakrishnania* (1), *Trochodium* (2), *Uromyces* (89); total 393 species.

Host families – *Acanthaceae*, *Apiaceae*, *Asteraceae*, *Berberidaceae*, *Boraginaceae*, *Celastraceae*, *Convolvulaceae*, *Cyperaceae*, *Elaeagnaceae*, *Euphorbiaceae*, *Fabaceae*, *Lamiaceae*, *Lauraceae*, *Liliaceae*, *Loranthaceae*, *Malvaceae*, *Orchidaceae*, *Pinaceae*, *Plantaginaceae*, *Poaceae*, *Polygonaceae*, *Ranunculaceae*, *Rubiaceae*, *Saxifragaceae*, *Schisandraceae*, *Solanaceae*.

Notes – The genus *Caeoma*, as typified by *C. berberidis*, is a synonym of *Puccinia* (Aime et al. 2018). One of its species *C. torreyae* is presented as basionym of *Rogerpetersonia torreyae* (Bonar) Aime & McTaggart (Aime & McTaggart 2020) based on broad molecular assessment. Similarly, the genus *Trochodium* has now been transferred to *Uromyces*. The types of two genera, *Gambleola* and *Ramakrishnania* are of Indian origin and identified mainly based on morphotaxonomic characters. The Indian records for all three genera are still unchanged (Index fungorum 2021) and required investigation at molecular level.

Raveneliaceae Leppik, Ann. bot. fenn. 9: 139. 1972. ***emend.*** Aime & McTaggart

Fig. 9

Type genus – *Ravenelia* Berk., Gard. Chron. 13:132. 1853.

Raveneliaceae consists Group VI (type 5, 7) spermogonia. The genera of this family produce typically uredo- (rarely aecidium-, caeoma-, or lecythea-) type aecia with or without peridium and paraphyses. Aeciospores are pedicellate and echinulate or verrucose borne singly or in chain. Uredinia are of subepidermal or erumpent, with or without paraphyses. These are similar to aecia while unknown in some cases. Urediniospores borne singly, mostly echinulate with several germ pores. Telia are erumpent with or without paraphyses contain pedicellate, vertically septate or vertically or radially arranged 1- to many-celled teliospores (2 or more) on the top of pedicel, often subtended by hygroscopic crystals or with pedicel having apical cells. Each cell or spore contains one or two germ pores. Basidium is of external type. Members of this family have autoecious and macrocyclic type of life cycle mostly on *Fabaceae* or *Rosaceae*. Although 24 genera and 384 species have been documented within this family (Wijayawardene et al. 2020), Aime & McTaggart (2020) proposed the inclusion of 16 genera and 16 more genera likely to include in this family. Total 10 genera with 61 species have been recorded in India.

Genera reported in India – *Chaconia* (1), *Didymopsorella* (1), *Diorchidium* (3), *Gymnopuccinia* (1), *Kernkampella* (5), *Maravalia* (11), *Scopella* (1), *Olivea* (3), *Prospodium* (2) *Ravenelia* (33); total 61 species.

Host families – *Fabaceae*, *Oleaceae*, *Phyllanthaceae*, *Poaceae*, *Rubiaceae*, *Rutaceae*.

Notes – The identification of Indian records in this family, *Didymopsorella macrospora* (Mundk. & Thirum.) Thirum., *Gymnopuccinia pulneyensis* K. Ramakr. and *Scopella dalbergiae* (T.S. Ramakr. & K. Ramakr.) Ragunathan & K. Ramakr. is mainly based on their morphological characters. Similarly, the genus *Scopella* has now been transferred to *Maravalia*. However, its indian record *Scopella dalbergiae* (T.S. Ramakr. & K. Ramakr.) Ragunathan & K. Ramakr. is still unchanged. DNA sequence studies can be helpful to establish their correct taxonomic placement.

Skierkaceae (Arthur) Aime & McTaggart, Fungal Systematics and Evolution 7: 21–47, 2020.

Figs 4B, 9

Type genus – *Skierka* Racib., Parasit. Alg. Pilze Javas (Jakarta) 2: 30. 1900.

Skierkaceae is a newly introduced family by Aime & McTaggart (2020), mainly characterized by subepidermal, periphysate, deep-seated spermogonia with convex hymenium. Aecia and uredinia uredo-type. The Uredia and telia (sporothalli sori) are deep-seated and subepidermal which differentiated these from all other rust fungi. Urediniospores and teliospores are single-celled produced on sporogenous cells through a narrow sorus opening. Before emergence, these spores leaving behind new spores on sporogenous cells from which they are detached. Teliospores strongly adherent, extruded in hair-like columns, germination external, without dormancy. These fungi possess autoecious and macrocyclic type of life cycle.

Genera reported in India – *Skierka* (3); total 3 species.

Host families – *Anacardiaceae*.

Notes – A total of 14 species of the genus *Skierka* have been reported so far (Index Fungorum 2021), three species reported from India too. *Skierka himalayensis* A.K. Gautam & S. Avasthi was reported as new from India (Gautam & Avasthi 2017c). But all three records are identified on based on morphological characters only and require molecular identification.

Sphaerophragmiaceae Cummins & Y. Hirats., Illustr. Gen. Rust Fungi, rev. Edn (St. Paul): 15. 1983. ***emend.*** Aime & McTaggart

Type genus – *Sphaerophragmium* Magnus Ber. dt. bot. Ges 9: 121. 1891.

Spermogonia are mostly lacking and unknown, Group V (type 4) in *Sphenorchidium*, if present. Aecia are aecidium-type and uredinia resembling aecia (lecythea-type in *Sphenorchidium*). Teliospores 2- to multicelled, pedicellate, globose to subglobose, with furcated or simple blunt wall projections, with one germ pore per cell borne in compact telia (Beenken & Berndt 2010). In *Austropuccinia*, urediniospores with a smooth patch (torse) as comparison to echinulate or verrucose in other cases. Telia subepidermal to erumpent, cylindrical to ellipsoidal, with a rounded apex, 2-celled teliospores, constricted at the septum. Basidia are mostly external. Species are autoecious with variable life cycles. Wijayawardene et al. (2020) documented 2 genera and 25 species in this family, however, Aime & McTaggart (2020) proposed the inclusion of 5 genera.

Genera reported in India – *Sphaerophragmium* (1); total 1 species.

Host families – *Fabaceae*.

Notes – Only single genus *Sphaerophragmium* with one species (*S. acacia* (Cooke) Magnus) was reported from India. The identification of this species is solely based on morphological characters, and DNA based molecular studies are necessary.

Tranzscheliaceae (Arthur) Aime & McTaggart, Fungal Systematics and Evolution 7: 21–47, 2020

Type genus – *Tranzschelia* Arthur, Rés. Sci. Congr. Int. Vienne: 340. 1906.

The rust fungi of family *Tranzscheliaceae* are mostly macrocyclic and heteroecious in nature. However, some microcyclic species may be found. The species consists of Group VI (type 7) spermogonia. Aecia are of aecidium type while, uredinia uredo-type. Teliospores produced by these fungi are 2-celled, pedicellate, produced from sterile basal cells.

Genera reported in India – *Leucotelium* (1), *Tranzschelia* (2); total 3 species

Host families – *Rosaceae*.

Notes – *Tranzscheliaceae* is proposed as new family by Aime & McTaggart (2020), included two genera, *Leucotelium* and *Tranzschelia*. Both the genera were previously treated within *Uropyxidaceae* (Cummins & Hiratsuka 2003). The Indian records of these genera still required DNA sequence based studies to establish their correct taxonomic position.

Zaghouaniaceae P. Syd. & Syd., Monogr. Uredin. (Lipsiae) 3(3): 586. 1915. ***emend.*** Aime & McTaggart

Type genus – *Zaghouania* Pat., Bull. Soc. mycol. Fr. 17: 187. 1901

The species of this family most often consists of deep seated and non-periphysate Group III (type 12) spermogonia. Aecia are mostly petersonia-type (without peridium or intercalary cells). Aeciospores are echinulate or verrucose; borne singly or in chain. The uredinia are generally

produced without peridium (most often uredo-type) or weakly developed peridium in some cases and produce echinulate, singly borne ureniniospores. Telia are with or without paraphyses, produce teliospores germinating externally (internally in some cases) by apical growth without dormancy. These rust fungi have both autoecious and heteroecious mode of life cycle.

Genera reported in India – *Cystopsora* (1), *Elateraceium* (1), *Hemileia* (10), *Zaghouania* (1); total 13 species

Host families – *Apocynaceae*, *Celastraceae*, *Oleaceae*, *Penaeaceae*, *Phyllanthaceae*, *Rubiaceae*.

Notes – Aime & McTaggart (2020) included 8 genera in this family, of which, four genera namely *Cystopsora*, *Elateraceium*, *Hemileia*, *Zaghouania* have been reported from India. The genus *Cystopsora* is now considered as synonym of *Zaghouania* (Aime & McTaggart 2020). The identity of Indian record *Cystopsora antidesmatis* T.S. Ramakr. & Sundaram is mainly based on morphological observations. DNA sequence based studies are required to provide its exact taxonomic position.

Figure 5 – Rust fungi *Puccinia* spp. A *Rubia cordifolia*. B *Clematis* sp. C *Berberis* sp. D *Clematis* sp. E *Oxalis* sp. F *Mentha* sp.

Figure 6 – Rust fungi *Uromyces* spp. A *Trifolium* sp. B *Geranium* sp. C *Rumex* sp.

Figure 7 – Uredinospores. A *Puccinia himachalensis* on *Clematis* sp. B *P. tiliaefolia* on *Grewia* sp. C *P. fagopyri* on *Fagopyrum* sp. D *P. menthae* on *Mentha* sp. E *P. Oxalidis* on *Oxalis* sp. F *P. flavipes* on *Duchesnea* sp. G *P. abrupta* on *Parthenium* sp. H *P. colletiana* on *Rubia* sp. I *Melampsora caprearum* on *Salix* sp. J *P. Nepalensis* on *Rumex* sp. K *Uredo* sp. on *Ehretia* sp. L *Melampsora populnea* on *Populus* sp. Scale Bar = 10µm.

Figure 8 – Teliospores of *Puccinia*. A *P. himachalensis* on *Clematis* sp. B *P. fagopyri* on *Fagopyrum* sp. C *P. tiliaefolia* on *Grewia* sp. D *P. agrostidis* on *Aquilegia* sp. E *P. Cynodontis* on *Cyanodon* sp. F *P. cynodontis* on *Cyanodon* sp. G *P. colletiana* on *Rubia* sp. H *P. colletiana* on *Rubia* sp. I *P. gouriana* on *Clematis* sp. Scale Bar = 10μm.

Excluded and replaced names of rust fungi in India

With the use of DNA sequence based techniques, the economically important rusts are relatively well explored, but not much attention has been paid to species infecting wild plants in general. The identification of most of the Indian rust fungi is largely based on morphological characters especially morphology of certain spore stages. Use of DNA sequence based studies along with morphotaxonomic characters has made identification and characterization of rust fungi more efficient and accurate. The names of many rust genera/species as reported in the cited publications have been replaced with new accepted names. Numbers of genera and species of Indian rust fungi have also been replaced with currently accepted name according to MycoBank (www.mycobank.org/) and Species Fungorum (www.speciesfungorum.org) websites and this is indicated in Table 3.

Figure 9 – Teliospores of rust fungi. A *Uromyces* on *Trifolium* sp. B *Uromyces* on *Rumex* sp. C *Uromyces* on *Geranium* sp. D *Ravenelia* on *Pongamia* sp. E *Skierka* on *Pistacia* sp. F *Kweilingia* on *Bamusa* sp. G *Phragmidium* on *Rosa* sp. H *Pileolaria* on *Pistacia* sp. I *Melampsora* on *Euphorbia* sp. Scale Bar = 10µm.

Table 3 Excluded and replaced names of rust fungi in India. (Index Fungorum 2020, Mycobank 2020)

Old Name	New Name
<i>Acervulopsora ichnocarpi</i> (Barclay) Thirum.	<i>Maravalia ichnocarpi</i> (Barclay) Sathe
<i>Aecidium acanthospermi</i> P.B. Chavan & Bakare	<i>Puccinia acanthospermi</i> Henn.
<i>Aecidium asterum</i> Schwein.	<i>Puccinia asterum</i> (Schwein.) F. Kern
<i>Aecidium barleriae</i> M.A. Salam & Ramachar	<i>Aecidium salamii</i> G.F. Laundon
<i>Aecidium berberidis</i> Pers. ex J.F. Gmel.	<i>Puccinia graminis</i> Pers.
<i>Aecidium cassiae</i> Bres.	<i>Endophyllum cassiae</i> (Bres.) F. Stevens & Mendiola
<i>Aecidium cunninghamianum</i> Barclay	<i>Roestelia cunninghamianum</i> (Barclay) F. Kern

Table 3 Continued.

Old Name	New Name
<i>Aecidium elaeagni-latifoliae</i> Petch	<i>Endophyllum elaeagni-latifoliae</i> (Petch) Gokhale, Thirum. & Patel
<i>Aecidium kaernbachii</i> Henn.	<i>Endophyllum kaernbachii</i> (Henn.) F. Stevens & Mendiola
<i>Aecidium leucospermum</i> DC.	<i>Ochropsora ariae</i> (Fuckel) Ramsb.
<i>Aecidium macowanianum</i> Thüm.	<i>Endophyllum macowanianum</i> (Thüm.) Pole-Evans
<i>Aecidium meliosmae-myrianthae</i> Henn. & Shirai	<i>Neophysopella meliosmae-myrianthae</i> (Henn. & Shirai) Jing X. Ji & Kakish.
<i>Aecidium patulum</i> Syd. & P. Syd.	<i>Roestelia patula</i> (Syd. & P. Syd.) F. Kern
<i>Aecidium plectranthi</i> Barclay	<i>Coleosporium plectranthi</i> (Barclay) Sacc.
<i>Aecidium ranunculacearum</i> DC.	<i>Uromyces dactylidis</i> G.H. Otth
<i>Angiopsora ampelopsidis</i> (Dietel & P. Syd.) Thirum. & F. Kern	<i>Neophysopella ampelopsidis</i> (Dietel & P. Syd.) Jing X. Ji & Kakish.
<i>Angiopsora elephantopodis</i> (Hirats.) Mundk. & Thirum.	<i>Phakopsora elephantopodis</i> Hirats.
<i>Angiopsora meliosmae</i> (Kusano) Thirum. & F. Kern	<i>Neophysopella meliosmae</i> (Kusano) Jing X. Ji & Kakish.
<i>Angiopsora vernoniae</i> T.S. Ramakr.	<i>Physopella vernoniae</i> (T.S. Ramakr.) Ramachar & Bhagyan.
<i>Bubakia cingens</i> (Syd. & P. Syd.) S. Ito	<i>Phakopsora cingens</i> (Syd. & P. Syd.) Hirats.
<i>Catenulopsora flacourtiae</i> Mundk. & Thirum.	<i>Kuehneola flacourtiae</i> (Mundk. & Thirum.) Thirum.
<i>Catenulopsora grewiae</i> Mundk. & Thirum.	<i>Kuehneola grewiae</i> (Mundk. & Thirum.) Thirum.
<i>Catenulopsora ziziphi</i> T.S. Ramakr. & Subram.	<i>Kuehneola ziziphi</i> (T.S. Ramakr. & Subram.) Thirum.
<i>Cerotelium fici</i> (Castagne) Arthur	<i>Puccinia fuirenicola</i> Arthur
<i>Chnoopsora butleri</i> Dietel, Syd. & P. Syd.	<i>Chrysocelis butleri</i> (Dietel, Syd. & P. Syd.) G.F. Laundon
<i>Chnoopsora sancti-johannis</i> (Barclay) Dietel	<i>Melampsora sancti-johannis</i> Barclay
<i>Cystopsora oleae</i> E.J. Butler	<i>Zaghouania oleae</i> (E.J. Butler) Cummins
<i>Dasturella divina</i> (Syd.) Mundk. & Khesw.	<i>Kweilingia divina</i> (Syd.) Buriticá
<i>Dasturella grewiae</i> (Pat. & Har.) Thirum.	<i>Uredopeltis chevalieri</i> J. Walker & R.G. Shivas
<i>Didymopsorella toddaliae</i> (Petch) Thirum.	<i>Skierka toddaliae</i> (Petch) Hirats.,
<i>Elateraecium divinum</i> (Syd.) Thirum., F. Kern & B.V. Patil	<i>Kweilingia divina</i> (Syd.) Buriticá
<i>Endophyllum tuberculatum</i> (Ellis & Kellerm.) Arthur & Fromme	<i>Puccinosira tuberculata</i> (Ellis & Kellerm.) Buriticá & J.F. Hennen
<i>Frommea obtusa</i> (F. Strauss) Arthur	<i>Phragmidium potentillae</i> (Pers.) P. Karst.
<i>Gymnosporangium distortum</i> Arthur & Cummins	<i>Roestelia distorta</i> (Arthur & Cummins) F. Kern
<i>Hamasporea benguetensis</i> Syd.	<i>Hamasporea rubi-sieboldii</i> (Kawagoe) Dietel
<i>Hemileia woodii</i> Kalchbr. & Cooke	<i>Puccinia woodii</i> (Kalchbr. & Cooke) P. Syd. & Syd.
<i>Jacksoniella holwayi</i> (H.S. Jacks.) Kamat & Sathe	<i>Phragmidiella holwayi</i> (H.S. Jacks.) Buriticá
<i>Kamatomyces narasimhanii</i> (Thirum.) Sathe	<i>Masseella narasimhanii</i> Thirum.
<i>Kuehneola aliena</i> (Syd., P. Syd. & E.J. Butler) P. Syd. & Syd. & E.J. Butler	<i>Phragmidiella aliena</i> (Syd., P. Syd. & E.J. Butler) Buriticá & J.F. Hennen
<i>Kuehneola trichosanthis</i> (Petch) T.S. Ramakr. & Sundaram	<i>Cerotelium trichosanthis</i> (Petch) Nag Raj, Govindu & Thirum.
<i>Kuehneola vitis</i> (E.J. Butler) P. Syd. & Syd.	<i>Chrysomyxa vitis</i> E.J. Butler
<i>Melampsora laricis-epitea</i> Kleb.	<i>Melampsora epitea</i> Thüm.
<i>Nyssopsora schefflerae</i> Ramachar, Bagyan., Subbal. & Hosag.	<i>Nyssopsora thwaitesii</i> (Berk. & Broome) Syd.
<i>Ochropsora sorbi</i> Dietel	<i>Ochropsora ariae</i> (Fuckel) Ramsb.
<i>Oplophora cedrelae</i> (Hori) Syd.	<i>Nyssopsora cedrelae</i> (Hori) Tranzschel
<i>Phakopsora apoda</i> (Har. & Pat.) Mains	<i>Angiopsora apoda</i> (Har. & Pat.) Aime & McTaggart.
<i>Phakopsora gossypii</i> (Lagerh.) Hirats. f.	<i>Phakopsora desmium</i> (Berk. & Broome) Cummins
<i>Phakopsora grewiae</i> (Pat. & Har.) Cummins	<i>Uredopeltis chevalieri</i> J. Walker & R.G. Shivas

Table 3 Continued.

Old Name	New Name
<i>Phakopsora tecta</i> H.S. Jacks. & Holw.	<i>Uromyces spegazzinii</i> (De Toni) Arthur
<i>Phakopsora vignae</i> (Bres.) Arthur	<i>Phakopsora pachyrhizi</i> Syd. & P. Syd.
<i>Phakopsora ampelopsidis</i> Dietel & P. Syd.	<i>Neophysopella ampelopsidis</i> (Dietel & P. Syd.) Jing X. Ji & Kakish.
<i>Phragmidium disciflorum</i> (Tode) J. James	<i>Phragmidium mucronatum</i> (Pers.) Schltdl.
<i>Phragmidium rubi</i> (Pers.) G. Winter	<i>Phragmidium bulbosum</i> (Fr.) Schltdl.
<i>Puccinia absinthii</i> DC.	<i>Puccinia chrysanthemi</i> Roze
<i>Puccinia abutili</i> Berk. & Broome	<i>Puccinia abutilonis</i> Berk. & Broome
<i>Puccinia allii</i> (DC.) F. Rudolphi	<i>Puccinia porri</i> (Sowerby) G. Winter
<i>Puccinia artemisiella</i> P. Syd. & Syd.	<i>Puccinia tanacetii</i> DC.
<i>Puccinia arthraxonis</i> (Henn.) Syd., P. Syd. & E.J. Butler	<i>Kuehneola loeseneriana</i> (Henn.) H.S. Jacks. & Holw.
<i>Puccinia bullata</i> (Pers.) J. Schröt.	<i>Puccinia angelicae</i> (Schumach.) Fuckel
<i>Puccinia calcitrapae</i> var. <i>centaureae</i> (DC.) Cummins	<i>Puccinia carthami</i> Corda
<i>Puccinia carduorum</i> Jacky	<i>Puccinia calcitrapae</i> DC.
<i>Puccinia caricis</i> Rebert.	<i>Puccinia dioicae</i> Magnus
<i>Puccinia coronata</i> f. <i>agrostidis</i> Erikss.	<i>Puccinia coronata</i> Corda
<i>Puccinia coronata</i> var. <i>himalensis</i> Barclay	<i>Puccinia coronata</i> Corda
<i>Puccinia dispersa</i> Erikss. & Henning	<i>Puccinia recondita</i> Roberge ex Desm.
<i>Puccinia epilobii-tetragoni</i> G. Winter	<i>Puccinia pulverulenta</i> Grev.
<i>Puccinia extensicola</i> Plowr.	<i>Puccinia dioicae</i> Magnus
<i>Puccinia glumarum</i> (J.C. Schmidt) Erikss. & Henning	<i>Puccinia striiformis</i> Westend.
<i>Puccinia graminis</i> var. <i>tritici</i> Erikss. & Henning	<i>Puccinia graminis</i> Pers.
<i>Puccinia himalensis</i> (Barclay) Dietel	<i>Chrysomyxa himalensis</i> Barclay
<i>Puccinia leptodermidis</i> (Barclay) Sacc.	<i>Coleosporium leptodermidis</i> (Barclay) P. Syd. & Syd.
<i>Puccinia levis</i> var. <i>panici-sanguinalis</i> (Rangel) Ramachar & Cummins	<i>Uromyces panici-sanguinalis</i> Rangel
<i>Puccinia lolii</i> E. Nielsen	<i>Puccinia coronata</i> Corda
<i>Puccinia lycoctoni</i> Fuckel	<i>Uromyces dactylidis</i> G.H. Oth
<i>Puccinia maydis</i> Béranger	<i>Puccinia sorghi</i> Schwein.
<i>Puccinia obtegens</i> (Link) Tul.	<i>Puccinia suaveolens</i> (Pers.) Rostr.
<i>Puccinia orientalis</i> (Syd., P. Syd. & E.J. Butler) Arthur & Cummins	<i>Diorchidium orientale</i> Syd., P. Syd. & E.J. Butler
<i>Puccinia orientalis</i> (Syd., P. Syd. & E.J. Butler) Arthur & Cummins	<i>Diorchidium orientale</i> Syd., P. Syd. & E.J. Butler
<i>Puccinia penniseti</i> Zimm.	<i>Puccinia substriata</i> Ellis & Barthol.
<i>Puccinia persistens</i> Plowr.	<i>Puccinia recondita</i> Roberge ex Desm.
<i>Puccinia poae-nemoralis</i> G.H. Oth	<i>Puccinia brachypodii</i> G.H. Oth
<i>Puccinia polygoni</i> Alb. & Schwein.	<i>Puccinia polygoni-amphibii</i> Pers.
<i>Puccinia prunicolor</i> Syd., P. Syd. & E.J. Butler	<i>Puccinia purpurea</i> Cooke
<i>Puccinia pruni-persicae</i> Hori	<i>Leucotelium pruni-persicae</i> (Hori) Tranzschel
<i>Puccinia pruni-spinosae</i> Pers.	<i>Tranzschelia pruni-spinosae</i> (Pers.) Dietel
<i>Puccinia pulsatillae</i> Kalchbr.	<i>Puccinia ustalis</i> Berk.
<i>Puccinia punctiformis</i> (F. Strauss) Röhl.	<i>Puccinia suaveolens</i> (Pers.) Rostr.
<i>Puccinia rubigo-vera</i> var. <i>tritici</i> (Erikss.) Carleton	<i>Puccinia striiformis</i> Westend.
<i>Puccinia rubigo-vera</i> (DC.) G. Winter	<i>Puccinia recondita</i> Roberge ex Desm.
<i>Puccinia saxifragae-micranthae</i> Barclay	<i>Puccinia heucherae</i> (Schwein.) Dietel
<i>Puccinia substriata</i> var. <i>indica</i> Ramachar & Cummins	<i>Puccinia substriata</i> Ellis & Barthol.
<i>Puccinia substriata</i> var. <i>penicillariae</i> (Speg.) Ramachar & Cummins	<i>Puccinia substriata</i> Ellis & Barthol.
<i>Puccinia taraxaci</i> Plowr.	<i>Puccinia hieracii</i> (Röhl.) H. Mart.
<i>Puccinia tricholaenae</i> (Syd. & P. Syd.) T.S. Ramakr. & K. Ramakr.	<i>Diorchidium tricholaenae</i> Syd. & P. Syd.
<i>Puccinia triticina</i> Erikss.	<i>Puccinia recondita</i> Roberge ex Desm.

Table 3 Continued.

Old Name	New Name
<i>Puccinia anomala</i> Rostr.	<i>Puccinia hordei</i> G.H. Otth
<i>Puccinia anthistiriae</i> Barclay	<i>Puccinia graminis</i> Pers.
<i>Puccinia baryi</i> (Berk. & Broome) G. Winter	<i>Puccinia brachypodii</i> G.H. Otth
<i>Puccinia brizae-maximae</i> T.S. Ramakr.	<i>Puccinia graminis</i> Pers.
<i>Puccinia bupleuri-falcati</i> (DC.) G. Winter	<i>Puccinia bupleuri</i> F. Rudolphi
<i>Puccinia cichorii</i> Bellynck ex J. Kickx f.	<i>Puccinia hieracii</i> (Röhl.) H. Mart.
<i>Ravenelia berkeleyi</i> Mundk. & Thirum.	<i>Ravenelia cassicola</i> G.F. Atk.
<i>Ravenelia breyniae</i> Syd. & P. Syd.	<i>Kernkampella breyniae</i> (Syd. & P. Syd.) Rajendren
<i>Ravenelia breyniae-patentis</i> Mundk. & Thirum.	<i>Kernkampella breyniae-patentis</i> (Mundk. & Thirum.) Rajendren
<i>Ravenelia emblicae</i> Syd. & P. Syd.	<i>Kernkampella emblicae</i> (Syd. & P. Syd.) G.F. Laundon
<i>Ravenelia evernia</i> Syd.	<i>Ravenelia fragrans</i> Long
<i>Ravenelia kirkaneliae</i> Mundk. & Thirum.	<i>Kernkampella kirkaneliae</i> (Mundk. & Thirum.) G.F. Laundon
<i>Ravenelia phyllanthi</i> Mundk. & Thirum.	<i>Kernkampella phyllanthi</i> (Mundk. & Thirum.) G.F. Laundon
<i>Scopella aulica</i> (Syd.) Mundk. & Thirum.	<i>Maravalia aulica</i> (Syd.) Y. Ono
<i>Scopella echinulata</i> (Niessl) Mains	<i>Maravalia echinulata</i> (Niessl ex Rabenh.) Y. Ono
<i>Scopella fici</i> Mundk. & Thirum.	<i>Maravalia fici</i> (Mundk. & Thirum.) Y. Ono
<i>Scopella gentilis</i> (Syd.) Mundk. & Thirum.	<i>Maravalia gentilis</i> (Syd.) Y. Ono
<i>Scopella mimusops</i> (Cooke) Cummins	<i>Maravalia mimusops</i> (Cooke) Y. Ono
<i>Stakmania formosana</i> (Syd. & P. Syd.) Sathe	<i>Phakopsora formosana</i> Syd. & P. Syd.
<i>Teloconia rosae</i> (Kuntze) Syd.	<i>Phragmidium kamtschatkae</i> (H.W. Anderson) Arthur & Cummins
<i>Thekopsora gaultheriae</i> (Syd. & P. Syd.) P. Syd. & Syd.	<i>Pucciniastrum gaultheriae</i> Syd. & P. Syd.
<i>Trachyspora intrusa</i> (Grev.) Arthur	<i>Trachyspora alchemillae</i> (Pers.) Fuckel
<i>Tranzschelia punctata</i> Arthur	<i>Tranzschelia pruni-spinosae</i> (Pers.) Dietel
<i>Tunicopsora bagchii</i> Suj. Singh & P.C. Pandey	<i>Kweilingia bagchii</i> (Suj. Singh & P.C. Pandey) Buriticá
<i>Uredo artocarpi</i> Berk. & Broome	<i>Physopella artocarpi</i> (Berk. & Broome) Arthur
<i>Uredo bombacis</i> Petch	<i>Calidion bombacis</i> (Petch) D.J. Soares & R.W. Barreto
<i>Uredo callicarpae</i> Petch	<i>Uromyces callicarpae</i> (Petch) Fujik. ex S. Ito
<i>Uredo colebrookeae</i> Barclay	<i>Olivea colebrookeae</i> (Barclay) Thirum. & Yadav
<i>Uredo fici</i> Castagne	<i>Cerotelium fici</i> (Castagne) Arthur
<i>Uredo gaultheriae</i> (Syd. & P. Syd.) Hirats. f.	<i>Pucciniastrum gaultheriae</i> Syd. & P. Syd.
<i>Uredo ipomoeae</i> Yadav	<i>Coleosporium ipomoeae</i> (Schwein.) Burrill
<i>Uredo plumeriae</i> Pravena, Nasheema & Balakrishna	<i>Coleosporium plumeriae</i> Pat.
<i>Uredo tephrosiicola</i> Henn.	<i>Ravenelia tephrosiicola</i> (Henn.) Hirats. f.
<i>Uredo ziziphi</i> Pat.	<i>Macabuna ziziphi</i> (Pat.) Buriticá & J.F. Hennen
<i>Uredopeltis boswelliae</i> (Patel, Payak & N.B. Kulk.) Sathe	<i>Dasturella boswelliae</i> Patel, Payak & N.B. Kulk.
<i>Uredopeltis boswelliae</i> (Patel, Payak & N.B. Kulk.) Sathe	<i>Dasturella boswelliae</i> Patel, Payak & N.B. Kulk.
<i>Uromyces fabae</i> (Pers.) de Bary	<i>Uromyces viciae-fabae</i> (Pers.) J. Schröt.
<i>Uromyces leptodermus</i> Syd. & P. Syd.	<i>Uromyces setariae-italicae</i> Yoshino
<i>Uromyces linearis</i> Berk. & Broome	<i>Puccinia peradeniyae</i> Demers & Castl.
<i>Uromyces lycoctoni</i> (Kalchbr.) Trotter	<i>Uromyces dactylidis</i> G.H. Otth
<i>Uromyces phaseoli</i> G. Winter	<i>Uromyces appendiculatus</i> (Pers.) Link
<i>Uromyces pisi</i> (DC.) G.H. Otth	<i>Uromyces pisi-sativi</i> (Pers.) Liro
<i>Uromyces scillarum</i> (Grev.) G. Winter	<i>Uromyces muscari</i> (Duby) Niessl
<i>Uromyces scirpi</i> Burrill	<i>Uromyces lineolatus</i> (Desm.) J. Schröt.
<i>Uromyces sojae</i> (Henn.) Syd. & P. Syd.	<i>Phakopsora pachyrhizi</i> Syd. & P. Syd.
<i>Xenostele indica</i> Thirum.	<i>Xenostele litseae</i> (Pat.) Syd. & P. Syd.

Discussion

This study provides an outline for rust fungi of India based on the literature. It provides complete information of Indian *Pucciniales* in one compilation as 69 genera and 640 species belonging to 16 families. Rust fungi are one of the extensively studied fungal groups of India, as evident from the number of researchers who have investigated these fungi since pre-independence. The outline presented in this study helps to better understand the taxonomy of Indian rust fungi. In addition to broadly studied fungal group of India, rust fungi possessed a broad host range and distribution too. As per earlier reports, rust fungi cause diseases on various plant hosts (Misra et al. 1975, Bisht & Srivastava 1990, Cummins & Hiratsuka 2003, Jiao et al. 2016). High relative humidity and dense forest cover might be the possible reasons to promote these rust fungi in these regions to cause diseases. The occurrence of 167 species of rust fungi belonging to 23 genera and 11 families on 170 plant species belonging to 52 families from Himachal Pradesh justified their diversity in this hilly state. Similarly, the broader host range from *Poaceae* with highest number of records followed by *Ranunculaceae*, *Rosaceae*, *Asteraceae*, *Polygonaceae*, *Fabaceae*, *Salicaceae*, *Acanthaceae*, *Lamiaceae*, *Pinnaceae*, *Apiaceae*, *Rubiaceae*, *Saxifragaceae*, *Cyperaceae*, *Euphorbiaceae*, *Berberidiaceae*, *Geraniaceae*, *Linaceae* and *Zinziberaceae* support a wide distribution of these fungi (Gautam & Avasthi 2019). The occurrence of 12 rust genera with 35 species belonging to 7 families on large number of herbaceous, shrubby plants including climbers, grass and trees also support the diversity and distribution of rust fungi in Himalayan regions (Singh & Palni 2011). However, these fungi are not only limited to hilly regions of India; Mohanan (2010) documented a total of 95 rust fungi belonging to 25 genera associated with 117 forest plant species belonging to 80 host genera under 43 host families from the Western Ghats regions of Kerala. Similarly, the checklist of the rust genus *Uromyces* was documented by Gautam & Avasthi (2017b), also support broad diversity of these fungi on wide-ranging host range.

Besides the diversity and distribution, rust fungi cause very devastating diseases on various agricultural crops in India. Wheat rusts caused by three species of *Puccinia* namely, stripe rust (by *P. striiformis* f. sp. *tritici* Westend.), stem rust (by *P. graminis* Pers. f. sp. *tritici* Eriks. & Henn.) and leaf rust (caused by *P. tritici* Eriks.) pose a threat to global wheat production. The detection of Ug99 led the global community to work together to combat this disease, re-emerged as a threat and the establishment of the Borlaug Global Rust Initiative (BGRI, earlier Global Rust Initiative) in September 9, 2005. Pathotyping of rust pathogens and their identification are some important steps being deployed by researchers to find out management strategies of rust diseases. Emphasis is laid on evaluation of germplasm for rust resistance and development of various rust resistance varieties through various breeding programmes. In comparison to other crops, wheat has achieved a record high production in India during the current century. The development of rust resistance varieties has also progressed which played a vital role in protecting wheat from any epidemic threat (Tomar et al. 2014). The ICAR scientists cracked the whole genome of *Puccinia tritici* which is now proving very helpful in understanding the nature of this wheat rust pathogen (Kiran et al. 2016). Similarly, about 22 varieties of wheat which are resistant to the deadly Ug99 fungal disease caused by *Puccinia graminis-tritici* are developed, of which, some of the varieties such as DBW 17, PBW 550, and Lok 1 are being cultivated in wheat-growing states in India (Bhardwaj et al. 2019).

Both morphological and molecular characterization of rust fungi is required to understand the natural classification and evolutionary relationship of rust fungi. Because with the difficulty of culturing of these fungi artificially, the success rate of culturing is also not so encouraging. The direct sequencing of rust fungi is also not so easy because of the isolation of DNA of other microbes associated with main rust pathogens. This may affect the quality and purity of DNA and ultimately the sequencing process and final identification. Due to all the above reasons, the information on molecular identification of Indian rust fungi is not adequate. Although a phylogeny of Indian rust fungi based on the sequence data of LSU and ITS available for corresponding rust fungi in GenBank (NCBI) is presented, the lack of molecular data for most of the rust fungi included requires the application of molecular techniques. Our phylogenetic studies based on LSU and ITS sequence data showed that few taxa of family *Pucciniaceae* include polyphetic taxa i.e. from *Puccinia* and

Uromyces. More studies are still required for the better understanding of their taxonomic placement at different levels. Hence, fresh collections are required to generate molecular data to understand their phylogenetic relationships. This study has set the foundation for the systematics and taxonomic studies of rust fungi in India at generic and species level.

Although 69 genera of Indian rust fungi were included in this study, very few of these are known to have DNA sequence data. Molecular studies of these fungi are still scanty and there is much scope for exploratory work on this fungal group. Due to the lack of molecular studies, many genera or species need to be recollected and epitypified, in order to place them in their correct taxonomic position. Some Indian rust fungi require much attention as there is confusion in their correct taxonomic placement. Therefore, future works are likely to focus on reassessing the samples of rust fungi reported from India on both morphological and molecular characterization. Emphasis should also be given on understanding the relationship between rust pathogens and host preference to elaborate this fungal group more precisely. In addition, a digital web based platform should be developed which help the researchers to identify Indian *Pucciniales* and to provide all information on their diversity, distribution and host association.

Acknowledgements

Authors are grateful to their respective organizations for providing the necessary laboratory facilities and valuable support during the study. We also thank the Anonymous reviewers for their helpful comments and suggestions.

References

- Agarwal GP, Nema KG, Beliram R. 1959 – Fungi causing plant diseases at Jabalpur (M.P.) – I. Proceedings of National Academy of Sciences (India) 29, 310–315.
- Agarwal GP, Sahni VP. 1964 – Fungi causing plant diseases at Jabalpur (M.P.). Mycopathologia et Mycologia Applicata 22, 245–247.
- Ahmad GU. 1981. – Studies from rusts from Nagaland and Arunachal Pradesh. Indian Phytopathology 34, 240–241.
- Ahmad S. 1941 – Higher fungi of Punjab plains -III. The *Gasteromycetes*. Journal of Indian Botanical Society 20, 135–143.
- Ahmad ST. 1977 – *Sehima nervosum* – a new host of *Puccinia versicolor*. Indian Phytopathology 3, 261.
- Ahmad ST, Singh S. 1969 – Addition to the wheat rust races in India-I. Race 12 & 61 of *Puccinia recondita* identified during 1966 – Indian Phytopathology 22, 524–525.
- Ahmad ST, Sinha VC, Mishra DP. 1969 – Addition to the wheat rust races in India. Race 14 & 38 of *Puccinia recondita* identified during 1965. Indian Phytopathology 22, 525–526.
- Aime M, Bell C, Wilson A. 2018 – Deconstructing the evolutionary complexity between rust fungi (*Pucciniales*) and their plant hosts. Studies of Mycology 89, 143–152.
- Aime MC. 2006 – Toward resolving family-level relationships in rust fungi (*Uredinales*). Mycoscience 47, 112–122.
- Aime MC, Matheny PB, Henk DA, Frieders EM et al. 2006 – An overview of the higher-level classification of *Pucciniomycotina* based on combined analyses of nuclear large and small subunit rDNA sequences. Mycologia 98, 896–905.
- Aime MC, McTaggart AR. 2020 – A higher-rank classification for rust fungi, with notes on genera. Fungal Systematics and Evolution 7, 21–47.
- Ajrekar SL. 1912 – The castor rust (*Melampsorella ricini* de Toni). Journal of Bombay Natural History Society 21, 1092–1095.
- Ajrekar SL. 1936 – India: New plant diseases in 1935. International Bulletin of Plant Protection 10, 122.
- Ajrekar SL, Tonapy BR. 1923 – A note on life history of *Uromyces aloes* (Cke) Magn. Journal of Indian Botanical Society 3, 267–269.

- Alaei H, De Backer M, Nuytinck J, Maes M et al. 2009 – Phylogenetic relationships of *Puccinia horiana* and other rust pathogens of *Chrysanthemum x morifolium* based on rDNA ITS sequence analysis. *Mycological Research* 113, 668–683.
- Alexopoulos CJ. 1962 – *Introductory Mycology*. New York: Wiley.
- Ali B, Sohail Y, Mumtaz AS. 2017 – Distribution of rust fungi (*Puccinia* and *Phragmidium*) and host plants in Pakistan. *Journal on New Biological Reports* 6, 27–32.
- Ananth KC, Chokanna NG. 1961 – A contribution to the knowledge of spore dispersal of *Hemileia vestatrix* by certain species of thrips occurring on *Coffea arabica* in South India. *Indian Coffee (Mon. Bulletin of Indian Coffee Bd.)* 25, 37–38.
- Anonymous. 1936 – Report of the tea scientific officer. United Planters Association South India pp. 131.
- Anonymous. 1950 – List of common names of Indian plant diseases. *Indian Journal of Agricultural Sciences* 20, 107–142.
- Anonymous. 1954 – Index of Fungi CMI 2(9), 165–181.
- Anonymous. 1959a – Eleventh annual report of research department of Coffee Board (1957–1958). *Bulletin of Indian Coffee Board Research Department* 11: 184 pp.
- Anonymous. 1959b – Mycology Branch. Forest Research Institute 1952–1953. pp 67–71.
- Arthur JC, Cummins GB. 1936a – Rusts of the North Western Himalayas. *Mycologia* 25, 397–406.
- Arthur JC, Cummins GB. 1936b – Philippine rust in Clemin's collection 1923–1926–II. *Philippine Journal of Science* 61, 468
- Arthur JC. 1917 – Relationship of the genus *Kuehneola*. *Bulletin of Torrey Botanical Club* 44, 501–511.
- Arthur JC. 1934 – *Manual of rusts in United States and Canada*, pp487, Fig XV 438, Lafayette, Indiana.
- Asthana RP. 1952 – Some observations on the incidences of *Uromyces cicer-arietini* on *Cicer arietinum*. *Nagpur Agruculture College Magazine* 31, 20A–20B.
- Bagchee KD. 1933 – Investigation on the infestation of *Peridermium himalayensis* Bachee on *Pinus latifolia* – II. *Cronarium himalayensis* n. sp. on *Swertia* sp. *Indian Forest Rec. Botanical Series* 18, 66.
- Bagchee KD. 1950a – A contribution to our knowledge of morphology, cytology and biology of Indian coniferous rust- II, observations on the *Cronatium ribicola* Fischer and *Peridermium indicum* Colley & Tayler on *Pinus excelsa* Wall in India with reference to their distributions, pathology, inoculation experiments and comparative morphology. *Indian Forest Rec. Botanical Series* 4, 1–41.
- Bagchee KD. 1950b – A contribution to our knowledge of morphology, cytology and biology of Indian coniferous rust -III, observations on the *Peridermium brevius* (Barel.) Sacc. (*Coleosporium barclayense* sp. nov. on *Senecio refinervis* DC) and *Melampsora oblonga* sp. nov. on needles of *Pinus excelsa* Wall. *Indian Forest Rec. Botanical Series* 4, 43–64.
- Bagchee KD. 1950c – Progress of forest pathology in India during quinquennium 1944-49. *Indian Forester* 76, 216–220.
- Bagchee KD, Singh U. 1960 – *Indian Forest records*, New Series 1: 199–348.
- Bagyanarayana G, Ravinder EJ, Ramesh P. 1998 – *Prospodium tirumalensis*, a new species from India. *Mycotaxon* 69, 473–476.
- Bagyanarayana G, Ravinder EJ. 1995 – Taxonomy of *Puccinia erebia* on *Clerodendrum (Verbenaceae)*. *Mycotaxon* 53, 433–435.
- Bahadur P, Sinha S. 1967 – Possibility of new collateral hosts for the rusts of gram. *Science and Culture* 53, 538–539.
- Bahekar VS. 1966 – Notes on some new fungi from India. *Mycopathologia et Mycologia Applicata* 30, 153–155.
- Baiswar P, Ngachan SV, Chandra S. 2014 – Identification of *Nyssopsora thwaitesii* on *Schefflera* in northeast India. *Australasian Plant Disease Notes* 9, 124.

- Bakshi BK, Reddy MAR, Puri YN, Singh S. 1972 – Survey of the diseases of important native and exotic forest trees in India. PL-480, report FRI Dehradun.
- Bakshi BK, Singh S. 1960 – A new genus in the plant rusts. *Canadian Journal of Botany* 38, 259–262.
- Bakshi BK, Singh S. 1961 – New and noteworthy records of some mildews and rusts of Indian trees. *Indian Forester* 87, 542–545.
- Bakshi BK, Singh S. 1972 – Susceptibility of exotic pine to *Cronartium himalayense*. *Indian Forester* 98, 239–240.
- Balasubramanian KA. 1973 – Green island in the rust infection of sorghum. *Current Science* 42, 44–441.
- Barclay A. 1890a – Description of new fungus *Aecidium esculentum* n. sp. on *Acacia eburnean* *Journal of Bombay Natural Society* 5, 161–165.
- Barclay A. 1890b – Descriptive list of *Uredineae* occurring in neighbourhood of Simla (Western Himalaya). *Journal of Asiatic Society of Bengal* 1887 II. *ibid* 58, 232–251, 1889 *ibid*. 59, 75–112.
- Barclay A. 1890c – On some rusts and mildews of India. *Journal of Botany* 28, 257–261.
- Barclay A. 1890d – On the history of a Himalayan *Gymnosporangium* (*G. cunninghamianum* n.sp.). *Scientific Memories by Medical Officers of Army of India* 5, 71–78.
- Barclay A. 1890e – On the life history of *Puccinia gerani-sylvatici* Karst. var. *himalensis*. *Linnaeus Botany* 5, 27–36.
- Barclay A. 1890f – On the life history of *Uredineae* on *Rubia cordifolia* nov.sp. *Scientific Memories by Medical Officers of Army of India* 5, 87–91.
- Barclay A. 1891 – Additional *Uredineae* from the neighbourhood of Simla. *Journal of Asiatic Society of Bengal* 60, 211–230.
- Basuchaudhary KC, Singh UP. 1971 – A sclerotial disease of *Cynodon dactylon* from India. *Indian Phytopathology* 24, 820–821.
- Bauer R, Begerow D, Sampaio JP, Weiss M, Oberwinkler F. 2006 – The simple-septate basidiomycetes: a synopsis. *Mycological Progress* 5, 41–66.
- Beenken L. 2014 – *Pucciniales* on *Annona* (*Annonaceae*) with special focus on the genus *Phakopsora*. *Mycological Progress* 13, 791–809.
- Beenken L, Berndt R. 2010 – Rust fungi on *Annonaceae*: the genus *Sphaerophragmium*. *Mycologia*, 102(3), 650–663.
- Beenken L, Lutz M, Scholler M. 2017 – DNA barcoding and phylogenetic analyses of the genus *Coleosporium* (*Pucciniales*) reveal that the North American goldenrod rust *C. solidaginis* is a neomycete on introduced and native *Solidago* species in Europe. *Mycological Progress* 16, 1073–1085.
- Behera N, Mukerji KG. 1974 – Fungi of Delhi-XXV. *Norway Journal of Botany* 21, 1–3.
- Berkeley MJ. 1839 – Description of exotic fungi in the collection of Sir W.J. Hooker from memoirs and notes of J.F. Klotzsch with additions and corrections. *Annals of Natural History* 3, 375–401.
- Berkeley MJ. 1856 – Decades of fungi, Decas 1-62 Nos. 1-620 In: Hooker's London. *Journal of Botany* 3–8, 1844–1856.
- Berlin A, Djurle A, Samils B, Yuen J. 2012 – Genetic variation in *Puccinia graminis* collected from oats, rye, and barberry. *Phytopathology* 102, 1006–1012.
- Bhagat SD, Kelkar PV. 1974 – Report of *Endogone microcarpus* Tul. from Maharashtra, India. *Maharashtra Vigyan Mandir Patrika* 9, 123–124.
- Bhagyanarayana G, Ramachar P. 1985 – Spermatogonial and aecial stages of *Kernkampella kiragnelliae*. *Transactions of the British Mycological Society* 84, 171–173.
- Bhagyanarayana G, Rao KN. 1995 – A new species of *Kuehneola* on *Gymnosporia montana* from India. *Canadian Journal of Botany* 63, 762–764.
- Bhardwaj SC, Singh GP, Gangwar OP, Prasad P, Kumar S. 2019 – Status of wheat rust research and progress in rust Management-Indian context. *Agronomy* 9, 892.

- Bhattacharya B, Baruah HK. 1953 – Fungi of Assam. Journal of University of Gauhati 4, 287–312.
- Bisht GS, Srivastava SL. 1990 – Fungal diseases of some important crop plants grown in Garhwal Himalaya. In: Microbial Activity in the Himalaya, Almora (ed. Khulbe R.D.). pp. 141–153.
- Blomquist CL, Scheck HJ, Haynes J, Woods PW, Bischoff J. 2014 – First published report of rust on white alder caused by *Melampsoridium hiratsukanum* in the United States. Plant Disease 98, 155.
- Bruckart WL, Eskandari FM, Berner DK, Aime MC. 2010 – Life cycle of *Puccinia acroptili* on *Rhaponticum* (= *Acroptilon*) *repens*. Mycologia 102, 62–68.
- Bubner B, Buchheit R, Friedrich F, Kummer V, Scholler M. 2019 – Species identification of European forest pathogens of the genus *Milesina* (*Pucciniales*) using urediniospore morphology and molecular barcoding including *M. woodwardiana* sp. nov. MycoKeys 48, 1–40.
- Butler EJ. 1905 – Pilzkrankheiten in Indian in Jahre 1903. Zeitsch.fur Pflanzenke 15, 44–48.
- Butler EJ. 1906 – Some Indian forest fungi. Indian Forester 31, 487–496, 548–556, 611–617.
- Butler EJ. 1910 – A new genus of *Uridinaceae*. Annals of Mycology 8, 444–448.
- Butler EJ. 1912 – The rust of wildvines in India. Annals of Mycology 10, 153–58.
- Butler EJ. 1914 – Notes on some rusts in India. Annals of Mycology 12, 76–82.
- Butler EJ. 1918 – Fungi and diseases in plants. Thacker Spink & Co, Culcutta VI, pp547.
- Butler EJ, Bisby GR. 1931 – The fungi of India. Imperial Council of Agricultural Research of India. Science Monograph I. XVIII, 1- 237pp.
- Butler EJ, Bisby GR. 1960 – The Fungi of India. ICAR Publications New Delhi, India.
- Butler EJ, Hayman JM. 1906 – Indian wheat rusts. Mem. Department of Agriculture of India 1: p58.
- Champion HG. 1922 – Notes on the death of chir (*Pinus longifolia*) poles in Almora plantations of Kashmir. Indian Forester 48, 168–174.
- Chaudhari S. 1958 – Notes on fungi of Assam. Lloydia 21, 115–116.
- Chavan PB. 1968 – Critical notes on rust fungi of Maharashtra, India. Sydowia 22, 292–294.
- Chavan PB. 1975 – Critical notes on rust fungi of Maharashtra, India. Maharashtra Vigyan Mandir Patrika 10, 23–26.
- Chavan PB, Bakare VB. 1973a – New rust from India. Maharashtra Vigyan Mandir Patrika 8, 36–43.
- Chavan PB, Bakare VB. 1973b – New rust from India. Maharashtra Vigyan Mandir Patrika 9, 132–139.
- Chavan PB, Bakare VB. 1974 – Some rust from Maharashtra. Indian Phytopathology 27, 266.
- Chavan PB, Bakare VB. 1977 – Critical notes on rust fungi of western Maharashtra, India. Botanique 8, 137–140.
- Chavan PB, Bhambure GB. 1975 – A rust on groundnut (*Arachis hypogaea* L.) from Maharashtra state, India. Maharashtra Vigyan Mandir Patrika 10, 1–2.
- Chavan PB, Patil SK. 1972 – Studies in some rust fungi from India. Sydowia 26, 277–281.
- Choi IY, Choi YJ, Kim JY, Shin HD. 2019 – Identification of *Puccinia iridis*, the rust fungus in general debt. The Korean Journal of Mycology 47, 89–94.
- Chona BL, Lall G, Kakria NC. 1958 – The fungi of Delhi, ICAR Bulletin no.81, pp43.
- Chona BL, Munjal RL, Kapoor JN. 1956 – Notes on the miscellaneous fungi – III. Indian Phytopathology 9, 125–132.
- Chona BL, Munjal RL. 1950 – *Puccinia kuehnii* (Krueg.) Butler on sugarcane in India. Current Science 19, 151–152.
- Chona BL, Munjal RL. 1955 – Notes on the miscellaneous fungi – II. Indian Phytopathology 8, 184–198.
- Chona BL, Munjal RL. 1956 – Notes on the miscellaneous fungi – III. Indian Phytopathology 9, 53–56.
- Chowdhary S. 1948 – Some fungi from Assam – III. Indian Journal of Agriculture Sciences 18, 177–184.

- Chung WH, Tsukiboshi T, Ono Y, Kakishima M. 2004 – Phylogenetic analyses of *Uromyces viciae-fabae* and its varieties on *Vicia*, *Lathyrus*, and *Pisum* in Japan. *Mycoscience* 45, 1–8.
- Cooke MC. 1876a – Some Indian fungi. *Grevillea* 4, 114–118.
- Cooke MC. 1876b – Some Indian fungi. *Grevillea* 5, 14–17.
- Cooke MC. 1877 – Some parasites of Coniferae. *Indian Forester* 43, 88–96.
- Cooke MC. 1878a – Some Himalayan fungi. *Grevillea* 7, 61.
- Cooke MC. 1878b – Some Indian fungi. *Grevillea* 6, 117–118.
- Cooke MC. 1879 – Some exotic fungi. *Grevillea* 7, 94–96.
- Cooke MC. 1880a – Fungi of India. *Grevillea* 8, 93–96.
- Cooke MC. 1880b – The genus *Ravenelia*. *Journal of Royal Microscopic Society* 3, 384–389.
- Crane PE, Hiratsuka Y, Currah RS. 2000 – Reproductive biology and evidence for water dispersal of teliospores in *Chrysomyxa weirii*, a microcyclic spruce needle rust. *Mycologia* 92, 745–763.
- Cummins GB. 1943 – *Uredinales* from North Western Himalayas. *Mycologia* 35, 446–458.
- Cummins GB. 1950 – The *Scopella* of the *Uredinales*. *Bulletin of Torrey Botanical Club* 77, 204–213.
- Cummins GB. 1953 – The species of *Puccinia* parasitic on *Andropogonaceae*. *Uredineana* 4, 5–90.
- Cunningham GH. 1931 – The rust fungi of New Zealand, together with the biology, cytology and therapeutics of the *Uredinales*. John McIndoe, NZ.
- Cummins GB, Hiratsuka Y. 1983 – Illustrated genera of rust fungi. 1–152.
- Cummins GB, Hiratsuka Y. 2003 – Illustrated Genera of Rust Fungi. 3rd edition. American Psychopathological Society, St. Paul, Minnesota, US.
- Dalela GG. 1956 – *Puccinia tumidepes* Peck. on *Lycium europaeum* L. *Indian Phytopathology* 9, 74–75.
- Dalela GG, Sinha S. 1964 – Experiments on physiologic specialization on *Puccinia penniseti* Zimm. *Indian Phytopathology* 17, 61–65.
- Damle VP. 1943 – A new species of *Cystopus* on *Evolvulus alsinoides* L. *Journal of Indian Botanical Society* 22, 133–136.
- Darr GN, Shah AM. 1980 – Three new additions to Indian fungi. *Indian Phytopathology* 33, 608–609.
- Deadman ML, Al Sadi AM, Al Jahdhami S, Aime MC. 2005 – First report of rust caused by *Puccinia carthami* on safflower in Oman. *Plant Disease* 89, 208.
- Deadman ML, Al Sadi AM, Al Maqbali YM, Farr DF, Aime MC. 2011 – Additions to the rust fungi (*Pucciniales*) from northern Oman. *Sydowia* 63, 155–168.
- Deadman ML, Maqbali YA, Subhi AA, Yahyai RA et al. 2007 – First report of rust caused by *Tranzschelia discolor* on peach in Oman. *Plant Disease* 91, 638.
- Demers JE, Liu M, Hambleton S, Castlebury LA. 2017 – Rust fungi on *Panicum*. *Mycologia* 109, 1–17.
- Deoraj SD. 1980 – *Puccinia xanthi* on *Xanthium strumarium* in India. *Indian Phytopathology* 33, 483–484.
- Dervis S, Dixon L, Doğanlar M, Rossman A. 2010 – Gall production on hawthorns caused by *Gymnosporangium* spp. in Hatay province, Turkey. *Phytoparasitica* 38, 391–400.
- Dewan BB, Kar AK. 1974 – Fungi of Eastern Himalaya (India). *Nova Hedwigia* 25, 225–227.
- Dietel P. 1890 – Uredineen aus dem Himalaya. *Hedwigia* 29, 259–270.
- Dietel P. 1928 – Hemibasidii (*Ustilaginales* und *Uredinales*). An Engler, K Prantl: Die natürlichen Pflanzenfamilien, Germany.
- Dixon LJ, Castlebury LA, Aime MC, Glynn NC, Comstock JC. 2010 – Phylogenetic relationships of Sugarcane rust fungi. *Mycological Progress* 9, 459–468.
Doi 10.3390/agronomy9120892
- Dube HD. 1958 – Some new hosts of rust fungi from India. *Indian Phytopathology* 11, 79–81.
- Dube VP, Charya MU, Khurana S, Tyagi S. 1979 – New host records for two species of *Uromyces*. *Indian Phytopathology* 32, 154–155.

- Dubhash PK, Singh PN. 1977 – Phytopathogenic fungi of Meerut, some new records. *Current Science* 46, 168.
- Duplessis S, Cuomo CA, Lin YC, Aerts A et al. 2011 – Obligate biotrophy features unraveled by the genomic analysis of rust fungi. *Proceedings of the National Academy of Sciences* 108, 9166–1971.
- Ebinghaus M, Maier W, Wingfield MJ, Begerow D. 2018 – New host associations and a novel species for the gall-inducing acacia rust genus *Ravenelia* in South Africa. *Mycologia* 110, 1–21.
- Ebinghaus M, Wingfield MJ, Begerow D, Maier W. 2020 – The genus *Ravenelia* (*Pucciniales*) in South Africa. *Mycological Progress* 19, 259–290.
- Engkhaninun J, Ono Y, Kakishima M. 2005 – Phylogenetic relationships of four *Puccinia* species parasitic on *Artemisia* in Japan. *Mycoscience* 46, 61–65.
- Feau N, Vialle A, Allaire M, Maier W, Hamelin RC. 2011 – DNA barcoding in the rust genus *Chrysomyxa* and its implications for the phylogeny of the genus. *Mycologia* 103, 1250–66.
- Feau N, Vialle A, Allaire M, Tanguay P et al. 2009 – Fungal pathogen (mis-) identifications: a case study with DNA barcodes on *Melampsora* rusts of aspen and white poplar. *Mycological Research* 113, 713–724.
- Fernandez JL, Alvarado P. 2016 – First DNA sequences of *Gymnosporangium amelanchieris* and *G. gracile*. *Boletín de la Sociedad Micológica de Madrid* 40, 105–119.
- Fleming J. 1874 – On some microscopic leaf fungi from the Himalayas. *Microbiology Journal* 12, 270–274.
- Frederick RD, Snyder CL, Peterson GL, Bonde MR. 2002 – Polymerase chain reaction assays for the detection and discrimination of the Soybean rust pathogens *Phakopsora pachyrhizi* and *P. meibomia*. *Phytopathology* 92, 217–227.
- Ganguly D, Pandotra VR. 1962 – Some of the commonly occurring diseases of important medicinal and aromatic plants of Jammu and Kashmir. *Indian Phytopathology* 15, 50–54.
- Ganguly D, Pandotra VR. 1963 – Fungi of medicinal and aromatic plants of North Western Himalayas – I. *Mycopathologia et Mycologia Applicata* 20, 39–40.
- Gautam AK, Avasthi S. 2016a – First checklist of rust fungi in the genus *Puccinia* from Himachal Pradesh, India. *Plant Pathology & Quarantine* 6, 106–120.
- Gautam AK, Avasthi S. 2016b – *Puccinia himachalensis* – a new rust fungus from Himachal Pradesh, India. *Plant Pathology & Quarantine* 6, 220–223.
- Gautam AK, Avasthi S. 2017a – Discovery of *Puccinia tiliaefolia* (*Pucciniales*) in northwestern Himalayas, India. *Polish Botanical Journal* 62, 135–137.
- Gautam AK, Avasthi S. 2017b – *Uromyces trifolii*, a new addition to rust fungi of Himachal Pradesh, India with a checklist of *Uromyces* in India. *Plant Pathology & Quarantine* 7, 1–14.
- Gautam AK, Avasthi S. 2017c – Fungi associated with *Pistacia integerrima* with a description of a new species and one new record from India. *Acta Mycologica* 52, 1100.
- Gautam AK, Avasthi S. 2018 – A new record to rust fungi of North Western Himalayas (Himachal Pradesh), India. *Studies in Fungi* 3, 234–240.
- Gautam AK, Avasthi S. 2019 – A checklist of rust fungi from Himachal Pradesh, India. *Journal of Threatened Taxa* 11, 14845–14861.
- Gerdemann JW, Bakshi BK. 1976 – Endogonaceae of India, two new species. *Transactions of the British Mycological Society* 66, 340–342.
- Gharse PS. 1944 – Life history and morphology of *Trochodinium ajreki* Gharse. sp. nov. *Journal of Indian Botanical Society* 17, 141–148.
- Glynn NC, Dixon LJ, Castlebury LA, Szabo LJ, Comstock JC. 2010 – PCR assays for the sugarcane rust pathogens *Puccinia kuehnii* and *P. melanocephala* and detection of a SNP associated with geographical distribution in *P. kuehnii*. *Plant Pathology* 59, 703–711.
- Gokhle VP, Patel MK. 1951 – *Kulkarniella* – a new genus of rust. *Indian Phytopathology* 2, 170–173.
- Gokhle VP, Patel MK. 1953 – A new species of *Arthuria*. *Current Science* 22, 246.

- Gokhle VP, Thirumalachar MJ, Patel MK. 1955 – *Endophyllum* sp. on *Elaeagnus latifolia*. Current Science 22, 46.
- Gopinathnair KR. 1972 – *Puccinia deodikarii* sp. nov. from India, *Uredinales*. Current Science 41, 575–576.
- Goswami RN, Bhattacharjee S. 1973 – Rust, a new disease of Tejpat. Current Science 42, 257.
- Goswami RN, Singh KL. 1973 – *Uredinales* of North East India. Indian Phytopathology 23, 310–314.
- Goswami RN. 1972 – Occurrence of *Aecidium vernoniae-cinereae* Patch in India. Current Science 41, 616.
- Goswami RN. 1974 – Rust, a new menace to groundnut in North East India. Indian Phytopathology 27, 238.
- Goyal JP, Desai BG, Bhatnagar LG, Pathak VN. 1971 – Fungal collections from Rajasthan state of India. Sydowia 25, 172–175.
- Gupta BK, Gupta C. 1985 – Some new fungi from Uttar Pradesh. Indian Phytopathology 38, 576.
- Gupta SC. 1977 – A new disease of sugarcane in UP, India. Current Science 46, 27.
- Gupta SL, Shukla TH. 1955 – Mycoflora Kanpurensis – I. Knapur Agriculture College Journal 14, 66–72.
- Hafeezkhan A. 1928a – A preliminary report on the *Peridermiums* of India and the occurrence of *Cronartium ribicola* Fisch. on *Rubrum* Linn. Indian Forester 54, 431–443.
- Hafeezkhan A. 1928b – Inoculation of Chir (*Pinus longifolia*) with *Coleosporium companulae* (Pers.) Lev. on *Companula canescens* Wall. and *Coleosporium inulae* (Kunze) Ed. Fisch. on *Inula cappa* DC. Indian Forester 54, 176–178.
- Hall TA. 1999 – BioEdit: a user-friendly biological sequence alignment editor and analysis program for Windows 95/98/NT. Nucleic Acids Symposium Series 41, 95–98.
- He MQ, Zhao RL, Hyde KD, Begerow D et al. 2019 – Notes, outline and divergence times of Basidiomycota. Fungal Diversity 1–263.
- Hennings P. 1900 – Einige Uredineen aus Verschiedenen Gebieten. Hedwigia 39, 153–155.
- Henricot B, Denton G, Lane C. 2007 – First report of *Puccinia heucherae* on *Heuchera* spp. in the UK. Plant Pathology 56, 352–352.
- Hiratsuka Y, Cummins GB. 1963 – Morphology of the spermogonia of the rust fungi. Mycologia 55, 487–507.
- Hiratsuka Y. 1983 – The nuclear cycle and terminology of spore states in *Uredinales*. Mycologia 65, 432–443.
- Hosagaudar VB. 1984 – A new rust of *Elaeocarpus tuberculatus* Roxb. from Iduki, Kerala, India. Current Science 53, 106–107.
- Hosagaudar VB. 1985 – *Teleomycetes* of South India. Indian Phytopathology 39, 278–281.
- Hrabetova M, Kolarik M, Markova J. 2015 – Phylogeny and taxonomy of grass rusts with aecia on *Ranunculus* and *Ficaria*. Mycological Progress 14, 12.
- Ishaq A, Aime MC, Ayala EK, Ullah S et al. 2020 – First report of Asian pistachio rust (*Pileolaria pistaciae*) in Pakistan. Canadian Journal of Plant Pathology 42, 210–217.
- Jadhav AN, Somani RB. 1978a – *Puccinia xanthi* – a report from India. Indian Phytopathology 31, 369–371.
- Jadhav AN, Somani RB. 1978b – *Puccinia xanthi* Schev. a first report from India. Current Science 47, 905.
- Jain AC, Nikam BG, Kulkarni SN, Sharma OP. 1966 – Fungi of Gwalior and Indore region. The Vikram 4, 181–187.
- Jhoothy JS, Sokhi SS, Bain SS, Rewal HS. 1977 – New diseases of some hosts of economic importance. India Journal of Mycology and Plant pathology 7, 162.
- Jiao W, Guoying Z, Shengsong S, Yuanhao H et al. 2016 – Identification of pathogens of the *Dalbergia tonkinensis* rust disease. Scientia Silvae Sinicae 52, 165–169.
- Jin Y, Szabo LJ, Carson M. 2010 – Century-old mystery of *Puccinia striiformis* life history solved with the identification of *Berberis* as an alternate host. Phytopathology 100, 432–435.

- Joshi LM, Lele VC. 1984 – Role of *Vulpia myuros* and *Briza minor* in the perpetuation of black rust of oats in the Nilgiri hills. *Indian Phytopathology* 17, 245–248.
- Joshi LM, Merchand WC. 1963 – *Bromus japonicas* Thumb. susceptible to wheat rust under natural conditions. *Indian Phytopathology* 16, 312.
- Joshi LM, Payak MM. 1963 – *Berberis Aecidium* in Lahul Valley, Western Himalayas. *Mycologia* 55, 247–249.
- Joshi LM, Reddy AR. 1958 – Taxonomic studies on *Uromyces* of *indigoferae* species in India. *Indian Phytopathology* 11, 59–61.
- Joshi LM, Reddy AR. 1959 – Some observations on *Uromyces indigoferae* Diet. & Holw. the rust of *Indigofera liniolla* Retz. *Indian Phytopathology* 12, 25–28.
- Joshi NC, Vashiist KPT. 1959 – Fungi of Ajmer (Rajasthan) – IV. *Proceedings of National Academy of Sciences India* 28(B), 147–150.
- Joshi NC. 1958 – Fungi of Ajmer (Rajasthan) – III. *Proceedings of National Academy of Sciences India* 28(B), 303–307.
- Kaitera J, Hiltunen R, Kauppila T, Hantula J. 2017 – Five plant families support natural sporulation of *Cronartium ribicola* and *C. flaccidum* in Finland. *European Journal of Plant Pathology* 149, 367–383.
- Kala SP, Gaur RD. 1983a – Some new hosts and fungal record from India. *Indian Phytopathology* 36, 370–371.
- Kala SP, Gaur RD. 1983b – Some new records of rust pathogens from Chamoli, Garhwal. *Indian Phytopathology* 36, 757–758.
- Kamal, Singh RP. 1981 – Fungi of Gorakhpur – XXVII. *Indian Journal of Mycology and Plant Pathology* 11, 1–4.
- Kamal, Singh S, Singh RP. 1979 – Fungi of Gorakhpur- IX. *Indian Journal of Mycology and Plant Pathology* 9, 245–246.
- Kamil D, Sharma RK, Maheswari CU, Devi TP, Jain RK. 2013 – Checklist of *Puccinia* species. Division of Plant Pathology Indian Agricultural Research Institute New Delhi 110 012, India.
- Kanadswamy PA, Vijyalakshmi U. 1959 – *Puccinia erianthi* Padwick & Khan on cultivated sugarcane. *Current Science* 28, 209–210.
- Kanaujia RS, Kishore R. 1981 – Annotated list of fungi from Faizabaad-V. *Indian Journal of Mycology and Pathology* 11, 292–293.
- Kanaujia RS. 1978 – Annotated list of fungi from Faizabaad-III, Additions to the list of Indian fungi. *Indian Phytopathology* 30, 435–437.
- Kapoor JN, Agarwal DK. 1972— Indian species of *Ravenelia* on *Abrus* and *Albizia*. *Indian Phytopathology* 25, 551–554.
- Kapoor JN, Agarwal DK. 1974– Indian species of *Ravenelia*- I on *Acacia*. *Indian Phytopathology* 27, 666–669.
- Kapooria RG, Sinha S. 1966 – Studies on host range of *Uromyces fabae* (Pers.) de. Bary. *Indian Phytopathology* 19, 229–230.
- Katoh K, Standley DM. 2013 – MAFFT multiple sequence alignment software version 7: improvements in performance and usability. *Molecular Biology and Evolution* 30, 772–780.
- Kaul B. 1959a – A new host for *Melampsora heliscopiae* (Pers.) Went from Kashmir. *Science and Culture* 24, 573–574.
- Kaul TN. 1959b – Outbreaks of new records. *FAO Plant Port. Bulletin* 7, 54.
- Kern FD, Thurston HW. 1944 – Additions to the *Uredinales* of Venezuela. *Mycologia* 36, 507.
- Khanna KK, Chandra S. 1975 – A new disease of apple fruit. *Plant Disease Reporter* 59, 329–330.
- Khanna PK. 1961 – A new report of a new host of *Puccinia kanmorensis* Cummins from India. *Proceedings of National Academy of Sciences, India* pp. 113.
- Khosla HK, Puranik KK, Nema KG. 1975 – Occurrence of rust of groundnut (*Puccinia arachidis* Speg.) in Madhra Pradesh. *JNKVV Research Journal* 8(3/4), 292.
- Khulbe RD, Verma BL. 1978 – A new rust record of *Xanthium strumarium* L. *Journal of Maharashtra Agriculture University* 3, 143.

- Kijpornyongpan T, Mondo SJ, Barry K, Sandor L et al. 2018 – Broad genomic sampling reveals a smut pathogenic ancestry of the fungal clade *Ustilaginomycotina*. *Molecular Biology and Evolution* 35, 1840–1854.
- Kiran K, Rawal HC, Dubey H, Jaswal R et al. 2016 – Draft genome of the wheat rust pathogen (*Puccinia triticina*) unravels genome-wide structural variations during evolution. *Genome Biology and Evolution* 8, 2702–2721.
- Kirk PM, Cannon PF, David JC, Stalpers JA. 2001 – *Dictionary of the Fungi*, 9th edn. Wallingford, UK: CABI Publishing.
- Kirk PM, Cannon PF, Minter DW, Stalpers JA. 2008 – *Dictionary of the Fungi* (10th ed.): CAB International Wallingford, UK.
- Kolmer JA, Ordonez ME, Groth JV. 2009 – The Rust Fungi. In: *Encyclopedia of Life Sciences (ELS)*. John Wiley & Sons, Ltd: Chichester. Doi 10.1002/9780470015902.a0021264
- Kolte SJ, Awasthi RP. 1979 – Some observations on occurrence of groundnut rust in Nainital Tarai region of Uttar Pradesh. *Indian Phytopathology* 32, 155–156.
- Konger G, Baruah HK. 1958 – The incidence of air borne spores in the potato plantations of upper Shilong. *Journal of University of Gauhati* 9, 81–89.
- Krishnamurthy CS, Rangaswamy G. 1947 – *Hemileia jasmine* Krishnamurthy & Rangaswamy sp. nov. on *Jasminium ritchiei* Clarke. *Current Science* 16, 31–33.
- Kumar K Garg SK, Ahmad ZU. 1975 – Additions to fungi of India. *Indian Journal of Mycology and Plant Pathology* 5, 107.
- Kwon JH, Kim J. 2014 – Asiatic dayflower rust caused by *Uromyces commelinae* and its phylogenetic analysis using rDNA Internal Transcribed Spacer Region. *Journal of Agriculture and Life Science* 48, 21–29.
- Laundon GF, Ponappa KM. 1966 – A new species of *Uredo* on *Hygrophila*. *Current Science* 35, 492–493.
- Lee SH, Lee CK, Cho SE, Shin HD. 2019 – First report of rust caused by *Puccinia oxalidis* on *Oxalis debilis* var. *corymbosa* in Korea. *Plant Disease* 103, Doi 10.1094/PDIS-05-18-0777-PDN
- Lele VC. 1952 – Indian wild linseed (*Linum mysorense* Heyne) a possible collateral host of the rust of the cultivated linseed (*Linum usitatissimum*) in the hills. *Indian Phytopathology* 5, 144–145.
- Liang YM, Tian CM, Kakishima M. 2006 – Phylogenetic relationships on 14 morphologically similar species of *Pucciniastrum* in Japan based on rDNA sequence data. *Mycoscience* 47, 137–144.
- Liu M, Hambleton S. 2013 – Laying the foundation for a taxonomic review of *Puccinia coronata* s.l. in a phylogenetic context. *Mycological Progress* 12, 63–89.
- Liu M, McCabe E, Chapados JT, Carey J et al. 2015 – Detection and identification of selected cereal rust pathogens by TaqMan real-time PCR. *Canadian Journal Plant Pathology* 37, 92–105.
- Liu M, Szabo LJ, Hambleton S, Anikster Y et al. 2013 – Molecular phylogenetic relationships of the brown leaf rust fungi on Wheat, Rye, and other grasses. *Plant Disease* 97, 1408–1417.
- Liu Y, Cao B, Tao S, Tian C, Liang Y. 2018 – *Phragmidium* species parasitizing species of *Rosaceae* in Tibet, China, with descriptions of three new species. *Mycological Progress* 17, 967–988.
- Lutz M, Bauer R, Begerow D, Oberwinkler F. 2004 – *Tuberculina* – *Thanatophytum/Rhizoctonia crocorum* – *Helicobasidium*: a unique mycoparasitic-phytoparasitic life strategy. *Mycological Research* 108, 227–238.
- Maheswari CU, Sharma RK, Kamil D, Devi TP. 2012 – *Herbarium Cryptogamae Indiae Orientalis (HCIO) catalogue of fungal specimens Volume 1*. Division of Plant Pathology Indian Agricultural Research Institute New Delhi 110 012, India.
- Maier W, Begerow D, Weiss M, Oberwinkler F. 2003 – Phylogeny of the rust fungi: an approach using nuclear large subunit ribosomal DNA sequences. *Canadian Journal of Botany* 81, 12–23.
- Maier W, McTaggart AR, Roux J, Wingfield MJ. 2016 – *Phakopsora myrtacearum* sp. nov., a newly described rust (*Pucciniales*) on eucalypts in eastern and southern Africa. *Plant Pathology* 65, 189–195.
- Maier W, Wingfield BD, Mennicken M, Wingfield MJ. 2007 – Polyphyly and two emerging lineages in the rust genera *Puccinia* and *Uromyces*. *Mycological Research* 111, 176–85.

- Malviya DS, Jain M. 1981 – Some new record of rust fungi. *Indian Phytopathology* 34, 379–380.
- Manocharachary C, Rehana AR, Raghuveer Rao P. 1976 – Some interesting fungi from India. *Maharashtra Vigyan Mandir Patrika* 11, 38.
- Manocharachary C. 1975 – New host records of some interesting fungi from India. *Science and Culture* 41, 237.
- Marin-Felix Y, Groenewald JZ, Cai L, Chen Q et al. 2017 – Genera of phytopathogenic fungi: *GOPHY* 1. *Studies of Mycology* 86, 99–216.
- Massee G. 1892 – Notes on exotic fungi in the Royal Herbarium Kew. *Grevillea* 21, 1–6.
- Massee G. 1906 – Revision of the genus *Hemileia* Berk. *Kew Bulletin* 1906, 35–42.
- Mathur PN. 1967 – On the occurrence of *Uromyces* sp. on *Euphorbia dracunculoides* in Rajasthan. *Science and Culture* 33, 67–68.
- Mathur RS, Singh DV. 1964 – A new host of *Uromyces proeminens* (DC) Lev. *Science and Culture* 30, 605–606.
- McKenzie EHC, Padamsee M, Dick M. 2013 – First report of rust on *Alnus* in New Zealand is *Melampsorium betulinum*, not *M. hiratsukanum*. *Plant Pathology and Quarantine* 3, 59–65.
- McLaughlin DJ, Frieders EM, Lu H. 1995 – A microscopist's view of heterobasidiomycete phylogeny. *Studies in Mycology* 38, 91–109.
- Mcrae W. 1917 – Notes on South Indian Fungi. *Madras Agriculture Department year book* 1917, 108–111.
- McTaggart AR, Aime MC. 2018 – The species of *Coleosporium* (*Pucciniales*) on *Solidago* in North America. *Fungal Biology* 122, 800–809.
- McTaggart AR, Doungsa-Ard C, Geering AD, Aime MC et al. 2015 – A co-evolutionary relationship exists between *Endoraecium* (*Pucciniales*) and its *Acacia* hosts in Australia. *Persoonia* 35, 50–62.
- McTaggart AR, Shivas RG, Doungsa-ard C, Weese TL et al. 2016a – Identification of rust fungi (*Pucciniales*) on species of *Allium* in Australia. *Australasian Plant Pathology* 45, 581–592.
- McTaggart AR, Shivas RG, van der Nest MA, Roux J et al. 2016b – Host jumps shaped the diversity of extant rust fungi (*Pucciniales*). *New Phytologist* 209, 1149–1158.
- Mehta KC. 1934 – *Indian Bulletin of Plant Protection* 8, M202.
- Mehta KC. 1940 – Further studies on cereal rust in India. *Science Monograph* No. 14, 224.
- Mishra AK, Mishra AP. 1975 – Groundnut rust in Bihar varietal reactions. *Indian Phytopathology* 28, 557–559.
- Mishra DP. 1963a – A new physiologic race of Indian rust in India. *Indian Phytopathology* 16, 102–103.
- Mishra DP. 1963b – Natural occurrence of the aecial stage of *Puccinia sorghii* Schw. on *Oxalis corniculata* Linn. in Nepal. *Indian Phytopathology* 16, 8–19.
- Mishra DP, Ahmad ST, Singh S. 1965 – Natural occurrence of specialized forms of *Puccinia graminis* and *P. striformis* on *Lolium perenne* *Indian Phytopathology* 18, 214.
- Mishra DP, Ahmad ST, Singh S. 1968 – A rust of *Helicortichum* alternating with *Thalictrum*. *Indian Phytopathology* 21, 253–256.
- Mishra DP, Lele VC. 1963 – The nature and the role of rust on *Muechlenbergia hugelii* Trin., a perennial grass in the Simla hills. *Indian Phytopathology* 16, 382–384.
- Mishra DP, Prasad R. 1966 – Status of linseed rust races in India and sources of resistance. *Indian Phytopathology* 19, 184–188.
- 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, Sharma SK. 1963 – A new race of *Puccinia reconditae* Roxb. ex. Desm. in India. *Indian Phytopathology* 16, 313.
- 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, Singh S, Ahmad ST. 1975 – Notes on some rust fungi from Simla hills. *Indian Phytopathology* 28, 256–260.

- Mishra RP. 1969 – The Uredinae of Jabalpur (M.P.-II). Proceedings of Bihar Academy of Agriculture Sciences 17, 76–80.
- Mishra RP, Khare MN. 1969 – Screening of *Lathyrus* germplasm collection against rust *Uromyces fabae* (Pers.) de Bary. Journal of Applied Science 1, 54–55.
- Mishra RP, Nema KG, Singh SS. 1976 – Uredinae of Jabalpur, Madhya Pradesh-IV). JNKVV Research Journal 10, 136–139
- Mishra RP, Nema KG. 1976 – Uredinae of Jabalpur (M.P.-III). JNKVV Research Journal 10, 132–135.
- Misra DP, Singh S, Ahmad ST. 1975 – Notes on some rusts from Simla hills. Indian Phytopathology 28, 256–260.
- Mitter JH, Tandon RN. 1930 – Fungus flora of Allahabad. Journal of Indian Botanical Society 9, 190–198.
- Mitter JH, Tandon RN. 1932a – Fungus flora of Nainital – I. Journal of Indian Botanical Society 11, 178–180.
- Mitter JH, Tandon RN. 1932b – Fungi of Nainital – II. Journal of Indian Botanical Society 17, 177–182.
- Mitter JH, Tandon RN. 1937 – Fungus flora of Allahabad, India Part-III. Proceedings of Indian Academy of Sciences 6(B), 194–201.
- Mohan C. 2010 – Rust Fungi of Kerala. Kerala, India. Kerala Forest Research Institute, Peechi, Kerala, India.
- More WD, Moniz L. 1964 – Telial stage of rust on *Sesbania aegyptiaca* Poir. Current Science 33, 449.
- Morin L, van der Merwe M, Hartley D, Muller P. 2009 – Putative natural hybrid between *Puccinia lagenophorae* and an unknown rust fungus on *Senecio madagascariensis* in KwaZulu-Natal, South Africa. Mycological Research 113, 725–736.
- Mulvey RL, Hambleton S. 2015 – Stem rust of highbush-cranberry (*Viburnum edule*) caused by *Puccinia linkii* near Juneau, Alaska. Plant Disease 99, 893.
- Mundkar BB. 1938 – Fungi of India – Supplement -I. ICAR Science Monograph 12, 54.
- Mundkar BB. 1943 – Indian species of *Phakopsora* and *Bubakia*. Mycologia 35, 538–554.
- Mundkar BB, Ahmad SS. 1946 – Revisions of and additions to Indian Fungi – II. Mycology Paper Imp. Mycology Institute 18, 11.
- Mundkar BB, Kheshwala KF. 1943 – *Dasturella* a new genus of Uredinales. Mycologia 35, 201–246.
- Mundkar BB, Prasad N. 1938 – On a new *Ravenelia* from Indian. Mycologia 30, 635–638.
- Mundkar BB, Thirumalachar MJ. 1945 – Two new genera of rust on Bignoniaceae. Mycologia 37, 619–628.
- Mundkar BB, Thirumalachar MJ. 1952 – Revision and additions to Indian rust fungi – I. Mycology Paper Imp. Mycology Institute 16, 27.
- Munjal RL, Kapoor JN. 1961 – Two fern rusts from India. Current Science 30, 308–310.
- Munshi AH. 1976 – *Polygonum demetorum* L., a new host for *Puccinia polygoni-abphibii* Pers. Current Science 45, 314.
- Mutkekar ML, Bhide VP, Patil VP. 1968 – Occurrence of a new physiologic race of *Puccinia graminis-tritici* (Pers.) Eriks. and P. Henn. in Maharashtra. Indian Phytopathology 21, 123–124.
- Nagachan SV, Goswami RN. 1985 – *Nyssopsora thirumalachari*- a new rust from India. Indian Phytopathology 38, 186–187.
- Nagachan SV, Verma MD. 1984 – *Uromyces coronatus* on *Zizania latifolia*. Indian Phytopathology 37, 741.
- Nagraj TR, Govindu HC, Thirumalachar MJ. 1971 – Some noteworthy rusts – IV. Sydowia 25, 157–161.
- Narasimhan MJ, Thirumalachar MJ. 1961 – *Ravenelia esculenta* an edible rust fungus. Phytopathology 41, 97–102.

- Narasimhan MJ, Thirumalachar MJ. 1964 – Heteroecism in *Uromyces setariae-italicae*, the rust on Italian millet. *Mycologia* 56, 554–559.
- Narayan P, Kamal. 1985 – New host records from India. *Indian Phytopathology* 38, 394–395.
- Nema KG, Agarwal GP. 1960 – Fungi causing plant disease at Jabalpur (M.P.) – IV. *Proceedings of National Academy of Sciences* 30(B), 55–68.
- Nema KG, Mishra RP. 1965 – The *Uredinales* of Jabalpur M.P. *Nagpur Agriculture College Magazine* 6, 79.
- Niskanen T, Douglas B, Kirk P, Crous P et al. 2018 – New discoveries: species of fungi described in 2017. In: K. J. Willis (ed.), *State of the World's Fungi. Report*. Royal Botanic Gardens, Kew. pp. 18–23.
- Ono Y, Hennen J. 1983 – Taxonomy of the chaconiaceous genera (*Uredinales*). *Transactions of the Mycological Society of Japan* 24, 369–402.
- Otálora MAG, Berndt R. 2018 – A taxonomic revision of the genus *Puccinia* on *Lycieae*, a tribe of *Solanaceae*. *Mycologia* 110(4): 692–709.
- Padamsee M, McKenzie EHC. 2014 – A new species of rust fungus on the New Zealand endemic plant, *Myosotidium*, from the isolated Chatham Islands. *Phytotaxa* 174, 223–230.
- Padamsee M, McKenzie EHC. 2017 – The intriguing and convoluted life of a heteroecious rust fungus in New Zealand. *Plant Pathology* 66, 1248–1257.
- Padwick GW. 1945a – Notes on Indian fungi – III. *Mycological Papers* 12, 15.
- Padwick GW. 1945b – Notes on Indian fungi – VI. *Mycological Papers* 17, 12.
- Padwick GW, Khan A. 1944 – Notes on Indian fungi – II. *Mycological Papers* 10, 17.
- Padwick GW, Merh JL. 1943 – Notes on Indian fungi – II. *Mycological Papers* 7, 7.
- Pandotra VR. 1966 – Notes on fungi of Jammu and Kashmir-I. *Proceedings of National Academy of Sciences* 54, 68–73.
- Pandotra VR, Ganguly D. 1962 – Notes on two fungi collected from Kulu Valley, Punjab. *Indian Phytopathology* 15, 216–217.
- Pandotra VR, Ganguly D. 1964a – Fungi on medicinal and aromatic plants of North West Himalayas I. *Mycopathologia et Mycologia Applicata* 22, 59–68.
- Pandotra VR, Ganguly D. 1964b – Fungi on medicinal and aromatic plants of North West Himalayas III. *Mycopathologia et Mycologia Applicata* 22, 106–116.
- Pandotra VR, Sastry KSM. 1969a – Fungi on medicinal and aromatic plants of North West Himalayas V. *Proceedings of India Academy of Science* 70(B), 88–89.
- Pandotra VR, Sastry KSM. 1969b – Notes on the fungi of Jammu and Kashmir II. *Proceedings of India Academy of Science* 69(B), 207–212.
- Parndekar SA. 1964 – A contribution to the fungi of Maharashtra I. *Journal of University of Poona*. 26, 56–64.
- Patel JG, Solanki VA, Valand GB. 1985 – Rust disease of Ray ambla (*Phyllanthus phyllathi*). *Indian Phytopathology* 38, 386–387.
- Patel MK, Gokhle VP, Kulkarni NB. 1951a – Additions to the fungi of Bombay – I. *Indian Phytopathology* 4, 64–66.
- Patel MK, Kamat MN, Bhide VP. 1949 – Fungi of Bombay, Supplement –I. *Indian Phytopathology* 2, 142–155.
- Patel MK, Kamat MN, Padhya YA. 1950 – A new record of *Puccinia* on sugarcane in Bombay. *Current Science* 19, 121–122.
- Patel MK, Payak MM, Kulkarni NB. 1951b – Additions to the fungi of Bombay –II. *Indian Phytopathology* 4, 71–73.
- Patil BV, Thirumalachar MJ. 1962 – Life history and relationship of *Uromyces clignyi*. *Indian Phytopathology* 20, 225–228.
- Patil BV, Thirumalachar MJ. 1964 – A new host of *Puccinia versicolor*. *Current Science* 33, 253.
- Patil BV, Thirumalachar MJ. 1968 – Life history and heteroecism of *Uromyces commellinae* Cke. *Indian Phytopathology* 21, 324–330.

- Patil BV, Thirumalachar MJ. 1971 – Some new and interesting rusts from Maharashtra, India. *Sydowia* 25, 149–156.
- Patil MS. 1977 – Studies on rusts of Maharashtra –II. *Journal of Shivaji University (Science)* 17, 143–147.
- Patil MS, Thite AN. 1978 – Fungal flora of Amboli (Ratanagiri). *Journal of Shivaji University (Science)* 18, 219–224.
- Patil SD. 1966a – Rust of Mahabaleshwar. The proceedings of the autumn school of botany, Mahabaleshwar, 254–261.
- Patil SD. 1966b – The genus *Ravenelia* Berk. in Maharashtra. *Maharashtra Vigyan Mandir Patrika* 1, 52–55.
- Patil SD, Date KG. 1977 – A new species of *Ravenelia* Berk. from Maharashtra. *Maharashtra Vigyan Mandir Patrika* 12, 21–24.
- Patil SD, Date KG. 1980 – New hosts records for *Puccinia* and *Uromyces* from Maharashtra. *Maharashtra Vigyan Mandir Patrika* 15, 81–85.
- Patwardhan PG. 1964 – A perfect stage of *Uredo treminalie* P. Henn. *Mycopathologia et. Mycologia Applicata* 24, 172–174.
- Pavgi MS, Singh UP. 1969 – Morphology of pycnia of some *Ravenelia* species. *Mycologia* 61, 826–830.
- Pavgi MS, Upadhyay HP. 1966 – Parasitic fungi from North India – VI. *Mycopathologia et. Mycologia Applicata* 30, 257–260.
- Pawar IS, Kulkarni UK. 1973 – Occurrence of telial stage of the rust *Cerotelium fici* (Cast.) Butl. in Maharashtra. *Journal of Shivaji University* 6, 75–77.
- Payak MM. 1949 – Some parasitic fungi collected in the vicinity of Banaras. *Indian Phytopathology* 2, 190–193.
- Payak MM. 1953 – Some records of fungi from Bombay state. *Science and Culture* 18, 342–343.
- Payak MM. 1962 – Natural occurrence gram rust in uredial stage on *Trigonella polycerata* L. in Simla hills. *Current Science* 31, 433–434.
- Payak MM. 1965 – *Berberis* as aecial host of *Puccinia brachypodii* in Simla hills, India. *Phytopathology* 52, 49–54.
- Payak MM, Khanna A. 1970 – On two unrecorded races and a new biotype of *Puccinia recondita*. *Indian Phytopathology* 18, 26–28.
- Payak MM, Mishra DP. 1963 – Physiologic specialization in *Puccinia coronata* Corda in India. *Indian Phytopathology* 16, 15–19.
- Payak MM, Renfro BL. 1966 – Diseases of maize new to India. *Indian Phytopathology* 19, 122.
- Pei MH, Bayon C, Ruiz C. 2005 – Phylogenetic relationships in some *Melampsora* rusts on *Salicaceae* assessed using rDNA sequence information *Mycological Research* 109, 401–409.
- Petch T. 1912 – *Ustilaginae* and *Uredineae* of Ceylon. *Annals of Research in Botany Gard Peradeniya* 5, 223–256.
- Ponappa KM. 1969 – On five fungi associated with coconut palm in India. *Indian Phytopathology* 22, 345–345.
- Prasad N. 1948 – Studies on rust fungi of some wild grasses occurring in neighborhood of Simla. *Indian Journal of Agriculture Sciences* 18, 165–176.
- Prasad N, Sharma LC, Singh RD. 1962 – Two new rusts from Rajasthan. *Indian Phytopathology* 15, 80–83.
- Prasada R. 1951 – Rust on wild grasses. *Current Science* 20, 242.
- Prillinger H, Oberwinkler F, Umile C, Tlachac K et al. 1993 – Analysis of cell wall carbohydrates (neutral sugars) from ascomycetous and basidiomycetous yeasts with and without derivatization *Journal of Applied Genetics* 39, 1–34.
- Puri YN. 1955 – Rusts and wood rotting fungi on some of the important conifers. *Forest Bulletin Dehradun (NS Mycology)* 179, 10pp.
- Rahalkar SR. 1977 – A new rust on Para grass from India. *Journal of Maharashtra Agriculture University* 2, 172–174.

- Rajendran RB. 1966 – A new species of *Caeoma* from India. Bulletin of Torrey Botanical club 93, 4.
- Rajendren RB. 1970 – *Kernkampella*: a new genus of the Uredinales. Mycologia 62, 837–843.
- Ramachar P. 1956 – *Curvularia pallescens* Boed. on *Aecidium urgineae* sp. nov. Proceedings of 43rd Indian Science Congress Association Agra Section B, 216.
- Ramachar P. 1965 – Taxonomy of *Puccinia penniseti*. Journal of Indian Botanical Society 44, 218–233.
- Ramachar P. 1966 – The species of *Phakopsora* and *Physopella* (rust fungi) on tribe Paniceae. Journal of Indian Botanical Society 45, 317–328.
- Ramachar P, Bhagyanarayana G, Kumar A. 1978 – Additions to our knowledge of rust (*Uredinales*) from Hydrabaad (India)-III. Proceedings to Indian Academy of Sciences 87(B), 113–118.
- Ramachar P, Bhagyanarayana G. 1976 – Nomenclatural changes in some *Uredinales*. Transactions of the British Mycological Society 67, 139–140.
- Ramachar P, Bhagyanarayana G. 1977a – A new species of *Melampsora* from Andhra Pradesh. Current Science 46, 315–316.
- Ramachar P, Bhagyanarayana G. 1977b – Mycological notes on some rust fungi from India. Mycologia 69, 1076–1079.
- Ramachar P, Bhagyanarayana G. 1979 – *Ramakrishnaniana*, a new genus of *Uredinales* from Southern India. Canadian Journal of Botany 57, 783–786.
- Ramachar P, Cummins GB. 1965 – The species of *Puccinia* on Paniceae. Mycopathologia et. Mycologia Applicata 25, 7–60.
- Ramakrishna V, Subbaya J. 1973 – Occurrence of groundnut rust in India. Indian Phytopathology 26, 574–575.
- Ramakrishnan K, Subramanian CV. 1952 – The Fungi of India- a second supplement. Journal of Madras University 22(B), 1–65.
- Ramakrishnan TS. 1950 – Some interesting rusts of South India. Indian Phytopathology 3, 43–50.
- Ramakrishnan TS. 1951a – Additions to rust fungi of Madras – X. Proceeding of Indian Academy of Sciences 34 (B), 63–72.
- Ramakrishnan TS. 1951b – Additions to rust fungi of Madras – XI. Proceeding of Indian Academy of Sciences 34 (B), 157–164.
- Ramakrishnan TS. 1951c – Two new rusts from South India. Transactions of the British Mycological Society 34, 141–145.
- Ramakrishnan TS. 1952 – Additions to rust fungi of Madras – XII. Proceeding of Indian Academy of Sciences 35 (B), 111–121.
- Ramakrishnan TS. 1955a – Decline of cashew nut. Indian Phytopathology 8, 58–63.
- Ramakrishnan TS. 1955b – Diseases of ornamental plants of Madras state, South India. Indian Horticulture 3, 1–9, 39–45.
- Ramakrishnan TS. 1956 – Notes on some fungi from South India – V. Proceeding of Indian Academy of Sciences 44 (B), 114–121.
- Ramakrishnan TS. 1957a – Notes on some fungi. Proceeding of Indian Academy of Sciences 45 (B), 176–180.
- Ramakrishnan TS. 1957b – Notes on some fungi from South India – VI. Proceeding of Indian Academy of Sciences 34 (b), 149–151.
- Ramakrishnan TS. 1959 – Notes on some fungi from South India – VII. Proceeding of Indian Academy of Sciences 49 (B), 124–128.
- Ramakrishnan TS. 1960 – Notes on some fungi from South India – VIII. Proceeding of Indian Academy of Sciences 51(B), 164–168.
- Ramakrishnan TS. 1965 – Notes on some fungi from South India – IX. Proceeding of Indian Academy of Sciences 62 (B), 32–35.
- Ramakrishnan TS, Narasimhalu IL. 1941 – The occurrence of *Darluca filum* (Biv.) Cast. on cereal rusts in South India. Current Science 10, 290–291.

- Ramakrishnan TS, Ramakrishnan K. 1946 – Additions to rust fungi of Madras – I. Proceeding of Indian Academy of Sciences 25 (B), 28–34.
- Ramakrishnan TS, Ramakrishnan K. 1947 – Additions to rust fungi of Madras – II. Proceeding of Indian Academy of Sciences 25 (B), 178–187.
- Ramakrishnan TS, Ramakrishnan K. 1948a – Additions to rust fungi of Madras – I. Proceeding of Indian Academy of Sciences 25 (B), 28–34.
- Ramakrishnan TS, Ramakrishnan K. 1948b – Additions to rust fungi of Madras – V. Proceeding of Indian Academy of Sciences 28 (B), 50–70.
- Ramakrishnan TS, Ramakrishnan K. 1949 – Additions to rust fungi of Madras – VI. Proceeding of Indian Academy of Sciences 29(B), 48–58.
- Ramakrishnan TS, Ramakrishnan K. 1950a – Additions to rust fungi of Madras – VII. Proceeding of Indian Academy of Sciences 32(B), 48–58.
- Ramakrishnan TS, Ramakrishnan K. 1950b – Additions to rust fungi of Madras – VIII. Proceeding of Indian Academy of Sciences 32(B), 97–111.
- Ramakrishnan TS, Ramakrishnan K. 1950c – Additions to rust fungi of Madras – IX. Proceeding of Indian Academy of Sciences 32 (B), 205–214.
- Ramakrishnan TS, Rangaswamy G. 1948 – *Uromyces acori* Ramakrishnan and Rangaswamy sp. nov. on *Acorus calamus*. Current Science 17, 240–241.
- Ramakrishnan TS, Shrinivasan KV, Sundaram NV. 1952a – Additions to rust fungi of Madras –XIII. Proceeding of Indian Academy of Sciences 36(B), 85–95.
- Ramakrishnan TS, Shrinivasan KV, Sundaram NV. 1952b – Additions to rust fungi of Madras –XIV. Proceeding of Indian Academy of Sciences 37 (B), 83–95.
- Ramakrishnan TS, Shrinivasan KV. 1950 – On two new rust fungi. Current Science 19, 216.
- Ramakrishnan TS, Soumini CK. 1946a – A new rust on *Premna mucronata* Wild. Proceeding of Indian Academy of Sciences 25 (B), 35–37.
- Ramakrishnan TS, Soumini CK. 1946b – *Hemileia wrightiae* Racib. on *Wrightia tinctoria* B. & Br. & *W. tomentosa* Roem. & Sch. Current Science 15, 256–257.
- Ramakrishnan TS, Sundaram NV. 1952a – A new rust on *Antidesma* in India. Transactions of the British Mycological Society 35, 26–28.
- Ramakrishnan TS, Sundaram NV. 1952b – Notes on some fungi from South India-I. Indian Phytopathology 5, 110–113.
- Ramakrishnan TS, Sundaram NV. 1953a – Additions to rust fungi of Madras – XV. Proceeding of Indian Academy of Sciences 32 (B), 187–194.
- Ramakrishnan TS, Sundaram NV. 1953b – Notes on some fungi from South India – II. Indian Phytopathology 6, 27–38.
- Ramakrishnan TS, Sundaram NV. 1954a – Notes on some fungi from South India – III. Indian Phytopathology 7, 61–68.
- Ramakrishnan TS, Sundaram NV. 1954b – Notes on some fungi from South India – IV. Indian Phytopathology 7, 140–151.
- Ramakrishnan TS, Sundaram NV. 1955a – Additions to rust fungi of Madras – XVII. Proceeding of Indian Academy of Sciences 41 (B), 189–195.
- Ramakrishnan TS, Sundaram NV. 1955b – Additions to rust fungi of Madras – XVIII. Proceeding of Indian Academy of Sciences 42 (B), 58–64.
- Ramakrishnan TS, Sundaram NV. 1956a – The life history of *Puccinia blepharidis* P. Henn. Proceeding of Indian Academy of Sciences 44 (B), 325–328.
- Ramakrishnan TS, Sundaram NV. 1956b – The life history of *Puccinia romagnoliana* Nair & Sacc. Proceeding of Indian Academy of Sciences 43 (B), 95–96.
- Rambaut A. 2012 – FigTree version 1.4.0. Available from: <http://tree.bio.ed.ac.uk/software/figtree/> (Accessed Oct 2, 2020)
- Rangaswamy G, Sheshadri VS, Lucy Channamma KA. 1968 – Fungi of South India. University of Agricultural Science Bangalore, 193.
- Ravindra Nath V, Narahari Reddy N. 1964 – Telia rust of castor. Current Science 33, 88.

- Rebenhorst. 1878 – Fungi europaei exsiccate. Hedwigia 17, 31–176.
- Rolla SR, Addala RS. 1963 – *Uromyces commelinae* Cooke new host plants. Science and Culture 29, 449–451.
- Roy AK. 1964 – Additions to fungal flora of Assam-I. Indian Phytopathology 18, 327–334.
- Roy AK. 1968 – Additions to fungal flora of Assam-II. Indian Phytopathology 21: 182–189.
- Roy B, Vogler D, Bruns T, Szaro T. 1998 – Cryptic Species in the *Puccinia monoica* Complex. Mycologia 90, 846–853.
- Roy RY, Gupta SK. 1959 – A new species of *Puccinia xanthocarp* sp. nov. Proceedings of 46th Indian Science Congress Part – III, 339.
- Roy TC. 1948 – Fungi of Bengal. Bulletin of Botanical Society of Bengal 2, 134–147.
- Sachan SN, Sharma MR, Chatarji R. 1980 – Additions to rust fungi of India. Indian Journal of Mycology and Plant Pathology 10, 130.
- Sahni ML, Chona BL. 1965 – Studies on sugarcane rust in India. Indian Phytopathology 18, 191–203.
- Saini LS, Chand JN. 1984 – *Uromyces dactylidis* on *Poa annua*. Indian Phytopathology 37, 586.
- Saksena HK. 1930 – Fungus flora of Allahabad, Part-I. Proceedings of Indian Science Congress 17, 284.
- Saksena HK. 1956 – Two new records of *Uromyces* sp. from India. Science and Culture 22, 337–338.
- Salam MA, Ramachar P. 1955 – Additions to our knowledge to the rust fungi of Hyderabad-I. Journal Indian Botanical Society 34, 191–195.
- Salam MA, Ramachar P. 1956 – Additions to our knowledge to the rust fungi of Hyderabad-II. Journal Indian Botanical Society 35, 152–157.
- Sanwal BD. 1951a – On some new and noteworthy *Ravenelia* from India. Sydowia 5, 412–417.
- Sanwal BD. 1951b – Taxonomic notes on tropical fungi – I. Sydowia 5, 384–387.
- Sathe AV. 1965a – A new species of *Dasturella* (Uredinales) from India. Sydowia 19, 148–449.
- Sathe AV. 1965b – Revision of *Masseella narasimhansii* Thirum. (Uredinales). Sydowia 19, 187–189.
- Sathe AV. 1965c – Some additions to rust fungi of Maharashtra. Journal of University of Poona 30, 3–4.
- Sathe AV. 1965d – Some new or revised species of *Physopella* (Uredinales) from India. Sydowia 19, 138–142.
- Sathe AV. 1965e – *Uredopeltis boswelliae* (Patel et al.) Sathe from India. Sydowia 19, 200–201.
- Sathe AV. 1966a – Some additions to fungi of India. Mycopathologia et Mycologia Applicata 29: 338–339.
- Sathe AV. 1966b – Some new reports of *Aecidium* from India. Mycopathologia et Mycologia Applicata 29, 118–123.
- Sathe AV. 1966c – *Stakmania*- a new genus of Uredinales from India. Sydowia 20, 252–255.
- Sathe AV. 1969a – A new rust record of *Pennisetum typhoides* Stapf and Hub. Mycologia 61, 198–199.
- Sathe AV. 1969b – *Peridospora* – a new genus of Uredinales from India. Transactions of the British Mycological Society 53, 143–145.
- Sathe AV. 1972b – Taxonomic studies of the genus *Cerotelium* (Uredinales). Indian Phytopathology 25, 76–79.
- Sathe AV. 1971 – Nomenclature of common rust fungi affecting sugarcane. Current Science 40, 42–43.
- Sathe AV. 1972a – Identity and nomenclature of soybean rust from India. Current Science 41, 264 – 265.
- Sathe AV, Rahalkar SR. 1976 – A new rust on *Polygonum glabrum* from India. Current Science 45, 382.
- Saumtally AS, Viremouneix TR, Ahondokpe B, Girard JCR et al. 2011 – First Report of orange rust of Sugarcane caused by *Puccinia kuehnii* in Ivory Coast and Cameroon. Plant Disease 95, 357.

- Savile DBO. 1971 – Coevolution of the rust fungi and their hosts. *The Quarterly Review of Biology* 46, 211–218.
- Scholler M, Lutz M, Aime MC. 2019 – Repeated formation of correlated species in *Tranzschelia* (*Pucciniales*). *Mycological Progress* 18, 295–303.
- Scholler M, Lutz M, Wood AR, Hagedorn G, Mennicken M. 2011 – Taxonomy and phylogeny of *Puccinia lagenophorae*: a study using rDNA sequence data, morphological and host range features. *Mycological Progress* 10, 175–187.
- Seier MK, Morin L, van der Merwe M, Evans HC, Romero A. 2009 – Are the microcyclic rust species *Puccinia melampodii* and *Puccinia xanthii* conspecific? *Mycological Research* 113, 1271–1282.
- Shanmugam N, Ranganathan K, Krishnamurthy CS. 1972 – A new record of rust caused by *Puccinia arachidis* Speg. *Madras Agriculture Journal* 59, 185.
- Sharma AD. 1977 – Studies on seed mycoflora of some medicinal plants. *Indian Journal of Mycology and Plant Pathology* 7, 171–172.
- Sharma BB, Mukerji SK. 1972 – A new record of rust on groundnut (*Arachis hypogea*) in Calcutta, W.B. *Current Science* 41, 229.
- Sharma ND. 1975 – Some foliicolous fungi-IV. *Botanique* 6, 99–102.
- Sharma ND, Jain AC. 1981 – *Oidium grewiae* sp. nov. and *Phakaopsora grewiae* (Pat. & Har.) Cumm. two new diseases on *Grewia asiatica* from Jabalpur. *Current Science* 50, 133–134.
- Sharma PD, Sanger DK, Garg AP. 1979 – A brachy *Puccinia* on *Cnicus arvensis*. *Indian Phytopathology* 32, 150.
- Sharma RK, Shankar V. 1979 – Two new host records of *Uredinales*. *Indian Journal of Forestry* 2, 12.
- Sharma SK, Singh S, Goel LB. 1973 – Notes on some new records of Sonalika infecting race of yellow rust in India and source of resistance. *Indian Journal of Agriculture Sciences* 43, 964–965.
- Sharma SK, Singh S. 1964 – A new physiologic race of *Puccinia striiformis* West in India. *Indian Phytopathology* 17, 72–73.
- Sharma SL. 1957 – A new report of rust (*Puccinia kuehni* (Krueg) Butler) on *Erianthus munja*. *Proceedings of Indian Academy of Sciences*. 46, 126–130.
- Shin HD, Lee SH, Seo ST, Lee SK. 2019 – First report of rust caused by *Coleosporium zanthoxyli* on *Zanthoxylum piperitum* in Korea. *Plant Disease* 103. Doi 10.1094/PDIS-06-18-1029-PDN
- Shinde PA, More WD. 1975 – Outbreak of groundnut rust at Rahuri. *Research Journal of Mahatma Phule Agriculture University* 6, 75.
- Shukla BN, Singh BP. 1976 – Occurrence of sunflower rust (*Puccinia helianthi*) in Madhya Pradesh. *JNKVV Research Journal* 10, 45–46.
- Siddiqui MR. 1957 – Two noteworthy foliicolous fungi from Saugar. *Bulletin of Society of University of Sagaur* 9 19–20.
- Siddiqui MR. 1971 – Natural incidence of *Puccinia helianthi* on *Helianthus cucumerifolius*. Torrey and Gray in India. *Science and Culture* 37, 151–157.
- Siddiqui MR. 1972– Studies on diseases of sunflower (*Helianthus annus*) in India. *Indian Phytopathology* 25, 160–161.
- Siddiqui MR. 1973 – *Helianthus cucumerifolius* – a new host for sunflower rust in India. *Indian Phytopathology* 26, 359–361.
- Singh A, Palni UT. 2011 – Diversity and distribution of rust fungi in central Himalayan region. *Journal of Phytology* 3, 49–59.
- Singh AK, Kamal. 1985 – New fungal records from India. *Indian Phytopathology* 38, 388.
- Singh BM, Sharma YR. 1977 – Rust on garlic. *FAO, Plant Protection Bulletin* 25, 41–42.
- Singh H, Jalan S. 1965 – A new rust on *Schizandra grandiflora*. *Indian Phytopathology* 18, 28–32.
- Singh H. 1962 – A new aecial host of *Puccinia aristidae* Tracy. *Current Science* 31, 521–522.
- Singh S. 1966 – A new species in plant rusts. *Sydowia* 20, 261–263.

- Sinha S, Kapooria RG. 1966 – An aspect of microbial control of Bajra Rust. *Indian Phytopathology* 19, 127–128.
- Singh S, Pandey PC. 1972 – New *Melampsoridium* on *Mangolia*. *Transactions of the British Mycological Society* 58, 342–344.
- Sohi HS, Durgapal JC, Gunganani HC. 1967 – *Narenga porphyrocoma* – a new host of sugarcane rust (*Puccinia helianthi*). *Indian Phytopathology* 20, 175.
- Sokhi SS, Sohi SS. 1976 – Studies on rust of cowpea caused by *Uromyces phaseoli* var. *vignae*. *Indian Phytopathology* 29, 99.
- Solanki VA, Patel JG, Patel RB. 1985 – Rust diseases of mahova (*Bassia latifolia*). *Indian Phytopathology* 38, 386.
- Somani RB. 1979 – A new species of *Puccinia* on *Cyondon*. *Biovigyanam* 5, 81–82.
- Soumini CK. 1949 – Investigation of cereal rusts-III. *Puccinia purpurea* Cooke. *Indian Phytopathology* 2, 35–38.
- Souza ESC, Aime MC, Elias SG, Pinho DB et al. 2018 – *Crossopsorella*, a new tropical genus of rust fungi. *Phytotaxa* 375, 189–202.
- Srivastava RC. 1979a – Additions to fungi of India. *Current Science* 48, 996.
- Srivastava RC. 1979b – Fungi causing plant diseases at Jounpur UP-II. *Indian Phytopathology* 32, 289–290.
- Srivastava RC. 1979c – New host record from India. *Maharashtra Vigyan Mandir Patrika* 14, 79–80.
- Srivastava RC. 1980 – Fungi causing plant diseases at Jounpur UP-IV. *Indian Phytopathology* 33, 221–224.
- Srivastava SL. 1982 – Some new records of rust fungi from Kedarnath Valley. *Acta Botanica Indica* 10, 96.
- Stamatakis A. 2014 – RAxML version 8: a tool for phylogenetic analysis and post-analysis of large phylogenies. *Bioinformatics* 30(9), 1312–1313.
- Stamatakis A, Hoover P, Rougemont J. 2008 – A rapid bootstrap algorithm for the raxml web servers. *Systematic Biology* 57, 758–771.
- Stuteville DL, Graves WL, Dixon LJ, Castlebury LA, Minnis AM. 2010 – *Uromyces ciceris-arietini*, the cause of chickpea rust: new hosts in the *Trifolieae*, *Fabaceae*. *Plant Disease* 94, 293–297.
- Subramaniam CV, Ramakrishnan K. 1956 – List of Indian Fungi 1952-56. *Journal of Madras University* 26 (B), 327–421.
- Subramaniam CV. 1986 – The progress and status of mycology in India. *Proceedings of Indian Academy of Sciences* 96, 379–392.
- Sunderam NV, Rao AV. 1950 – A new rust disease on *Garcinia indica*. *Science and Culture* 23, 98–99.
- Sunderam NV, Renfro BL, Singh JP, Rachie GKO. 1966 – Reactions of the world collection of sorghum to five important diseases. *Indian Phytopathology* 19, 127.
- Sunderam NV. 1956 – New and complete life cycle of *Puccinia rufipes* Diet. *Indian Phytopathology* 9, 133–137.
- Sunderam NV. 1961 – Notes on some fungi from South India. *Indian Phytopathology* 14, 202–209.
- Sunderam NV. 1963 – A new host record for *Puccinia citrulli* Syd. & Butler. *Madras Agriculture Journal* 50, 479.
- Sunderam NV. 1964 – Physiologic specialization in *Uromyces leptodermus* Syd. *Indian Journal of Agriculture Sciences* 34, 215–218.
- Swann EC, Frieders EM, McLaughlin DJ. 2001 – *Urediniomycetes*. In: D. J. McLaughlin, E. J. McLaughlin and P. Lemke, eds., *The Mycota. Vol. VII. Part B, Systematics and Evolution*. Springer, Berlin, Heidelberg, 37–56.
- Swann EC, Taylor JW. 1995a – Phylogenetic diversity of yeast-producing *Basidiomycetes*. *Mycol Res* 99, 1205–1210.
- Swann EC, Taylor JW. 1995b – Phylogenetic perspectives on *Basidiomycete* systematics: evidence from the 18S rRNA gene. *Canadian Journal of Botany* 73, 862–868.

- Sydow H. 1913 – *Beitrage zur Kennitius de Pilze flora Sudlichen Ostindiens*. I. Annals of Mycology 11, 326–330.
- Sydow H. 1914 – *Beitrage zur Kennitius de Pilze flora Sudlichen Ostindiens*. I. Annals of Mycology 12, 424–490.
- Sydow H. 1921 – Novae fungorum species – XVII. Annales Mycologici. 19: 304–309.
- Sydow H. 1922 – Uber einige Wenig bekannte Uredineen aus dem Kew Herber. Annals of Mycology 20, 54–60.
- Sydow H. 1938 – Fungi Himalayensis. Annals of Mycology 36, 437–442.
- Sydow H. 1939 – Novae fungorum species. Annals of Mycology 37, 198.
- Sydow H, Butler EJ. 1901 – Fungi Indiae Orientalis Part – I. Annals of Mycology 4, 424–445.
- Sydow H, Mitter JH. 1933 – Fungi Indici – I. Annals of Mycology 31, 84–97.
- Sydow H, Mitter JH. 1935 – Fungi Indici – II. Annals of Mycology 33, 46–71.
- Sydow H, Mitter JH, Tandon RN. 1937 – Fungi Indici – III. Annals of Mycology 35, 222–243.
- Sydow H, Sydow P. 1904a – Novae fungorum species. Annales Mycologici 2, 162–174.
- Sydow H, Sydow P. 1904b – Monographia Uredinearum. Volume I. leipzig, UK.
- Sydow H, Sydow P. 1917 – Novae fungorum species – I. Annals of Mycology 15, 143–148
- Sydow H, Sydow P. 1924 – Monographia Uredinearum. Volume XXV, leipzig, UK.
- Sydow H, Sydow P. 1911 – Novae fungorum species – VI. Annales Mycologici 9, 142–146.
- Sydow H, Sydow P. 1912a – Novae fungorum species – VII. Annales Mycologici 10, 77–85.
- Sydow H, Sydow P. 1912b – Novae fungorum species – VIII. Annales Mycologici 10, 405–410.
- Sydow H, Sydow P, Butler EJ. 1907 – Fungi Indiae Orientalis Pars – II. Annals of Mycology 5, 485–515.
- Sydow H, Sydow P, Butler EJ. 1911a – Fungi Indiae Orientalis Pars – III. Annals of Mycology 9, 372–421.
- Sydow H, Sydow P, Butler EJ. 1911b – Fungi Indiae Orientalis Pars – V. Annals of Mycology 14, 177–220.
- Sydow H, Sydow P, Butler EJ. 1912 – Fungi Indiae Orientalis Pars – IV. Annals of Mycology 10, 243–280.
- Sydow P, Sydow H. 1915 – Monographia Uredinearum seu Specierum Omnium ad hunc usque Diem Descriptio et Adumbratio Systematica. Fratres Borntraeger, Germany.
- Talbot PHB. 1971 – Fungi with Basidia and Basidiospores Usually in Fruit bodies: *Eumycota* Subdivision *Basidiomycotina*. In: Principles of Fungal Taxonomy. Palgrave, London.
- Thirumalachar MJ. 1941a – A new species of *Puccinia* on *Ocimum adscendens*. Proceedings of Indian Academy of Sciences 14(B), 466–471.
- Thirumalachar MJ. 1941b – A preliminary note on *Melampsora* parasite on *Lobelia trigona* Roxb. Current Science 10, 366–367.
- Thirumalachar MJ. 1942a – Morphology and parasitism of *Trochodium* sp. nov. Journal of Indian Botanical Society 21, 59–68.
- Thirumalachar MJ. 1942b – *Phragmotelium mysorensis* – a new rust on Indian raspberry. Proceedings of Indian Academy of Sciences 16(B), 186–193.
- Thirumalachar MJ. 1943a – A new rust disease of *Cardamom*. Current Science 12, 231–232.
- Thirumalachar MJ. 1943b – *Masseella breyniae* – a new species of rusts. New Phytologist 42, 45–48.
- Thirumalachar MJ. 1943c – *Masseella narasimhanii* – a new species of rust on *Flugea leucopyrus* Willd. Proceedings of Indian Academy of Sciences 18(B), 36–40.
- Thirumalachar MJ. 1945 – Some noteworthy rusts –I. Mycologia 37, 295–310.
- Thirumalachar MJ. 1947 – Some noteworthy rusts –I. Mycologia 39, 231–248.
- Thirumalachar MJ. 1949a – Critical notes on some plant rusts. Bulletin of Torrey Botanical Club 76, 339–342.
- Thirumalachar MJ. 1949b – Preliminary notes on heteroecism of *Puccinia versicolor*. Current Science 18, 252–253.
- Thirumalachar MJ. 1950a – An undescribed genus of *Uredinales*. Science and Culture 16, 201–211.

- Thirumalachar MJ. 1950b – Some new and interesting fungi –II. *Sydowia* 4, 63–73.
- Thirumalachar MJ. 1950c – Some noteworthy rusts-III. *Mycologia* 42, 224–332.
- Thirumalachar MJ. 1951 – Critical notes on some plant rusts-II. *Sydowia* 5, 23–29.
- Thirumalachar MJ, Bhatt VV, Dhande GW, Patel MK. 1956 – Additions to the fungi of Bombay-III. *Indian Phytopathology* 9, 9–14.
- Thirumalachar MJ, Cummins GB. 1948 – Status of *Allopuccinia*, *Leucotelium*, *Edythea*, and *Ypsilospora*. *Mycologia* 40, 417–422.
- Thirumalachar MJ, Cummins GB. 1949 – Taxonomic significance of sporogenous basal cells in the *Uredinales*. *Mycologia* 41, 523–526.
- Thirumalachar MJ, Gopalkrishnan KS. 1947 – Morphology and spore forms and heteroecism in the giant bamboo rust, *Dasturella divina*. *Botanical Gazette* 108, 371–379.
- Thirumalachar MJ, Govindu HC. 1954 – Morphological and cytological studies of a bisporidial species of *Endophyllum*. *Botanical Gazette* 115, 388–391.
- Thirumalachar MJ, Kern FD, Patil BV. 1966 – *Elateracecium* –a new genus of the *Uredinales*. *Mycologia* 58, 391–395.
- Thirumalachar MJ, Mundkar BB. 1949 – Genera of rusts-II. *Indian Phytopathology* 2, 193–244.
- Thirumalachar MJ, Mundkar BB. 1950 – Genera of rusts, Appendix. *Indian Phytopathology* 3, 203–204.
- Thirumalachar MJ, Mundkar BB. 1951 – Revision of and addition to Indian fungi-III. *Mycological Papers* 40, 15.
- Thirumalachar MJ, Narsimhan MJ. 1947 – Studies on the morphology and parasitism *Hemileia* species on Rubiaceae in Mysore. *Annals of Botany in London* NS 11, 77–89.
- Thirumalachar MJ, Narsimhan MJ. 1950a – Alternation of generation and heteroecism in *Puccinia versicolor*. *Annals of Botany* 14, 341–346.
- Thirumalachar MJ, Narsimhan MJ. 1950b – Cytology and life history of a bisporidial *Endophyllum*. *New Phytology* 49, 117–120.
- Thirumalachar MJ, Swamy BJ, Khan BAK. 1943 – Contribution to the flora of Nandi Hills, Part I, some interesting rusts and smuts. *Journal of Mysore University* NS Section B 3, 195–304.
- Thite AN, Patil MS. 1970 – Additions to the rusts of Maharashtra. *Journal of Shiva University* 15, 49–51.
- Tilak ST, Rao R. 1968 – Second supplement to fungi of India (1962-1967). Marathwada University, Marathwada, 1–312.
- Tomar SMS, Singh SK, Sivasamy M, Vinod 2014 – Wheat rusts in India: Resistance breeding and gene deployment – A review. *Indian J. Genet.*, 74(2): 129–156.
- Tyagi RNS, Prasad N. 1972 – The morphographic studies on genus *Ravenelia* occurring in Rajasthan. *Indian Journal of Mycology and Plant Pathology* 2, 108–135.
- Tyagi RNS, Prasad N. 1978 – Some new *Ravenelias* from Rajasthan. *Science and Culture* 44: 268.
- Ulbitch E. 1938 – The fungi collected by German Himalaya expedition of 1937. *Notizblock Botany Gartens Berlin* 14, 139–150.
- Unni PN, Philip VJ. 1974 – Gall formation by *Puccinia thwasitesii* Berk. apud. Berk. Berl. on *Gendarussa vulgaris* Nees. *Current Science* 43, 359.
- Uppal BN, Patel MK, Kamat MN. 1935 – The fungi of Bombay – VIII, 1–56.
- Vaheeduddin S. 1955 – Rust on grape fruit. *Current Science* 24, 345.
- Vasudeva RS. 1948 – Report of the Head of the Division of Mycology and Plant Pathology, Scientific Report of Agriculture Research Institute New Delhi for the year (1946–47), 145–160.
- Vasudeva RS. 1949 – Report of the Head of the Division of Mycology and Plant Pathology, Scientific Report of Agriculture Research Institute New Delhi for the year (1947–48), 177–190.
- Vasudeva RS. 1950a – Report of the Head of the Division of Mycology and Plant Pathology, Scientific Report of Agriculture Research Institute New Delhi for the year (1948–49), 81–90.
- Vasudeva RS. 1950b – Report of the Head of the Division of Mycology and Plant Pathology, Scientific Report of Agriculture Research Institute New Delhi for the year (1949–50), 55–56.

- Vasudeva RS. 1957 – Report of the Head of the Division of Mycology and Plant Pathology, Scientific Report of Agriculture Research Institute New Delhi for the year (1954–55), 87–101.
- Vasudeva RS. 1958 – Report of the Head of the Division of Mycology and Plant Pathology, Scientific Report of Agriculture Research Institute New Delhi for the year (1956–57), 86–100.
- Vasudeva RS. 1962 – Fungi of India, Supplement –I, ICAR New Delhi.
- Venkatakrishnaiya NS. 1958 – Control of fig rust caused by *Cerotelium fici* (Cast.) Arth. Mysore Agriculture Journal 33, 25–26.
- Virtudazo E, Nakamura H, Kakishima M. 2001 – Phylogenetic Analysis of sugarcane rusts based on sequences of ITS, 5.8 S rDNA and D1/D2 regions of LSU rDNA. Journal of General Plant Pathology 67, 28–36.
- Vogler DR, Bruns TD. 1998 – Phylogenetic relationships among the pine stem rust fungi (*Cronartium* and *Peridermium* spp.). Mycologia 90, 244–257.
- Vu D, Groenewald M, de Vries M, Gehrman T et al. 2019 – Large-scale generation and analysis of filamentous fungal DNA barcodes boosts coverage for kingdom fungi and reveals thresholds for fungal species and higher taxon delimitation. Studies of Mycology 92, 135–154.
- Wakhloo JL. 1962 – Rust on *Solanum xanthocarpum* Schrad & Wendl. Journal of Indian Botanical Society 41, 217–219.
- Wang J, Zhou G, Su S, He Y et al. 2016 – Identification of pathogens of the *Dalbergia tonkinensis* rust Disease. Scientia Silvae Sinicae 52, 165–169.
- Wani DD, Thirumalachar MJ. 1969 – Studies on *Elsinoe* and *Sphaeloma* diseases of plants in Maharashtra, India-V. Sydowia 23, 257–260.
- Waritch KS, Khatri HL. 1976 – The occurrence of pink disease and rust of plums in India. Abstract in Indian Phytopathology 29,100.
- Waritch KS, Khatri HL. 1977 – The occurrence of pink disease and rust of plums in India. Indian Journal of Mycology and Plant Pathology 7, 203–206.
- Weber RW, Webster J, Engel G. 2003 – Phylogenetic analysis of *Puccinia distincta* and *P. lagenophorae*, two closely related rust fungi causing epidemics on *Asteraceae* in Europe. Mycological Research 107, 15–24.
- Webster J. 1980 – Introduction to Fungi, 2nd edn. Cambridge: Cambridge University Press.
- Wells K. 1994 – Jelly fungi, then and now. Mycologia 86, 18–48.
- Wijayawardene NN, Hyde KD, Al-Ani LKT, Tedersoo L et al. 2020 – Outline of Fungi and fungus-like taxa. Mycosphere 11, 1060–1456.
- Wijayawardene NN, Hyde KD, Rajeshkumar KC, Hawksworth DL et al. 2017 – Notes for genera: *Ascomycota*. Fungal Diversity 86, 1–594.
- Wijayawardene NN, Pawłowska J, Letcher PN, Krik PM et al. 2018 – Notes for genera: basal clades of Fungi (including *Aphelidiomycota*, *Basidiobolomycota*, *Blastocladiomycota*, *Calcarisporiellomycota*, *Caulochytriomycota*, *Chytridiomycota*, *Entomophthoromycota*, *Glomeromycota*, *Kickxellomycota*, *Monoblepharomycota*, *Mortierellomycota*, *Mucoromycota*, *Neocallimastigomycota*, *Olpidiomycota*, *Rozellomycota* and *Zoopagomycota*). Fungal Diversity 92, 43–129.
- Yadav AS. 1953 – Contribution to the knowledge of *Uredineae* of Bihar- I. Indian Phytopathology 6, 86–91.
- Yadav AS. 1963a – Additions to the microfungi II. Indian Phytopathology 16, 167–170.
- Yadav AS. 1963b – Contribution to the knowledge of *Uredineae* of Bihar- III. Indian Phytopathology 16,138–142.
- Yadav AS. 1964a – Contribution to the knowledge of *Uredineae* of Bihar- IV. Indian Phytopathology 16, 251–254.
- Yadav AS. 1964b – *Uredo thelypteridis* sp. nov. Current Science 33, 88–89.
- Yadav AS, Thirumalachar MJ. 1955 – Contribution to the knowledge of *Uredineae* of Bihar. Indian Phytopathology 8, 143–149.
- Yadav AS, Yadav SC. 1965 – Nuclear condition on *Aecidium* of *Puccinia cacao* Mcalp. Journal of Indian Botanical Society 44, 163–166.

- Yadav HL, Swarup J, Saxena HK. 1975 – Occurrence of groundnut rust (*Puccinia arachidis* Speg.) – a new record from Uttar Pradesh, India. Indian Journal of Farm Science 3, 109.
- Yadav PK, Saran K. 1985 – *Aecidium hartwegiae* Thuem., an addition to Indian Mycoflora. Current Science 54, 941–942.
- Zhao P, Liu F, Li YM, Cai L. 2016 – Inferring phylogeny and speciation of *Gymnosporangium* species, and their coevolution with host plants. Scientific Reports 6, 29339.
- Zhao P, Qi XH, Crous PW, Duan WJ, Cai L. 2020 – *Gymnosporangium* species on *Malus*: species delineation, diversity and host alternation. 45, 68–100.
- Zuluaga C, Buriticá P, Marín M. 2011 – Phylogenetic analysis of rust fungi (*Uredinales*) from the Colombian Andean region using 28S ribosomal DNA sequences. Revista de Biología Tropical 59, 517–40.