Bangladesh J. Bot. **46**(1): 73-81, 2017 (March)

NEW REPORTS AND HOST RECORDS OF RUST FUNGI FROM PAKISTAN

MUHAMMAD FIAZ[1], HABIB AHMAD[2], NAJAM-UL-SEHAR AFSHAN[3]* AND ABDUL NASIR KHALID

Department of Botany, University of the Punjab, Quaid-e-Azam Campus, Lahore, 54590, Pakistan

Key words: Mansehra, New additions, *Phakopsora*, Uredinales

Abstract

Aecidium saussureae-affinis and *Uredopeltis chevalieri* are first time described and illustrated from Pakistan and are new records for this area. *Grewia optiva*, *Carpesium trachelifolium* and *Malus pumila* are being reported here as new host records for rust fungi. Telial stage of *Phakopsora ziziphi-vulgaris* is first time recorded from Pakistan and is an addition to the already reported stages of this rust. *Ravenelia taslimii*, *Tranzschelia discolor* and *T. pruni-spinosae* are additions to the rust flora of Khyber Pakhtunkhwa Province, Pakistan.

Introduction

Khyber Pakhtunkhwa (KP), formerly known as the Northwest Frontier Province (NWFP), is one of the five provinces of Pakistan, located in the northwest of the country. It is situated at approximately 34.00°N 71.32°E. Khyber Pakhtunkhwa is famous for hill coniferous forests, herbal plants, and large biodiversity. This floristically rich area is affected by many biotic and abiotic stresses including plant diseases such as leaf blights, red rot, smut, mosaic, and rust (Ishaq *et al*. 2013). Previously about 174 species of rust fungi have been reported from this area (Afshan and Khalid 2008, 2009, Afshan *et al*. 2008a, b, c, d, 2010, Ishaq *et al.* 2013). During the exploration of Uredinales of Khyber Pakhtunkhwa (KP), rust infected plants were collected from different localities and examined macro-microscopically. Among the described species, *Aecidium saussureae-affinis* and *Uredopeltis chevalieri* are new records for Pakistan. *Grewia optiva*, *Carpesium trachelifolium* and *Malus pumila* are being reported here as new host records for rust fungi while telial stage of *Phakopsora ziziphi-vulgaris* is an addition to the already reported stages of this rust. *Ravenelia taslimii*, *Tranzschelia discolor* and *T. pruni-spinosae* are additions to the rust flora of Khyber Pakhtunkhwa Province. This work brings the total of rust taxa recorded from Khyber Pakhtunkhwa to 179.

Materials and Methods

Freehand sections and scrape mounts of infected plant materials were made in lactic acid. The plants were photographed and infected portions were observed under a stereomicroscope. Twenty spores of each spore state were examined under microscope (Nikon YS 100) and paraphyses and spore dimensions were taken by an Ocular micrometer (Zeiss Eyepiece Screw Micrometer). Sections, paraphyses and spores were microphotographed by digiporo-Labomed. Illustrations of spores and paraphyses were made under a Lucida camera (Ernst Leitz Wetzlar Germany).

*Author for correspondence: <pakrust@gmail.com>. [1]Department of Botany, Hazara University, Mansehra. [2]Department of Genetics, Hazara University, Mansehra. [3]Centre for Undergraduate Studies, University of the Punjab, Lahore.

Results and Discussion

Aecidium saussureae-affinis Dietel, Bot. Jb. 34: 591, (1905) (**Fig. 1**)

Spermogonia epiphyllous, equally spread over the surface or aggregate, brownish, subepidermal, globose to subglobose, 127 - 142 µm in diam. Aecia hypophyllous, on yellowish to dark brown lesions, 6 - 10 mm in diam, cupulate, 203 - 280 µm in diam., margins white, denticulate; Peridial cells usually hyaline, firmly conjoint, cylindrical or polyhedrally irregular, densely verrucose, 10.4 - 19.5 × 23.6 - 41.5 µm, outer walls 6.6 - 9.4, inner walls 2.3 - 5.4 µm. Aeciospores 10.3 - 14.4 × 13.1 - 17.2 µm, globose to ovate, catenulate, basal cell of chain stalked, sub-hyaline, almost smooth or minutely verrucose, usually two hyaline papillae bulging out from each spore, walls 1 - 1.5 µm thick.

Specimen examined: On *Carpesium trachelifolium* Less., Pakistan, Khyber Pakhtunkhwa Province, District Mansehra, Balakot, Nadibanglaw, at 2502 m a.s.l., 0 + I stages, Jul. 2011. MF # FR-006. (HUP Herbarium No. MFR-284).

Aecidium saussureae-affinis has previously been reported on different members of Compositae (Asteraceae) family i.e. *Hemisteptia carthamoides* (DC.) Kuntze, *H. lyrata* (Bunge) Fisch. & C.A.Mey., *Saussurea affinis* DC., *S. deltoidea* C.B. Clarke, *S. epilobioides* Maxim., *Saussurea japonica* (Thunb.) DC., *S. nigrescens* Maxim., *S. nuda* Ledeb., *S. oligantha* Franch., *S. phaeantha* Maxim., *S. populifolia* Hemsl., *S. superba* J. Anthony from Russia, China and Japan (Hiratsuka *et al*. 1992, Cao *et al*. 2000, Zhuang 2005, Farr and Rossman 2014). It is a new record for Pakistan and *Carpesium trachelifolium* is a new host for this rust fungus.

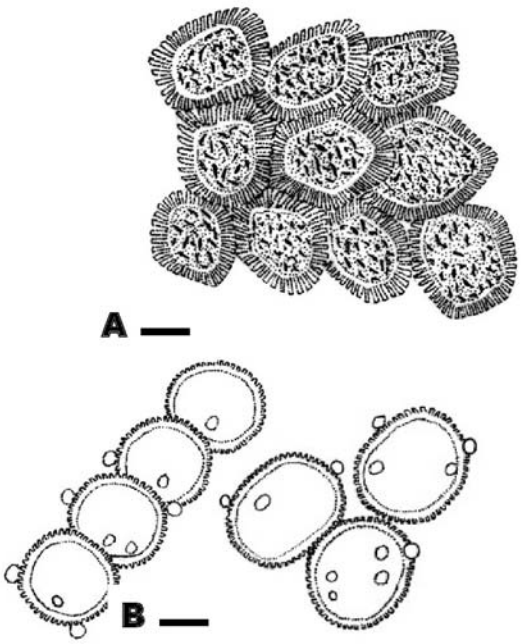

Fig. 1. *Aecidium saussureae-affinis* A. Line drawings of peridial cells. B. Aeciospores. Scale bar for A = 10 µm.

Uredopeltis chevalieri J. Walker & R.G. Shivas, Australas. Pl. Path. **33**(1): 43 (2004) (**Fig. 2**)

Spermogonia, aecia and telia not found. Uredinia minute, scattered, subepidermal, 150 µm across, sometime in small groups, up to 1 mm in diam, reddish brown; Paraphysis numerous,

clavate, mostly incurved and united at the base, thin walled, hyaline, up to 52.3 µm long, 8 - 13 µm wide at the broadest diam, with apically thick walls. Urediniospores subglobose to ovoid or pyriform, occasionally irregular. 15.3 - 21.4 × 19.4 - 34.6 µm, light yellowish brown, wall 1 - 1.5 µm thick, finely echinulate, germ pores 4, equatorial.

Specimen examined: On *Grewia optiva* J.R. Drumm. ex Burret, Pakistan, Khyber Pakhtunkhwa Province, District Mansehra, near Hathi Mara link road, at 950 m a. s. l., II stage, Oct. 2009. MF # FR-012. (HUP Herbarium No. MFR-278).

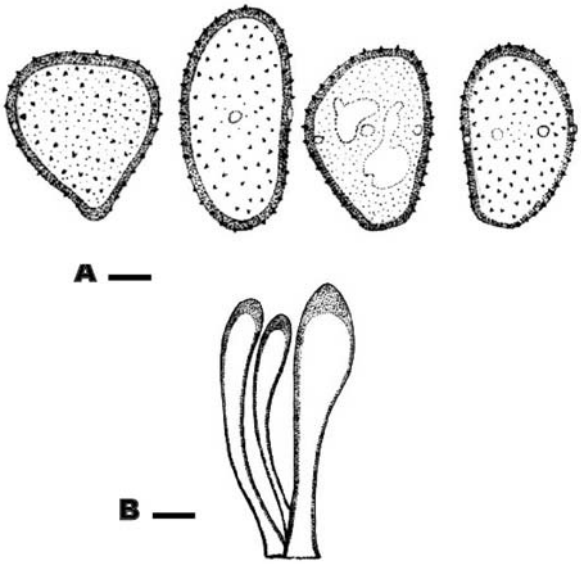

Fig. 2. *Uredopeltis chevalieri* A. Line drawing of urediniospores B. Clavate paraphyses. Scale bar for A = 7 µm, B = 8 µm.

Uredopeltis chevalieri is first time described and illustrated from Pakistan and *Grewia optiva* is a new host for rust fungi in Pakistan. The specimen has been collected a number of times in the same season and also in the consecutive years but the telial stage have not been found. Previously it has been reported on *Grewia latifolia* Benth., *G. asiatica* L., *G. bicolor* Juss., *G. breviflora* Benth., *G. cana* Sond., *G. ferruginea* Hochst., *G. hexamita* Burret, *G. monticola* Sond., *G. pubescens* Beauv., *G. salviifolia* L.f. and *G. tiliifolia* Vahl from North Africa, South Africa, Australia and India in South Asia (Mennicken *et al.* 2005, Wood 2007). From Pakistan, the uredinial stage of this rust fungus has been studied on *Grewia asiatica* from pathological point of view (Walker and Shivas 2004). *Grewia optiva* is a new host for this rust fungus.

Phakopsora ziziphi-vulgaris Dietel, Annls Mycol. **8**(3): 469 (1910) (**Fig. 3**)

Spermogonia, aecia and telia unknown. Uredinia hypophyllous, scattered or in small irregular groups, variable in size and shape, covered by epidermis; Paraphysis very few, hyphal, colorless, 29 - 44 µm long, 4 - 6.5 µm broad. Urediniospores ellipsoid to ovoid or obovoid, sometime slightly irregular, pale yellowish to yellowish brown, 12.3 - 17.5 × 15.1 - 25.3 µm, walls 1 - 1.6 µm thick, densely and minutely echinulate, germ pores obscure. Telia hypophyllous, subepidermal, not erumpent, minute, rounded, 0.1 - 0.4 mm in diam., dark reddish brown to

blakish. Teliospores in 2 - 4 layers, oblong or polygonal, 5.7 - 9.5 × 9.6 - 22.3 µm, walls 1 µm 1.65 µm thick, upper cells slightly thickened above, yellowish brown, smooth.

Specimen examined: On *Ziziphus jujuba* Mill., Pakistan, Khyber Pakhtunkhwa Province, District Mansehra, Parhena, at 1150 m a.s.l., II + III stages, Sep. 2009. MF # FR-061. (HUP Herbarium No. MFR-255).

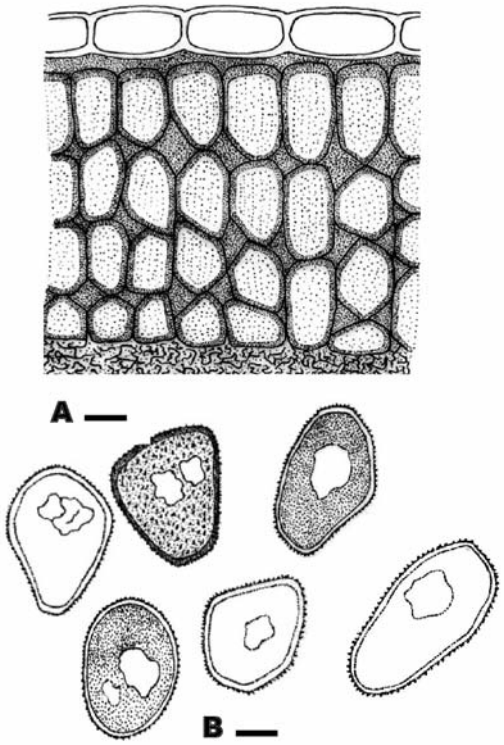

Fig. 3. *Phakopsora ziziphi-vulgaris* A. Line drawings of subepidermal telium
B. Urediniospores. Scale bar = 10 µm.

Telial stage of *Phakopsora ziziphi-vulgaris* is first time recorded from Pakistan and is an addition to the already reported stages of this rust. The uredinial stage of *Phakopsora ziziphi-vulgaris* has been reported on the leaves of *Ziziphus jujuba* from Tandojam, Lahore, Changa Manga, Bhalik, Hazara and Malir by Sydow and Ahmad (1939), Malik and Khan (1944), Ahmad (1956a, b) and Hasnain *et al*. (1959) and on *Ziziphus oxyphylla* Edgew. from Chakwal and Kallar Kahar (Kaneko 1993).

Ravenelia taslimii Mundk., Mycologia **30**(6): 687 (1939) [1938] (**Fig. 4**)

Uredinia subepidermal, mostly epiphyllous, sometime amphigenous, intermixed with teliosorus, Paraphysis in the sorus. Urediniospores oval to oblong, 12.4 - 16.2 × 15.2 - 26.6 µm, wall 1 - 1.5 µm, hyaline to reddish brown, echinulate, germ pores 2 - 4, equatorial. Telia mostly epiphyllous, rarely amphigenous or caulicolous, blakish brown, in groups or scattered, up to 1 mm

in diameter, subepidermal. Telial heads circular or almost circular in front view, convex and hemispherical in lateral view, 76.9 - 118.7 µm in diameter, 6 - 10 cells across, chestnut brown, smooth. Teliospores one celled, 8.7 - 15.3 × 16.9 - 30.6 µm, walls up to 5 µm thick at the apex, cyst hyaline, as many as the individual spores, hyaline, oblong to ovate.

Specimen examined: On *Acacia modesta* Wall., Pakistan, Khyber Pakhtunkhwa Province, District Mansehra, Khaki, Susal, at 1120 m a.s.l., II + III stages, Aug. 2010. MF # FR-011. (HUP Herbarium No. MFR-275).

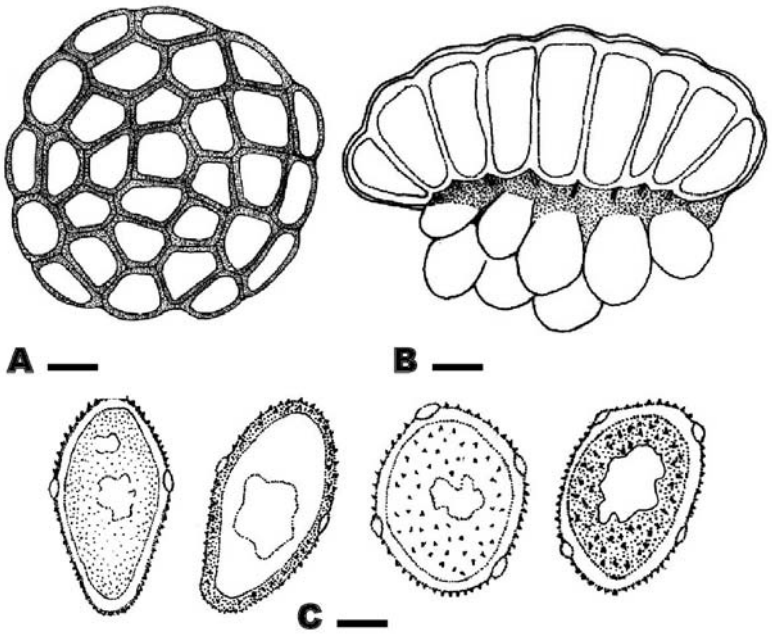

Fig. 4. *Ravenelia taslimii* A. Line drawing of telial head B. Section of the telial head C. Urediniospores: Scale bar for A = 25 µm, B = 17 µm, C = 5 µm.

R. taslimii is first time reported from Khyber Pakhtunkhwa Province. It is previously reported on *Acacia melanoxylon* R. Br. and *A. modesta* from India (Mundkur and Thirumalachar 1946, Kapoor and Agarwal 1974, Pande and Rao 1998); on *A. modesta* from different regions of Punjab, Pakistan by Sydow and Ahmad (1939), Ahmad (1956ab, 1976) and Kaneko (1993).

Tranzschelia discolor (Fuckel) Tranzschel & M.A. Litv., J. Bot., Paris **24**(3): 248 (1939) (**Fig. 5**)

Uredinia hypophyllous, on yellowish spots, scattered, often confluent, pulverulent, reddish brown; Urediniospores ovoid to ellipsoid or fusiform, 14.63 - 17.22 × 23.6 - 34.45 µm, walls upto 2 µm at the sides and 8.5 µm at the conical apex, light yellowish brown below, becoming dark brown at the conical apex, walls smooth above, echinulate at the lower half, germ pores 2 - 4, equatorial, numerous capitate paraphyses, hyaline to yellowish brown, thickened at the apex. Telia hypophyllous, crowded, erumpent, pulverulent, blakish brown, teliospores ellipsoid to oblong, 17.7 - 21.2 × 23.6 - 34.2 µm, walls 1 - 2 µm thick, chestnut brown, deeply constricted at the septum, upper cell globoid, chestnut brown, walls densely and coarsely verrucose, lower cell oblong or elliptic, light colored, more or less smooth; Pedicels colorless, up to 40 µm long.

Specimen examined: On *Malus pumila* Mill., Pakistan, Khyber Pakhtunkhwa Province, District Mansehra, Oghi, Kathai, at 1150 m a. s. l., II + III stages, Sep. 2009. MF # FR-060. (HUP Herbarium No. MFR-276).

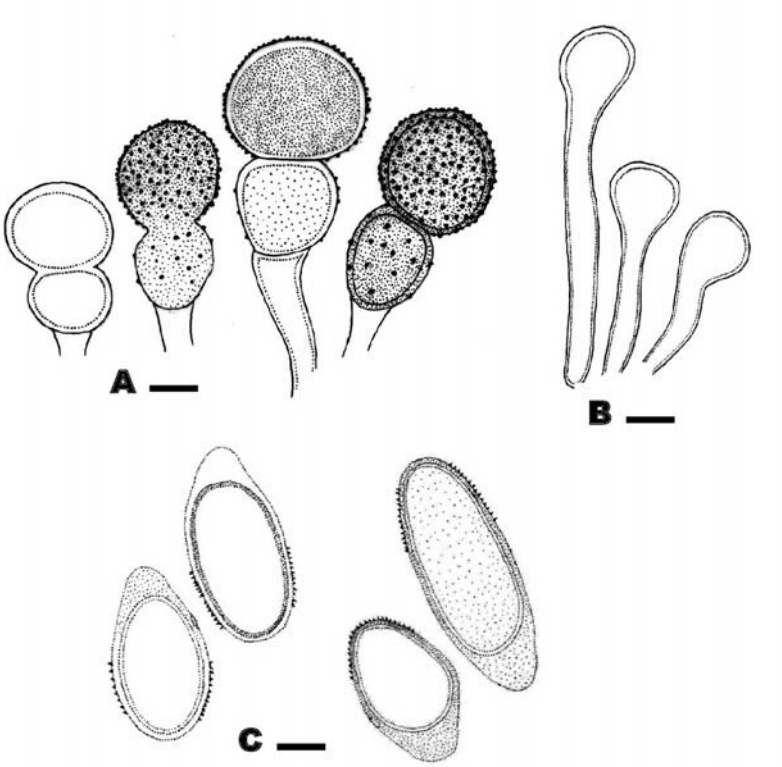

Fig. 5. *Tranzschelia discolor* A. Line drawings of teliospores B. Capitate paraphyses C. Urediniospores. Scale bar = 8 µm.

Malus pumila is a new host for this rust fungus and *Tranzschelia discolor* is a new record for Khyber Pakhtunkhwa Province, Pakistan. *Tranzschelia discolor* is a cosmopolitan rust fungus with aecial state on *Anemone* spp. (Ranunculaceae), uredinial and telial states on *Prunus* spp. (Rosaceae) (Laundon and Rainbow 1971a, b; Bolkan *et al*. 1985). From Pakistan, this rust is reported on leaves of *Prunus persica* from Tandojam by Khan and Kamal (1968).

Tranzschelia pruni-spinosae (Pers.) Dietel, Annls Mycol. **20**(1/2): 31 (1922) (**Fig. 6**)

Uredinia hypophyllous, scattered, often crowded, erumpent, reddish brown. Urediniospores ovoid to ellipsoid or fusiform 14.9 - 18.2 × 21 - 2.5 µm (mean 26.34 µm); walls up to 6.5 µm thick at the conical apex, smooth and dark brown, echinulate in the lower half, pale brown, germ pores 2 - 4, equatorial; Paraphyses numerous, yellowish brown or paler, capitate, thickened at the apex. Telia hypophyllous, often crowded, erumpent, blakish brown. Teliospores ellipsoid to oblong, 17.3 - 21.2 × 27.3 - 37.4 µm, constricted at the septum, both cells globose, wall 1.4 - 2 µm thick at the sides, apices up to 4.4 µm thick, dark brown, coarsely verrucose, pedicel hyaline, up to 30 µm long, deciduous.

Specimen examined: On *Prunus persica* L. Batsch., Pakistan, Khyber Pakhtunkhwa Province, District Mansehra, College doraha, at 978 m a. s. l., II + III stages, Oct. 2009. MF # FR-077. (HUP Herbarium No. MFR-277).

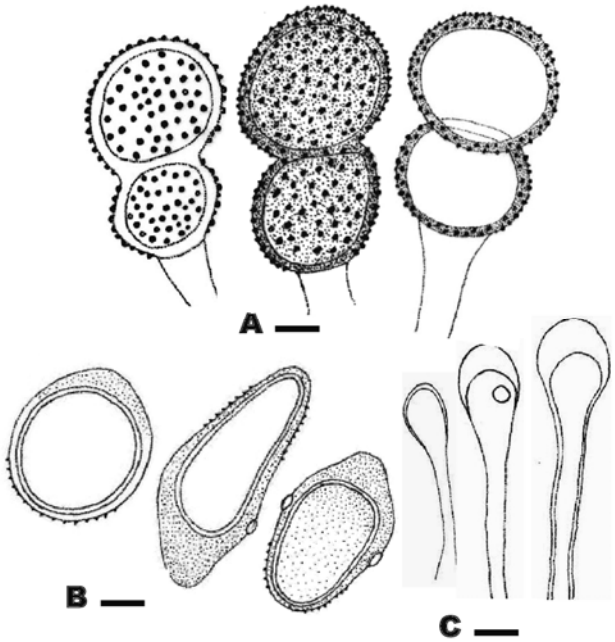

Fig. 6. *Tranzschelia pruni-spinosae* A. Line drawings of teliospores B. Urediniospores C. Capitate paraphyses. Scale bar for A = 10 µm.

Tranzschelia pruni-spinosae is cosmopolitan rust. It is reported on about 279 taxa of Ranunculaceae and 157 *Prunus* species (Laundon and Rainbow 1971a, b, Wilson and Henderson 1966, Farr and Rossman 2014). It differs from *T. discolor* by mode of teliospore development and shape of teliospores (Hiratsuka *et al.* 1992). From Pakistan, *T. pruni-spinosae* has previously been reported on *Prunus persica* from Choa Saiden Shah by Ahmad (1956a, 1976), Khan and Kamal (1968), Malik *et al.* (1968), Malik and Virk (1968), Iqbal and Khalid (1996). But it is a new record for Khyber Pakhtunkhwa Province.

Acknowledgements

uthors sincerely thank Dr. Abdul Rehman Niazi (Department of Botany, University of the Punjab, Lahore, Pakistan) for his help in the field tours and laboratory work.

References

Afshan NS and Khalid AN 2008. New rust fungi on noxious weeds from Pakistan. Pakistan Journal of Phytopathology **20**: 82-87.

Afshan NS and Khalid AN 2009. New records of *Puccinia* and *Pucciniastrum* from Pakistan. Mycotaxon **108**: 137-146. http://dx.doi.org/10.5248/108.137

Afshan NS, Khalid AN, Niazi AR 2008a. New records and distribution of rust fungi from Pakistan. Mycotaxon **105**: 257-267.

Afshan NS, Khalid AN, Niazi AR 2008b. New records of graminicolous rust fungi from Pakistan. Pakistan J. Bot. **40**: 1279-1283.

Afshan NS, Khalid AN, Javed H 2008c. Further addition to the rust flora of Pakistan. Pakistan J. Bot. **40**: 1285-1289.

Afshan NS, Berndt R, Khalid AN, Niazi AR 2008d. New graminicolous rust fungi from Pakistan. Mycotaxon **104**:123-130.

Afshan NS, Niazi AR, Khalid AN 2010. Three new species of rust fungi from Pakistan. Mycological Progress **9**: 485-490. http://dx.doi.org/10.1007/s11557-010-0655-8.

Ahmad S 1956a. Uredinales of Pakistan. Biologia **2**: 29-101.

Ahmad S 1956b. *Fungi of Pakistan*. Biological Society of Pakistan, Lahore.

Ahmad S 1976. Contribution to the fungi of Pakistan. XVII. Sultania **18**: 1-6.

Bolkan HA, Ogawa JM, Michailides TJ, Kable PF 1985. Physiological specializations in *Tranzschelia discolor*. Plant Diseases **69**: 485-486.

Cao ZM, LI ZQ, Zhuang JY 2000. Uredinales from the Qinling Mountains. II. Mycosystema **19**: 312-316.

Farr DF and Rossman AY 2014. Fungal Databases, Systematic Mycology and Microbiology Laboratory, ARS, USDA. http://nt.ars-grin.gov/fungaldatabases/

Hasnain SZ, Khan A, Zaidi AJ 1959. *Rusts and smuts of Karachi*. Department of Botany, University of Karachi.

Hiratsuka N, Sato S, Katsuya K, Kakishima M, Hiratsuka Y, Kaneko S, Ono Y, Sato T, Harada Y, Hiratsuka T, and Nakayama K 1992. *The rust flora of Japan*. Tsukuba Shuppankai, Tsukuba.

Iqbal SH and Khalid AN 1996. Material for the fungus flora of Pakistan. II. An updated check list of rust fungi (Uredinales) of Pakistan. Sultania **1**: 39-67.

Ishaq A, Afshan NS, Khalid AN 2013. New records of *Puccinia* on Poaceae from Khyber Pakhtunkhwa, Pakistan. Mycotaxon **126**: 177-182.

Kaneko S 1993. Parasitic fungi on woody plants from Pakistan. *Cryptogamic Flora of Pakistan*, Vol. 2 (Eds. T. Nakaike and S. Malik), Nat. Sci. Mus., Tokyo, Japan. pp. 149-168.

Kapoor JN and Agarwal DK 1974. Indian species in *Ravenelia* - I : on *Acacia*. Ind. Phytopathol. **21**: 666-669.

Khan SA and Kamal M 1968. The fungi of South West Pakistan. Part 1. Pakistan Journal of Science & Industrial Research **11**: 61-80.

Laundon GF and Rainbow AF 1971a. *Tranzschelia pruni-spinosae* var. *discolor*. C.M.I. Descriptions of pathogenic fungi and bacteria **287**: 1-2.

Laundon GF and Rainbow AF 1971b. *Tranzschelia pruni-spinosae* var. *pruni-spinosae*. C.M.I. Descriptions of pathogenic fungi and bacteria **288**: 1-2.

Malik SA and Khan MA 1944. Parasitic fungi of the North West Frontier Province. Indian Journal of Agricultural Sciences **13**: 522-527.

Malik SA and Virk 1968. Contribution to the knowledge of parasitic fungi of Quetta-Kalat Region. Biologia **14**: 27-35.

Malik SA, Javaid MT, Ahmad M 1968. Uredinales of Quetta-Kalat region of Pakistan. Biologia **14**: 37-46.

Mennicken M, Maier W, Oberwinkler F 2005. A contribution to the rust flora (Uredinales) of southern Africa, with an emphasis on Namibia. Mycological Progress **4**: 55-75.

Mundkur BB and Thirumalachar MJ 1946. Revisions of and additions to Indian fungi. I. Mycological Papers **16**: 1-27.

Pande A and Rao VG 1998. *A Compendium of Fungi on Legumes from India*. Scientific Publishers (India), Jodhpur. pp. 188.

Sydow H and Ahmad S 1939. Fungi Punjabensis. Annals of Mycology **37**: 439-447.

Walker J and Shivas RG 2004. *Uredopeltis chevalieri* sp. nov., the rust of *Grewia* (Tiliaceae) formerly known as *Phakopsora* (or *Dasturella*) *grewiae*, its first record in Australia and a summary of the known rusts of Grewia. Australian Plant Pathology **33**: 41-47.

Wilson M and Henderson DM 1966. *British rust fungi*, Cambridge University Press, Cambridge. pp. 62-64.

Wood AR 2007. Rust fungi (Uredinales) on *Grewia* species (Tilliaceae) in South Africa, with *Uredopeltis atrides* comb. nov. the new name for *Ravenelia atrides*. Mycological Progress **6**: 93-99.

Zhuang WY 2005. *Fungi of northwestern China*. Mycotaxon, Ltd., Ithaca, NY, pp. 430.

(Manuscript received on 5 July, 2015; revised on 20 July, 2016)