



Full Length Article

New Records of Uredinales (Basidiomycota) from Azad Jammu and Kashmir and Adjacent Northern Areas of Pakistan

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Abstract

A contribution is made to the rust fungus flora of AJ and K (Lawat, Leepa Valley and Jabba) and adjacent Northern Areas (Fairy Meadows) of Pakistan. During this survey, eleven different host plants were found infected with ten rust fungi belonging to five different genera. Among these, *Cerotelium fici*, *Puccinia aestivalis*, *P. chrysanthemi*, *P. sibirica*, *P. swertiae*, *P. wattiana*, *Pucciniastrum agrimoniae* and *Tranzschelia discolor* are newly recorded from Azad Jammu and Kashmir, while *Puccinia nitidula*, *P. sibirica* and *Uromyces vossiae* are first time reported from Northern Areas of Pakistan. Moreover, *Bistorta vivipara* for *Puccinia sibirica*, *Microstegium nudum* for *P. aestivalis* and *Prunus domestica* for *Tranzschelia discolor* are reported as new hosts from Pakistan. In addition to the light microscopy, scanning electron microscopy have been incorporated to upgrade the previous descriptions and for correct identification of these fungi. © 2013 Friends Science Publishers

Keywords: Fairy meadows; First report; Phytopathogens; Rust fungi

Introduction

Azad Jammu and Kashmir lies in the Northeast of Pakistan. Azad Kashmir has very significant geographical distribution among mountainous ranges. It comprises foothills of the Himalayas rising to Jamgarh Peak (4, 734 m) with the Northwestern reaches of the Pir Panjal Range (3,753 m) to the South. Due to extensive topographic variations in the areas of Azad Kashmir, there exists a diversity of plant species. About 10.6% of the total flora of Pakistan is represented in the area of Azad Kashmir and adjacent Northern Areas of Pakistan (Ali and Qaiser, 1986; Afshan *et al.* 2011). In spite of being floristically rich, these areas have not been thoroughly surveyed for rust fungi and approximately 105 species have been reported to date (Ahmad, 1956a, b; Gjaerum and Iqbal, 1969; Kakishima *et al.*, 1993a, b; Kaneko, 1993; Khalid *et al.*, 1995; Khalid and Iqbal, 1996, 1997; Ahmad *et al.*, 1997; Sultan *et al.*, 2006a, b, 2008; Iqbal *et al.*, 2008, 2009; Afshan and Khalid, 2009; Afshan *et al.*, 2009, 2010, 2011; Ishaq *et al.*, 2011; Khalid and Saba, 2011; Saba and Khalid, 2011; Saba *et al.*, 2011).

During collecting trips for the rust fungi of Azad Jammu and Kashmir (Lawat, Leepa Valley, Jabba) and adjacent Northern Areas (Fairy Meadows) of Pakistan in 2009 to 2011, eight new records for Azad Jammu and Kashmir and three for Northern Areas of Pakistan along with some new host records have been described. With these additions, the number of rust fungi has been raised to 116 from these areas of Pakistan.

Materials and Methods

During a field survey on the rust fungi of the Azad Jammu and Kashmir and adjacent Northern Areas, infected plants were collected from selected sampling sites i.e., Lawat, Leepa Valley and Jabba (AJ and K) and Fairy Meadows (Northern Areas). Healthy plants were collected along with inflorescences and fruits for accurate identification. Host plants were identified by comparing them with specimens in the herbarium of the Department of Botany, University of the Punjab, Lahore (LAH).

Free hand sections of infected portions of material and spores were mounted in lactophenol. Semi-permanent slides were prepared by cementing cover slips with nail lacquer (Dade and Gunnell, 1969). Preparations were observed under a NIKON YS 100 microscope. Drawings of spores were made by using a Camera Lucida (Ernst Leitz, Wetzlar, Germany). Spores were measured using an ocular micrometer (Zeiss, St Albans, Hertfordshire, England). At least twenty-five spores were measured for each spore stage. Measurements include the usual range and the arithmetic means; extremes are given in parentheses.

Results and Discussion

Cerotelium fici (Castagne) Arthur, *Bull. Torrey bot. Club* 44: 509 (1917) (Fig. 1).

Spermogonia, aecia and telia not seen. Uredinia hypophyllous, yellowish, minute, covered with ruptured

epidermis, pulverulent, scattered over the whole leaf surface, surrounded by numerous incurved paraphyses. Urediniospores subglobose or ovoid, yellowish brown, $12\text{--}18 \times 16\text{--}26 \mu\text{m}$; wall densely echinulate, germ pores 2–4, scattered.

Material Examined

On *Ficus palmata* Roxb., with II stage, Pakistan, Azad Jammu and Kashmir, Leepa Valley, at 1981 m a.s.l., October, 2010. MSB # 028 (LAH).

Comments

Cerotelium fici has been reported on leaves of *Ficus palmata*, *F. carica* L., *F. religiosa* L. from Lahore, Changa Manga, Sangla Hill, Tandojam, Malir (Karachi) and Rawalpindi by Ahmad (1956a, b), Hasnain *et al.* (1959), Khan and Kamal (1968), Ghaffar and Kafi (1968) and Kaneko (1993).

Cerotelium fici is a new record for Azad Jammu and Kashmir, Pakistan.

Puccinia aestivalis Dietel, *Bot. Jb.* 34: 585 (1905) (Fig. 2).

Spermogonia, aecia and telia not seen. Uredinia on abaxial surface of leaf, blackish brown, covered with ruptured epidermis, scattered. Urediniospores mostly oval, cinnamon brown, $14.8\text{--}21.7 \times 18.8\text{--}29.5 \mu\text{m}$ (mean $19.3 \times 22.9 \mu\text{m}$); wall $1\text{--}1.6 \mu\text{m}$; echinulate, germ pores 3 (4), equatorial; pedicel $4.4\text{--}5.9 \times 7\text{--}31.6 \mu\text{m}$. Amphispores obovoid or pyriform, thick walled. Paraphyses capitate, $28.7\text{--}59 \mu\text{m}$ long, $14\text{--}18.4 \mu\text{m}$ thick apically, while $4.2\text{--}6.3 \mu\text{m}$ at the base.

Material Examined

On *Microstegium nudum* A. Camus, with II stage, Pakistan, Azad Jammu and Kashmir, Leepa Valley, at 1981 m a.s.l., October, 2010. MSB # 029 (LAH).

Comments

Puccinia aestivalis has been reported on *Microstegium* sp. from Rawlakot (AJ and K) by Kakishima *et al.* (1993b). This rust fungus is a new record for Leepa Valley, Azad Jammu and Kashmir, Pakistan and *Microstegium nudum* is a new host for this rust fungus.

Puccinia chrysanthemi Roze, *Bull. Soc. mycol. Fr.* 16: 92 (1900) (Fig. 3).

Spermogonia and aecia not seen. Uredinia abaxial, yellowish, pulverulent, scattered, minute. Urediniospores subglobose, ellipsoid or obovoid, yellowish brown, $19\text{--}25 \times 28\text{--}35$ (–40) μm ; wall echinulate, $1\text{--}1.5 \mu\text{m}$; germ pores upto 2, equatorial. Telia hypophyllous, pulverulent, black, gregarious. Teliospores ellipsoid–oblong or oblong–clavate, slightly constricted at the septum, slightly attenuated below,

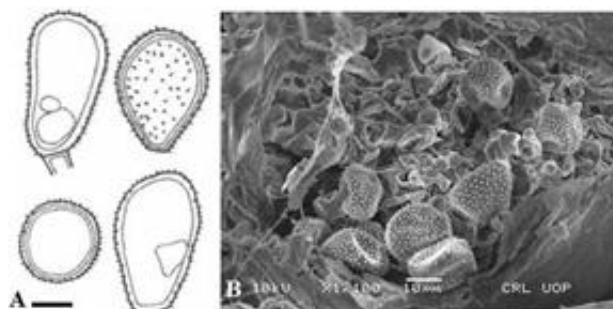


Fig. 1: *Cerotelium fici* (A) Lucida drawings of urediniospores showing echinulate ornamentation (B) Uredinium showing urediniospores surrounded by several incurved paraphyses as seen by scanning electron microscope. Scale bar: A = 7 μm

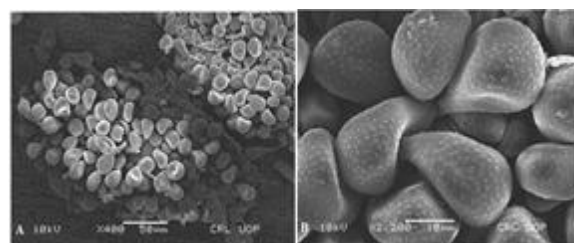


Fig. 2: *Puccinia aestivalis* (A–B) Uredinium showing urediniospores with echinulate ornamentation as seen by scanning electron microscope

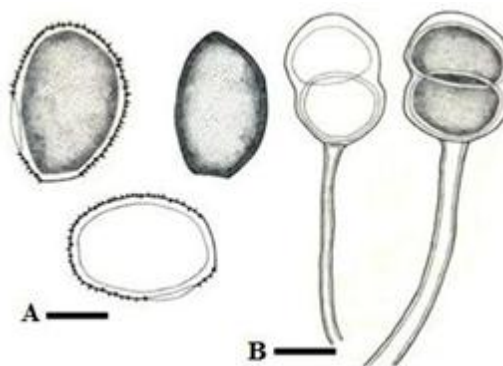


Fig. 3: Lucida drawings of *Puccinia chrysanthemi* (A) Urediniospores showing germ pores and echinulate ornamentation (B) Teliospores. Scale bar: A = 11 μm and B = 22 μm

$29\text{--}33 \times 47\text{--}61 \mu\text{m}$; wall verrucose, $1.5\text{--}2.5 \mu\text{m}$; apex dark brown with hyaline papilla, conical or rounded, $3\text{--}6 \mu\text{m}$; pedicel hyaline to yellowish brown, persistent, $6\text{--}8 \times 26\text{--}122 \mu\text{m}$.

Material Examined

On *Artemisia parviflora* Buch.-Ham. ex Roxb., with II + III

stages, Pakistan, Azad Jammu and Kashmir, Neelum Valley, Lawat at 1,981 m a.s.l., October, 2009. MSB # 030 (LAH).

Comments

Puccinia chrysanthemi has previously been reported on *Artemisia persica* Boiss., *A. parviflora* Buch.-Ham. ex Roxb. *A. dubia* Wall., *A. dracuncululus* L., *A. brevifolia* L. and *A. maritima* L. from Quetta, Chitral, NWFP, Swat, Kaghan Valley and Fairy Meadows by Ahmad *et al.* (1997) and Afshan *et al.* (2008b).

It is a new record for Lawat, Azad Jammu and Kashmir, Pakistan.

Puccinia nitidula Tranzschel (1911) (Fig. 4).

Spermogonia and aecia not seen. Uredinia amphigenous but mostly hypophyllous, intermixed, scattered, roundish, pulverulent, blackish brown, 0.14–0.3 × 0.2–0.3 mm. Urediniospores subglobose, obovoid or ellipsoid, hyaline to pale yellow, (15–) 17–23 × (18–) 20–24 μm; wall 1–1.5 μm thick, echinulate; germ pores obscure, upto 4 in number, equatorial. Telia amphigenous, but mostly hypophyllous, intermixed, roundish, scattered, pulverulent, naked, blackish brown, 0.14–0.3 × 0.2–0.3 mm. Teliospores ellipsoid, rounded at both ends, dark brown, slightly constricted at the septa, 18–21 × 26–32 μm; wall 1–1.5 μm thick, smooth; germ pore 1 per cell, mostly apical in the distal cell and near the pedicel or at the septum in the proximal cell, hyaline umbos over the germ pores; apex not thickened; pedicel short, hyaline, not persistent, 3–13 μm long.

Material Examined

On *Bistorta amplexicaulis* (D. Don) Greene, (*Polygonum amplexicaule* D. Don.), with II + III stages, Pakistan, Northern Areas, Fairy Meadows, at 3,036 m a.s.l., July, 2010. MSB # 034 (LAH).

Comments

Puccinia nitidula has previously been reported on *Bistorta amplexicaulis* (D. Don) Greene (= *Polygonum amplexicaule*) from Swat Valley, Neelum Valley and Dunga Gali (NWFP) by Okane *et al.* (1992); on *B. vivipara* (L.) S. F. Gray from Swat Valley, Saiful Maluk, and Sharan (Kaghan Valley) by Ono and Kakishima (1992), Ono (1992) and Kakishima *et al.* (1993a, b); on *Aconogonon molle* (D. Don) H. Hara from Hazara, Sharan, Shogran (Kaghan Valley) by Kakishima *et al.* (1993a).

Puccinia nitidula is a new record for Fairy Meadows (Northern Areas), Pakistan.

Puccinia sibirica Tranzschel (1911) (Figs. 5–6).

Spermogonia and aecia not seen. Uredinia on abaxial side, scattered, naked, pulverulent, cinnamon brown to dark brown, similar, 0.06–0.1 × 0.1–0.3 mm.

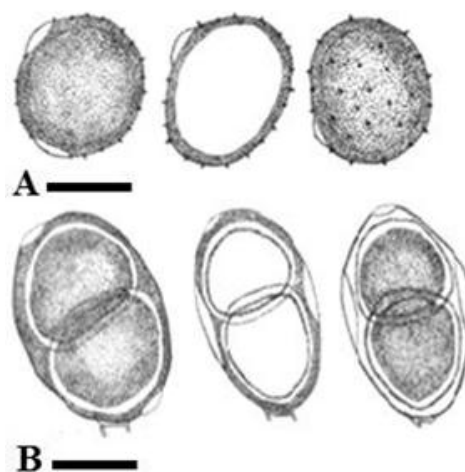


Fig. 4: Lucida drawings of *Puccinia nitidula* (A) Urediniospores showing echinulate ornamentation and germ pores (B) Teliospores showing apical germ pore in distal cell and at the septum or near the pedicel in proximal cell. Scale bar: A and B = 8 μm

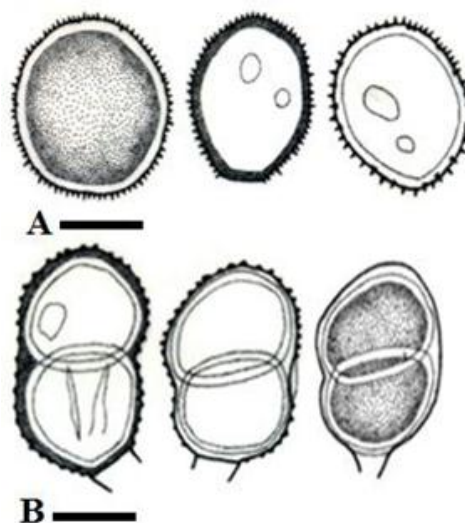


Fig. 5: Lucida drawings of *Puccinia sibirica* (A) Urediniospores showing echinulate ornamentation (B) Teliospores showing verrucose ornamentation. Scale bar: A and B = 8 μm

Urediniospores globose to subglobose or ellipsoid, cinnamon brown, 17–22 × 20–24 μm; wall 1–1.2 μm, echinulate; germ pores 3 or 4, obscure, equatorial. Telia similar to uredinia, black, naked, 0.06–0.1 × 0.1–0.3 mm. Teliospores broadly ellipsoid or broadly ovoid, dark brown to chestnut brown, rounded at both ends, not or slightly constricted at the septum, 17.7–22 × 21–32 μm; wall verrucose, 1–1.5 μm; germ pores one per cell, mostly adjacent to the septum, or rarely apical in upper cell; apex not thickened, dark brown; pedicel short, deciduous, hyaline, 5–9.4 × 3–6.4 μm.

Material Examined

On *Polygonum* L., with II + III stages, Pakistan, Azad Jammu and Kashmir, Neelum Valley, Lawat, at 1,981 m a.s.l., October, 2009. MSB # 035 (LAH); On *Bistorta vivipara* (L.) Delarbre, with II + III stages, Pakistan, Northern Areas, Fairy Meadows, at 3,036 m a.s.l., July, 2010. MSB # 036 (LAH).

Comments

Puccinia sibirica has previously been reported on *Polygonum alpinum* All. and *Aconogonon molle* (D. Don) H. Hara from Naran and Swat by Ahmad (1960, 1969), Jørstad and Iqbal (1967), Ono and Kakishima (1992) and Ono (1992).

It is a new record for Fairy meadows (Northern Areas) and Lawat (Azad Jammu and Kashmir), Pakistan. *Bistorta vivipara* is a new host for this rust fungus.

Puccinia swertiae (Opiz) G. Winter, *Rabenh. Krypt.-Fl.*, Edn 2 (Leipzig) 1.1: 205 (1881) [1884] (Fig. 7).

Spermogonia and uredinia not seen. Aecia on abaxial side, cupule, yellowish, gregarious, 0.2–0.3 × 0.3–0.45 mm. Peridial cells yellowish brown, rhomboidal to oblong or irregular, 17.7–39 × 22–53 µm (mean 35.28–37.86 µm); wall densely verrucose, 2.8–8.5 µm. Aeciospores obovoid or subglobose, hyaline to brown, 19.6–25.2 × 20.5–27 (–36) µm (mean 21.8 × 24.4 µm); wall finely verrucose, 0.5–1.2 µm. Telia abaxial, black, pulverulent, covered by ruptured epidermis, scattered, naked, 0.1–0.2 × 0.18–0.8 mm. Teliospores obovoid or ellipsoid, rounded at both ends, not or hardly constricted at septum, dark brown to chestnut brown, 25–30.4 × 31–39 µm (mean 27 × 35 µm); wall verrucose, 1.8–3.5 (–4) µm; germ pores two, next to the septum in both upper and lower cells, rarely apical in upper cell; apex dark brown to chestnut brown, not or slightly thickened, 1.2–2 µm; pedicel short, hyaline, persistent, 4–9.4 × 2.6–8.5 µm.

Material Examined

On *Swertia petiolata* Royle, with II + III stages, Pakistan, Azad Jammu and Kashmir, Neelum Valley, Jabba, at 1,981 m a.s.l., October, 2009. MSB # 037 (LAH).

Comments

Puccinia swertiae has been reported on *Swertia petiolata* D. Don., *S. speciosa* Wall. from Kalam (Swat), Sargodha, Shogran (Kaghan Valley) by Ahmad (1956a,b), Jørstad and Iqbal (1967), Ono and Kakishima (1992) and Ono (1992). *Puccinia swertiae* is a new record for Azad Jammu and Kashmir, Pakistan.

Puccinia wattiana Barclay, *Journal of the Asiatic Society of Bengal* 54: 109 (1890) (Fig. 8).

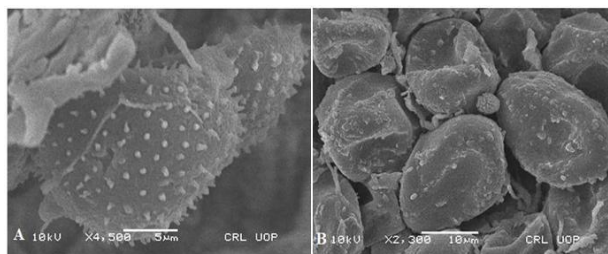


Fig. 6: Scanning electron micrographs of *Puccinia sibirica* (A) Urediniospore showing echinulate ornamentation (B) Teliospores showing verrucose ornamentation

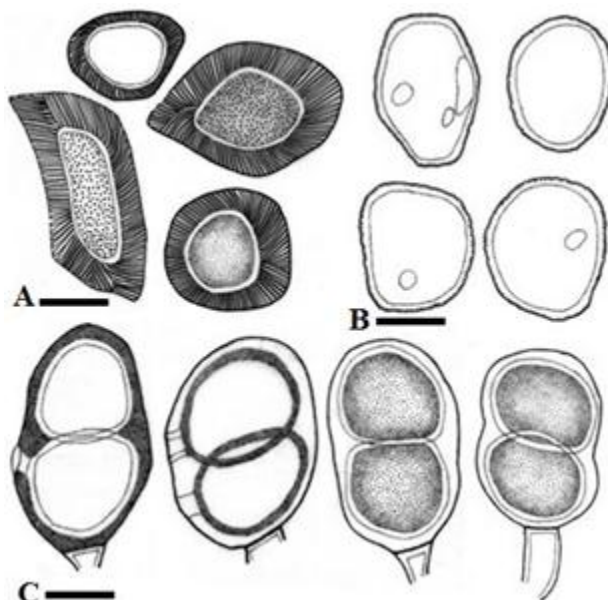


Fig. 7: Lucida drawings of *Puccinia swertiae* (A) Peridial cells showing deep verrucose ornamentation (B) Aeciospores with minute verrucose ornamentation (C) Smooth walled teliospores. Scale bar: A, B and C = 10 µm

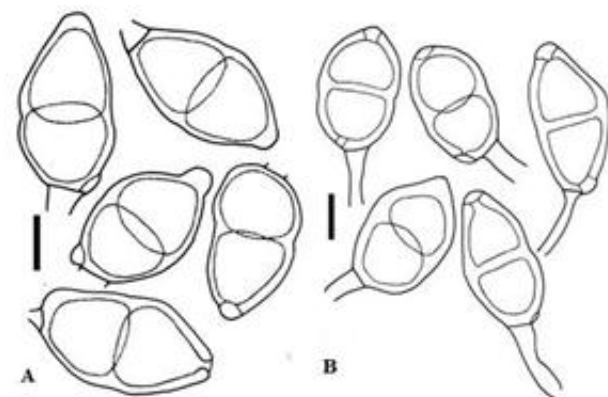


Fig. 8: Lucida drawings of *Puccinia wattiana* (A) Thin walled teliospores (B) Thick walled teliospores. Scale bar: A and B = 15 µm

Spermogonia, aecia and uredinia not seen. Telia amphigenous, blackish, rounded, pulverulent, rarely in groups, naked, sometimes surrounded by ruptured epidermis. Teliospores 1–4 celled, 1–2 celled abundantly, rarely 3–4 celled, dimorphic, ellipsoid or oblong, golden brown to chestnut or blackish brown, $21.2\text{--}25.7 \times 35.4\text{--}45$ ($\text{--}50.7$) μm ; wall chestnut brown or paler, smooth, $1.6\text{--}2.8$ μm , not constricted at the septum, rounded at both ends, germ pores 2, apical in upper cell and near or adjacent to the pedicel in lower cell; apex dark brown, rounded or rarely conical, $2\text{--}5.4$ μm ; pedicel long, deciduous, collapsing, hyaline, $5\text{--}9.2 \times 3\text{--}112$ μm . One-celled teliospores abundant, ellipsoid, chestnut brown, $14.6\text{--}22.4 \times 26.1\text{--}35.8$ μm ; smooth walled; apex conical, $4.2\text{--}5.6$ μm ; pedicel long, hyaline, $12.5\text{--}81$ μm . Teliospores germinate without dormancy. Phragmobasidia present, external. Basidiospores borne on sterigmata, globose to ovoid, hyaline.

Material Examined

On *Clematis grata* Wall. with III + IV stages, Pakistan, Leepa Valley, Azad Jammu and Kashmir, at 1,981 m a.s.l., October, 2010. MSB # 031 (LAH).

Comments

Puccinia wattiana has previously been reported on *Clematis grata* from Miana, Margzar (Swat) and Murree by Ahmad (1956a, b); on *C. barballata* Edgew., from Kawai (Kaghan Valley) by Ono (1992) and Kakishima et al. (1993a). It is a new record for Leepa Valley, Azad Jammu and Kashmir.

Pucciniastrum agrimoniae (DC.) Tranzschel, *Scripta Bot. Horti Univ. Imper. Petrop.* 4: 301 (1895). (Fig. 9).

Spermogonia, aecia and telia not seen. Uredinia on abaxial side of leaf, yellowish orange, scattered but somewhat compact, in groups, sub-epidermal, pulverulent, $0.06\text{--}0.07 \times 0.1\text{--}0.2$ mm. Urediniospores globose, subglobose, obovoid or ellipsoid, hyaline to yellowish brown, $10\text{--}15 \times 15\text{--}19$ μm ; wall $1\text{--}1.5$ μm thick, echinulate; germ pores 4–6, obscure, scattered.

Material Examined

On *Agrimonia aitchisonii* Schonb. -Tem., with II stage, Pakistan, Azad Jammu and Kashmir, Leepa Valley, at 1,981 m a.s.l., October, 2010. MSB # 032 (LAH).

Comments

Pucciniastrum agrimoniae has previously been reported from Hazara by Malik and Khan (1944) and Ahmad (1956a, b).

It is a new record for Leepa Valley, Azad Jammu and Kashmir, Pakistan.

Tranzschelia discolor (Fuckel) Tranzschel and M.A. Litv., *J. Bot.*, Paris 24 (3): 248 (1939) (Fig. 10).

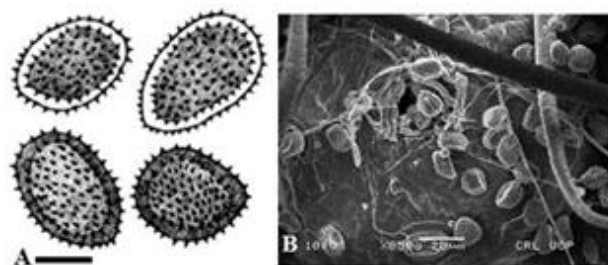


Fig. 9: *Pucciniastrum agrimoniae* (A) Lucida drawings of urediniospores showing echinulate ornamentation (B) Urediniospores as seen by scanning electron microscope. Scale bar: A = 10 μm

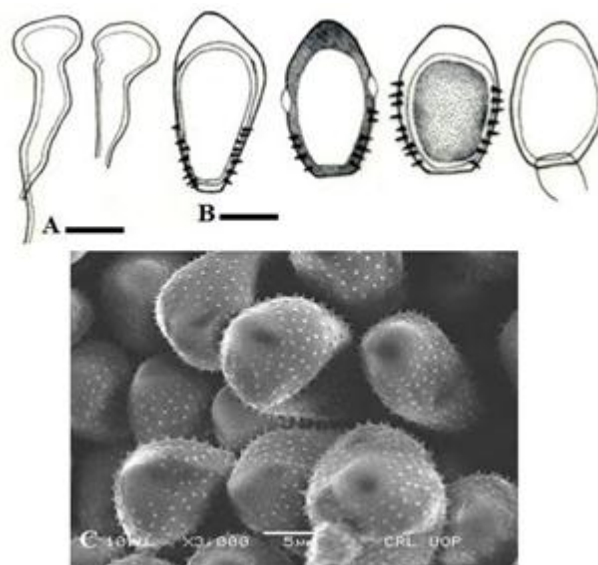


Fig. 10: *Tranzschelia discolor* (A–B) Lucida drawings of capitulate paraphyses and urediniospores showing echinulate ornamentation at the proximal end (C) Urediniospores showing smooth apices and echinulated base as seen by scanning electron microscope. Scale bar: A and B = 10 μm

Spermogonia, aecia and telia not seen. Uredinia hypophyllous, yellowish, pulverulent, naked, scattered, sometimes gregarious. Urediniospores reddish brown or pale brown, ellipsoid or fusiform, $14\text{--}18 \times 21\text{--}29$ μm ; wall pale brown, echinulate near the proximal end, $1\text{--}2$ μm ; apex $2\text{--}5$ μm thick; germ pores 4, equatorial; pedicel hyaline, short, deciduous; paraphyses capitulate, present abundantly, hyaline at the base and pale brown at the apex, thin walled, $36\text{--}45$ μm long, $5\text{--}9$ μm thick basally and $14\text{--}24$ μm thick apically.

Material Examined

On *Prunus domestica* L., with II stage, Pakistan, Azad Jammu and Kashmir, Leepa Valley, at 1,981 m a.s.l., October, 2010. MSB # 033 (LAH).

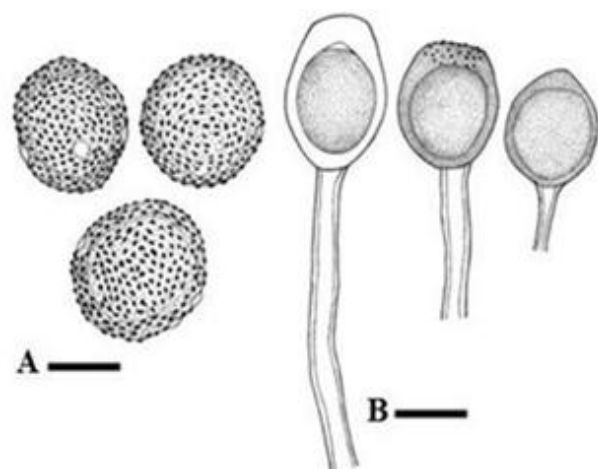


Fig. 11: *Uromyces vossiae* (A) Urediniospores showing striolate verrucose ornamentation and germ pores (B) Teliospores showing verrucose ornamentation at the apices. Scale bar: A and B = 10 μ m

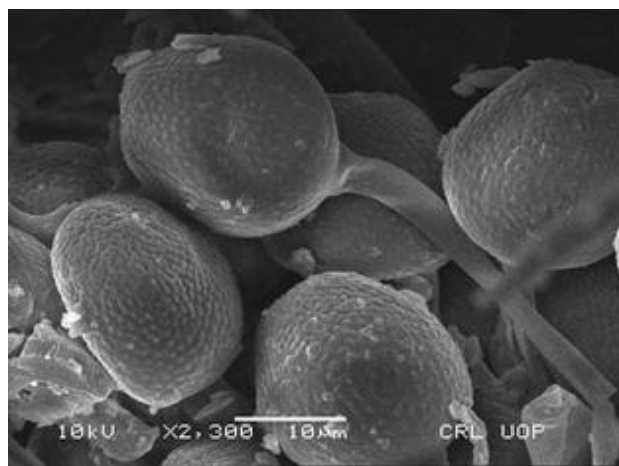


Fig. 12: Urediniospores, showing striolated verrucose ornamentation and a teliospore showing verrucose ornamentation with long pedicel, of *Uromyces vossiae* as seen by scanning electron microscope

Comments

Tranzschelia discolor has previously been reported on leaves of *Prunus persica* (L.) Batsch. from Tandojam by Khan and Kamal (1968).

Prunus domestica is a new host for this rust fungus and it is a new record for Leepa Valley, Azad Jammu and Kashmir, Pakistan.

Uromyces vossiae Barcl. *J. Asiat. Soc. Bengal* 59: 76 (1890) (Figs. 11–12).

Spermogonia and aecia not seen. Uredinia on abaxial side of leaf, sub-epidermal, yellowish brown to dark brown, scattered, 0.06–0.1 \times 0.12–0.2 mm. Urediniospores globose to subglobose or ellipsoid, golden brown to dark brown,

18–24 \times 21–25 μ m; wall 1–2 (–3) μ m thick, striolate verrucose; germ pores 2–4, obscure, equatorial; paraphyses clavate, up to 55 μ m long and 8 μ m wide. Telia amphigenous but mostly on abaxial surface, black, compact, sub-epidermal, 0.04–0.07 \times 0.06–0.14 mm. Teliospores ovoid to ellipsoid, cinnamon brown to chestnut brown, 20–26 \times 23–31 μ m; wall 1–3 μ m thick, minutely verrucose at the apex; germ pore 1 per cell, equatorial; apex 4–6 μ m thick. Pedicel hyaline, persistent, collapsing, 6–7 \times 16–80 μ m.

Material Examined

On *Phacelurus speciosus* (Steud.) C.E. Hubbard, with II + III stages, Pakistan, Northern Areas, Fairy Meadows, at 3,036 m a.s.l., July, 2010. MSB # 038 (LAH).

Comments

Uromyces vossiae has previously been reported on *Phacelurus speciosus* from Kaghan and Khanspur by Ahmad (1962; 1969) and Afshan *et al.* (2008a). It is a new record for Northern Areas of Pakistan.

Acknowledgments

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