Short paper

Puccinia taeniatheri a new graminicolous rust species from Iran

Mehrdad Abbasi

Department of Botany, Iranian Research Institute of Plant Protection, Agricultural Research Education and Extension Organization (AREEO), Tehran, Iran.

Abstract: Puccinia taeniatheri sp. nov., is newly described from Iran on Taeniatherum asperum (Poaceae) based on morphological study and rDNA ITS sequencing. An identification key for Puccinia species known on the genus Taeniatherum is provided. Re-examination of herbarium material of P. hordei on T. crinitum collected from Iraq revealed that specimen also belongs to P. taeniatheri sp. nov.

Keywords: Pucciniales, Poaceae, Taxonomy, Biodiversity, New species

Introduction

The knowledge of graminicolous rust fungi in Iran has risen in recent years. Abbasi (2002), Abbasi et al. (2002a, 2002b, 2002c, 2004, 2005) and Abbasi and Hedjaroude (2004) have made a tremendous addition to the taxonomy of rust fungi on Poaceae in Iran. So far, 39 Puccinia species have been reported on Poaceous plants in Iran (Abbasi, unpublished data). Here, another Puccinia species on a member of Poaceae family is described as a new taxon to the science based on morphological and molecular data.

Materials and Methods

Source of specimens

The materials for morphological studies and DNA extraction were collected by the author during the last 30 years (Table 1) and were preserved at the herbarium of the Ministry of Agriculture (Iran).

Morphological studies

Morphological studies and microscopy were carried out using the methods described in Abbasi (2002).

DNA extraction, PCR amplification, and sequencing

DNA was extracted according to the method of Abbasi (2002) and Abbasi et al. (2004). The ITS region (ITS-1, 5.8S gene, ITS-2) of each specimen was amplified with primers ITS4 and ITS5 of White et al. (1990). Amplification was as described by Zambino and Szabó (1993) with the following cycling parameters: 40 cycles of 94 C for 30 sec, 50 C for 1 min, 72 C for 2 min, and a final extension of 10 min at 72 C. The size and quantity of amplification products were verified on 1% agarose gels and extracted with the GeneClean spin kit (BIO 101, Vista, CA) according to the manufacturer’s instructions. Purified products were cloned with TA cloning kit (Invitrogen Corp., Carlsbad, CA). Several clones per rust specimen were obtained, and the presence of inserts was confirmed by digestion with Eco RI and agarose electrophoresis. Plasmid DNA was prepared with the Wizard Miniprep Kit (Promega, Madison, WI) and DNA concentration was estimated with a fluorometer. DNA samples were sequenced with the ThermoSequenase fluorescent labeled primer

Handling Editor: Rasoul Zare

* Corresponding author: puccinia@gmail.com
Received: 27 August 2020, Accepted: 17 January 2021
Published online: 30 January 2021
cycle sequencing kit (Amersham Pharmacia Biotech) and sequenced on an ALFexpress automated DNA sequencer (Amersham Pharmacia Biotech) as described by Goodwin & Zismann (2001). Several clones were sequenced per rust specimen to minimize errors caused by PCR amplification.

**DNA sequence alignment and analysis**

DNA sequences were aligned with the profile mode of Clustal X (Thompson et al. 1997) and were edited manually when necessary. Phylogenetic tree was constructed using the neighbor-joining method with the Kimura 2-parameter substitution model in MEGA 6.0. Branch robustness was assessed via bootstrap analysis with 1,000 replicates.

**Results and Discussion**

*Puccinia taeniatheri* M. Abbasi & Hedjar., sp. nov., MB 835520 – Fig. 1


**Table 1** Summary information for rust specimens included in the sequence analysis.

<table>
<thead>
<tr>
<th>Rust species</th>
<th>Host species</th>
<th>Locality</th>
<th>Length of ITS region (bp)</th>
<th>GenBank accession nos.</th>
<th>Herbarium (IRAN) accession nos.</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Puccinia persistens</em> ssp. triticina</td>
<td><em>Aegilops taushii</em></td>
<td>Iran, Golestan prov.</td>
<td>697</td>
<td>AY956549</td>
<td>8274F</td>
</tr>
<tr>
<td><em>Puccinia persistens</em> ssp. triticina</td>
<td><em>Triticum aestivum</em></td>
<td>Iran, West Azarbaijan prov., Khoy</td>
<td>696</td>
<td>AY880845</td>
<td>8226F</td>
</tr>
<tr>
<td><em>Puccinia persistens</em> ssp. agropyrina</td>
<td><em>Elymus hispidus</em> var. villosus</td>
<td>Iran, Ardabil prov., Sareyn</td>
<td>700</td>
<td>AY956552</td>
<td>11513F</td>
</tr>
<tr>
<td><em>Puccinia persistens</em> ssp. agropyrina</td>
<td><em>Thalictrum minus</em></td>
<td>Iran, Alborz prov., Karaj</td>
<td>706</td>
<td>AY956561</td>
<td>11511F</td>
</tr>
<tr>
<td><em>Aecidium</em> sp.</td>
<td><em>Thalictrum sultanabadense</em></td>
<td>Iran, Hamedan prov. Malayer</td>
<td>685</td>
<td>AY956563</td>
<td>11487F</td>
</tr>
<tr>
<td><em>Puccinia bromina</em></td>
<td><em>Bromus sterilis</em></td>
<td>Iran, Alborz prov., Karaj</td>
<td>693</td>
<td>AY956550</td>
<td>11507F</td>
</tr>
<tr>
<td><em>Puccinia bromina</em></td>
<td><em>Bromus tectorum</em></td>
<td>Iran, Golestan prov.</td>
<td>690</td>
<td>AY956548</td>
<td>9059F</td>
</tr>
<tr>
<td><em>Puccinia hordei</em></td>
<td><em>Hordeum vulgare</em></td>
<td>Iran, Khuzestan prov.</td>
<td>695</td>
<td>AY874150</td>
<td>10835F</td>
</tr>
<tr>
<td><em>Puccinia taeniatheri</em> sp. nov.</td>
<td><em>Taeniatherum asperum</em></td>
<td>Iran, Golestan prov.</td>
<td>689</td>
<td>AY956557</td>
<td>11491F</td>
</tr>
<tr>
<td><em>Puccinia schismi</em></td>
<td><em>Lophochaera phileoides</em></td>
<td>Iran, Bushehr prov.</td>
<td>689</td>
<td>AY956555</td>
<td>10196F</td>
</tr>
<tr>
<td><em>Puccinia schismi</em> var. lolii</td>
<td><em>Lolium temulentum</em></td>
<td>Iran, Golestan prov.</td>
<td>688</td>
<td>AY956554</td>
<td>3922F</td>
</tr>
<tr>
<td><em>Puccinia triseti</em></td>
<td><em>Trisetum flavescens</em></td>
<td>Iran, Golestan prov.</td>
<td>688</td>
<td>AY956556</td>
<td>11490F</td>
</tr>
<tr>
<td><em>Puccinia recondita</em> s.str.</td>
<td><em>Elymus sp.</em></td>
<td>Iran, Golestan prov.</td>
<td>691</td>
<td>AY956533</td>
<td>11506F</td>
</tr>
<tr>
<td><em>Puccinia recondita</em> s.str.</td>
<td><em>Secale cereale</em></td>
<td>Iran, Golestan prov.</td>
<td>691</td>
<td>AY956551</td>
<td>11505F</td>
</tr>
<tr>
<td><em>Puccinia recondita</em> s.str.</td>
<td><em>Cerinthe minor</em></td>
<td>Iran, Qazvin prov.</td>
<td>692</td>
<td>AY956562</td>
<td>11486F</td>
</tr>
<tr>
<td><em>Puccinia striiformoides</em></td>
<td><em>Dactylis glomerata</em></td>
<td>Iran, Tehran prov., Tehran</td>
<td>684</td>
<td>AY956558</td>
<td>9052F</td>
</tr>
<tr>
<td><em>Puccinia striiformis</em></td>
<td><em>Tricicum aestivum</em></td>
<td>Iran, Alborz prov., Karaj</td>
<td>682</td>
<td>AY874152</td>
<td>11502F</td>
</tr>
<tr>
<td><em>Puccinia striiformis</em></td>
<td><em>Hordeum generale</em></td>
<td>Iran, Kolougluyeh and Boyer-Ahmad prov, Yasuj</td>
<td>683</td>
<td>AY956559</td>
<td>11497F</td>
</tr>
<tr>
<td><em>Puccinia pseudostrigiformis</em></td>
<td><em>Poa pratensis</em></td>
<td>Iran, Mazandaran prov.</td>
<td>683</td>
<td>AY956560</td>
<td>11500F</td>
</tr>
<tr>
<td><em>Puccinia coronata</em> var. avenae</td>
<td><em>Avena ludoviciana</em></td>
<td>Iran, Mazandaran prov.</td>
<td>700</td>
<td>AY956564</td>
<td>11475F</td>
</tr>
<tr>
<td><em>Puccinia trebusii</em></td>
<td><em>Melica jacquemontii</em></td>
<td>Iran, Alborz prov., Azadbar</td>
<td>686</td>
<td>AY956565</td>
<td>11482F</td>
</tr>
<tr>
<td><em>Puccinia wolgensis</em></td>
<td><em>Stipa hohenackeriana</em></td>
<td>Iran, Alborz prov., Dizin</td>
<td>686</td>
<td>AY956566</td>
<td>11481F</td>
</tr>
</tbody>
</table>
Figure 1 *Puccinia taeniatheri* sp. nov., from holotype, A. urediniospores, B. teliospores, arrow shows brown septum at the point of attachment of pedicel to the spore (Bar = 10 µm).

**Other material examined:**
On *Taeniatherum crinitum* (Schreb.) Nevski, Iraq, Zawita, 1 Aug. 1955, leg. V. C. Robertson (PUR F17567).

Spermogonia and aecia unknown. Uredinia mostly on adaxial surface, scattered, elliptic, yellow or brownish yellow; urediniospores (22) 24-28 × 20-23 µm, subglobose, broadly ellipsoid or ellipsoid, wall 1.5-2 µm, hyaline, yellowish or rarely very pale brownish, echinulate, germ pores (10)11-14 (15) scattered. Telia mostly abaxial, covered by
P. taeniatheri a new graminicolous rust species from Iran

J. Crop Prot.

the epidermis, blackish, oblong, scattered or irregularly aggregated, mostly loculated with brown paraphyses; teliospores 46-72 x 16-25 µm, mostly oblong-clavate or oblong, apex rounded, truncate, conical or obliquely conical, constricted at the septum, attenuated below, wall of upper cell 1.5-2 µm at sides, thickened up to 5-8(10) µm at the apex, smooth, chestnut-brown above, golden basally; one-celled spores occasional; pedicel short, yellowish, with brown, mostly 1.5 (2) µm thick septum at the point of attachment.

Combination of morphological features and ITS sequence data separate Puccinia taeniatheri sp. nov., from other reported Puccinia species on Poaceae.

Judging from the literature (Cummins 1971; Ulyanisheva 1978; Abbasi 2002) and online databases of U.S. National Fungus Collections (https://nt.ars-grin.gov/fungaldatabases/) the following Puccinia species viz. Puccinia agropyrina Erikss. (= P. persistens subsp. agropyrina (Erikss.) Z. Urb. & J. Marková), P. graminis Pers., P. hordei G. H. Otth, P. rubigo-vera (DC.) G. Winter (= P. recondita Roberge ex Desm.) and P. striiformis Westend., have been reported on Taeniatherum spp. across the world.

The molecular analysis and NJ tree reconstruction based on rDNA ITS sequencing showed that Puccinia taeniatheri sp. nov., differs from all above mentioned Puccinia species (Fig. 2). BLAST query of P. taeniatheri sp. nov., sequence shared 94% (660/699) identity with P. hordei, 94% identity (660/701) with P. schismi, 92% identity (642/701) with P. recondita and 91% identity (646/709) with P. persistens ssp. agropyrina. Comparison of P. taeniatheri sp. nov. ITS sequence with that obtained from P. striiformis using Blast 2 sequences (bl2seq) available at NCBI website also showed 89% (622/700) identity.

In addition to molecular analysis, morphological data also showed that rust species on Taeniatherum is a new species different from all other Puccinia species reported on this host plant. Urediniospores with hyaline or yellowish wall and up to 15 scattered germ pores, teliospores with brown septum at the pedicel attachment point and thin side wall of teliospore upper cell (1.5-2 µm), not thickened toward spore apex, are among characteristic features of P. taeniatheri sp. nov. The following identification key separates P. taeniatheri sp. nov. from all other Puccinia species reported on the genus Taeniatherum:

1-telia exposed, urediniospores with mostly 4-5 equatorial germ pores .................. P. graminis 1-telia covered, urediniospores with scattered germ pores .............................................. 2 2-uredinia in chlorotic streaks ........... P. striiformis 2-uredinia not in such streaks ...................... 3 3-urediniospore wall brownish ............... 4 3-urediniospore wall hyaline to yellowish .... 5 4-urediniospores with 6-9 scattered germ pores, teliospore pedicels do not possess a conspicuous deposition of dark brown material on the wall of the pedicel below the point of attachment .............................................. P. recondita 4-urediniospores with 8-11 scattered germ pores, teliospore pedicels with a deposition of a brown material in form of truncate cone below the point of the spore attachment .................................. P. persistens subsp. agropyrina 5-urediniospores with 7-10 scattered germ pores, 1-celled teliospores (mesospores) abundant, the side wall of teliospore upper cell thickening progressively toward the apex .............................................. P. hordei 5-urediniospores with 10-15 scattered germ pores, 1-celled teliospores occasional, the side wall of teliospore upper cell not thickening progressively toward the apex .......... P. taeniatheri

The ITS sequence analysis showed that P. hordei with 94% identity, is among the closest species to the P. taeniatheri sp. nov. There is a report of P. hordei on T. crinitum from Iraq (Mathur, 1972). Re-examination of the specimen of P. hordei on T. crinitum (PUR F17567), collected from Zawita, Iraq revealed that specimen fitted well description of P. taeniatheri sp. nov., and was considered under the name of this taxon.
Figure 2 Unrooted neighbor-joining tree of 22 sequences of the internal transcribed spacer (ITS) region of ribosomal DNA from graminicolous Puccinia species and their related Aecial states on miscellaneous plants. Bootstrap values were determined on the basis of 1000 bootstrap replications. The ITS sequences of P. coronata var. avenae, P. trebouxi and P. wolgensis were used as outgroup.

References


پوکسیا تانیاتهرا

مهرداد عباسی

یک زنگ جدید روی گندمیان از ایران Puccinia taeniatheri

پست الکترونیکی نویسنده مسئول مکاتبه:
puccinia@gmail.com

دربافت: 6 شهبر 1399؛ پذیرش: 28 دی 1399

چکیده: گونه زنگ Puccinia taeniatheri sp. nov. برای اولین بار از ایران روی گونه گیاهی Puccinia hordei از تیره گندمیان (Poaceae) براساس مطالعات ریخت‌شناسی و توالی‌نامی ITS ناحیه‌ای ریبووزومی توصیف می‌شود. کلید شناسایی برای گونه‌های Puccinia گزارش شده روی P. hordei ارائه می‌گردد. همچنین با استفاده از نمونه‌هایی از P. taeniatheri از جنس Taeniatherum در عرصه گزارش شده از ایران نموده می‌شود که این نمونه‌ها نیز به گونه جدید P. taeniatheri تعلق دارند.

واژگان کلیدی: Puccinia, Taeniatherum, Pucciniales, Poaceae