Conidial state of *Leveillula taurica* (Ascomycota: Erysiphaceae): A new record on *Peganum harmala* from arid Sinai, Egypt

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**Abstract**

In May 2013 to May 2015, leaves of *Peganum harmala* with typical symptoms of powdery mildew were collected in Saint Katherine Protectorate, South Sinai, Egypt. The pathogen was identified as the anamorphs of *Leveillula taurica*. Phenotypic identification of the pathogen with light and SEM is provided. This is the first report of a powdery mildew on *Peganum harmala* in Egypt.

**Keywords:** anamorph, powdery mildew, Saint Katherine protectorate, wild Syrian rue

**INTRODUCTION**

Egypt is home to 384 different species of medicinal plants found in the Mediterranean coastal region, in the deserts, in the oases of the Libyan Desert and in the Sinai Peninsula (Baka, 2014). The Sinai Peninsula is one of Egypt’s most floristically diverse and phytogeographically interesting regions.

Many of the plants growing the desert in Sinai and the Negev are utilized by Bedouin for pasture, medicine (for animals and themselves), food and other miscellaneous uses (Bailey and Danin, 1981). The mountainous region of southern Sinai contains a greater biodiversity than the rest of Egypt, and 4350 km² of the area was declared a Protectorate in 1996 (Zalat et al., 2008).

The Saint Katherine Protectorate is one of Egypt’s largest protected areas and includes the country’s highest mountains. Its situated in the southern part of Sinai and is a part of the upper Sinai massif. It is located between 33° 55’ to 34° 30’ East and 28° 30’ to 28° 35’ North (Khafagia et al., 2012). Wild Syrian rue (*Peganum harmala* L. family Zygophyllaceae) is well-known in the high-elevation sites surrounding the ring dyke of Saint Katherine Protectorate, South Sinai and various parts of this plant including, its seeds, bark, and root have been used as folk medicine (Chatterjee et al., 1968; Mahmoudian et al., 2002; Guenther et al., 2005; Movafeghi et al., 2009; Aboul-Enein et al., 2012; Zhao et al., 2011).

Powdery mildew disease is one of the most important obligate parasitic diseases infecting a large number of plant species and causing economic losses of the plant, both in terms of quantity or quality (Hirata, 1968; Amano, 1986; Correll et al., 1987; Carlos and Soares, 2012).

Surveying of plant pathogens in Egyptian protectorates is overlooked and only one study has been conducted during the last decade in Saint Katherine protectorate (Abdel-Azeem and Abdel-Moneim, 2009).

During our continuous survey of plant pathogens conducted on wild plants in Saint Katherine protectorate, typical symptoms of powdery mildew disease were observed on nearly 7% of the *Peganum harmala* plants in Wadi Itlah, Al-Arbaen and El-Talaa during the period from 2013 to 2015. However such symptoms were not observed in *Peganum harmala* in Saint Katherine Protectorate before. The pathogen was examined and the pathogenicity test was demonstrated by fulfilling Koch’s
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MATERIALS AND METHODS

Infected plants of *P. harmala* were collected from different altitudes and locations and recorded by GPS (Global Positioning System) form Wadi Itlah, Al-Arbaen and El-Tala’el, Saint Katherine protectorate respectively from May 2013 to May 2015 (Figure 1, Table 1).

Cotton-like masses of mycelia and conidia were recorded as the disease progressed on abaxial leaf surface, stems and petioles (Figure 2). Ascoma were not observed in any of sampled plants. Representative material of each of the examined samples is deposited as typical dried samples in the Mycological Herbarium of Royal Botanical Garden, Kew, UK with an accession number is: H2014/01254. Samples were collected under the permission of Saint Katherine protectorate for scientific purposes.

**Morphological characterization**

Infected leaves and hand made cross sections of infected petioles of all samples were examined under ×100 to ×1,000 using bright field microscopy (Leitz Laborlux S, Germany). Measurements of conidia length and width were done using 1000 primary and secondary conidia that were collected from host plant described in the present investigation. Other morphological criteria of the fungal structures associated with the imperfect stages of powdery mildew fungi were observed including color of conidia, vacuoles and type of germination tube according to postulates.

![Study area map within Saint Katherine Protectorate.](image-url)

**Table 1. Location of sampling sites**

<table>
<thead>
<tr>
<th>Site No.</th>
<th>Site Name</th>
<th>GPS Reading</th>
<th>Elevation (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Abu Sayla</td>
<td>28° 35' 15.9&quot; N 33° 55' 06.6&quot; E</td>
<td>1300</td>
</tr>
<tr>
<td>2</td>
<td>Abu Sayla</td>
<td>28° 35' 32.6&quot; N 33° 55' 11.9&quot; E</td>
<td>3342</td>
</tr>
<tr>
<td>3</td>
<td>Itlah</td>
<td>28° 34' 34.0&quot; N 33° 55' 34.9&quot; E</td>
<td>1370</td>
</tr>
<tr>
<td>4</td>
<td>Tala'</td>
<td>28° 34' 31.4&quot; N 33° 55' 34.4&quot; E</td>
<td>1374</td>
</tr>
<tr>
<td>5</td>
<td>Tala'</td>
<td>28° 34' 31.6&quot; N 33° 55' 43.5&quot; E</td>
<td>1375</td>
</tr>
<tr>
<td>6</td>
<td>Itlah</td>
<td>28° 34' 20.0&quot; N 33° 55' 43.5&quot; E</td>
<td>1431</td>
</tr>
<tr>
<td>7</td>
<td>Arbaein</td>
<td>28° 33' 04.0&quot; N 33° 56' 54.0&quot; E</td>
<td>1498</td>
</tr>
<tr>
<td>8</td>
<td>Arbaein</td>
<td>28° 32' 55.3&quot; N 33° 57' 01.2&quot; E</td>
<td>1504</td>
</tr>
<tr>
<td>9</td>
<td>Arbaein</td>
<td>28° 32' 40.1&quot; N 33° 56' 28.0&quot; E</td>
<td>1570</td>
</tr>
<tr>
<td>10</td>
<td>Arbaein</td>
<td>28° 33' 04.8&quot; N 33° 56' 53.0&quot; E</td>
<td>1594</td>
</tr>
</tbody>
</table>
Pathogenicity test

Six-week-old twenty plants of *P. harmala* were used for Koch postulates in the garden of Mr. Ramadan Gably Wadi Al-Arbaen, Saint Katherine (http://st-katherine.net/en/local-initiatives/) in early of March 2014 and 2015. Plants were dusted copiously with conidia (3x10^6 conidia/mL) collected from infected *P. harmala* until the young leaves had a white powdery appearance. Relative humidity was not controlled and fluctuated between 23 and 55%. Development of powdery mildew symptoms as evidenced by white powdery spots was observed and recorded at 2-day intervals for 3 weeks, then at weekly intervals until plants matured. The experiment was repeated twice.

RESULTS AND DISCUSSION

Phenotypic examination showed that mycelium internal and external, superficial mycelium on stem and leaves, amphigenous, mostly persistent, thin to dense, white, patches, or covering the inter leaves or stems occasionally

to relevant references (Boesewinkel, 1980; Braun, 1987; Palti, 1988; Liberato and Barreto, 2005; Cook and Braun, 2009 and Vivas, et al., 2010). For SEM specimens were kept in 100% ethanol for 2 h and then successively transferred to mixtures of amyl acetate-ethanol according to Figueras and Guarrou (1988). Observations were done using an Environmental Hitachi scanning electron microscope S-3200.

Conidiophores emerging through stomatas, solatary or in groups (Figure 3A), occasionally rising from superficial hyphae, erect, straight, cylindrical-filiform about 146-170 µm long, 4 µm wide, forming conidia singly, rarely adhering in short false chains.

Primary conidia lanceolate (Figure 3B) in the upper half narrowed towards the apex, tips pointed, base rounded, subtruncate to obconically truncate, vase-like, relatively cylinder, 45-52 x 12-14 µm, mostly widest in the lower half, sometimes in the middle of conidium, secondary conidia cylindrical, subcylindrical or some what clavate, approximately as large as the primary conidia, usually 45-55 x 11-15 µm, widest in the middle or usually in the upper half.

SEM studies show that conidial surface wrinkled to form ridges (Figure 4), 0.3-0.5 um thick; and a net of polyangular, oblong meshes, 3-7 x 0.9-2.9 µm, papillate usually hemispherical, usually evenly scattered, but on the secondary conidia also in groups within meshes, 0.3 x 0.07 µm. Chasmothecia completely absent.

Koch’s postulates were fulfilled for *P. harmala* healthy plants after 32 to 45 days. Symptoms and signs of powdery mildew developed on the foliage of inoculated plants. Fungal morphology on all samples was similar to that described for the imperfect stage of *Leveillula taurica* (Braun and Cook 2012).

*Leveillula taurica* has been reported on *P. harmala* worldwide (Marios-Nektarios 2004; Khodaparast et al., 2011) but this is the first report of this powdery mildew species on *P. harmala* in Egypt (Abdel-Azeem, 2010; Abdel-Azeem and Salem, 2014). Finally, the spread of plant pathogens among wild plants in Saint Katherine.
protectorate may be referred to the climate change which affected the area in the last five years. Our findings in agreement with Pautasso et al. (2012) who stated that climate change is one of the most important factors affecting the spread of plant diseases by increasing, decreasing or remain stable depending on the particular pollutant and host-pathogen interaction.

**CONCLUSION**

We conclude that Egyptian Environmental Affairs Agency (EEAA) should make a regular survey and update the information concerning plant pathogens infect the wild plants especially medicinal taxa in the Egyptian protectorates.

**REFERENCES**


