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A contribution to the study of smut fungi of Israel

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Abstract — Four species of smut fungi, *Antherospora vaillantii, Microbotryum holostei, Urocystis magica,* and *U. muscaridis,* are reported for the first time in Israel. *Urocystis magica* was found in the Judean desert on a new host plant, *Allium rothii,* and *M. holostei* is new for Asia.

Key words — *Urocystales*, biodiversity, *Microbotryales*, Middle East

Introduction

The smut fungi that occur in Israel have been studied by mycologists and phytopathologists since the start of the 1900s (Magnus 1900; Reichert 1921, 1930, 1931; Săvulescu & Rayss 1935; Rayss & Zwirn 1944; Rayss 1952; Palti et al. 1966). Nevertheless, knowledge about species composition and distribution of these fungi was incomplete until a critical revision of the published accounts of smut fungi in Israel that showed 59 species were recorded (Savchenko et al. 2010).

During February–March 2011, we collected plants infected by smut fungi, mainly in the territory of Mount Carmel, a coastal mountain range in northern Israel that stretches southeast from the Mediterranean Sea. This region is botanically very rich in species with a typical East-Mediterranean flora with luxuriant herbaceous components. Some of them are host plants for smut fungi. In the present study we report three smut species found in this region and one species from the Judean Desert.

Materials & methods

Sorus and spore characteristics were studied using both fresh and dried herbarium specimens. Spores were dispersed in a droplet of lactophenol on a microscope slide,

covered with a cover glass, gently heated to boiling point to rehydrate the spores, cooled, and then examined by a Carl Zeiss Axiostar light microscope (LM) at 1000× magnification. For scanning electron microscopy (SEM), spores were attached to specimen holders by double-sided adhesive tape and coated with gold. The surface structure of spores was observed at 15 kV and photographed with a scanning electron microscope JEOL JSM-6700F. Specimens used in this study are stored in the Herbarium of Haifa University (HAI).

Results & discussion

Descriptions and critical notes of four new Israeli species of smut fungi are given below.

Antherospora vaillantii (Tul. & C. Tul.) R. Bauer et al., Mycol. Res. 112: 1304 (2008) Figs. 1–2

Sori in the anthers and on the surface of inner floral organs, producing dark olive-brown powdery mass of spores, enclosed by the floral petals. Infection systemic, all flowers of an inflorescence are infected. Spores variable in shape and size, globose, subglobose, ovoid, slightly elongated, 7–8.5 × 8–10(–11) µm, olive-brown. Spore wall even, ca. 0.5–0.7 µm thick, finely, densely verruculose. In SEM spores densely irregularly verruculose. Spore profile appears wavy.

Distribution: Europe, Asia, Africa, North America, Oceania.

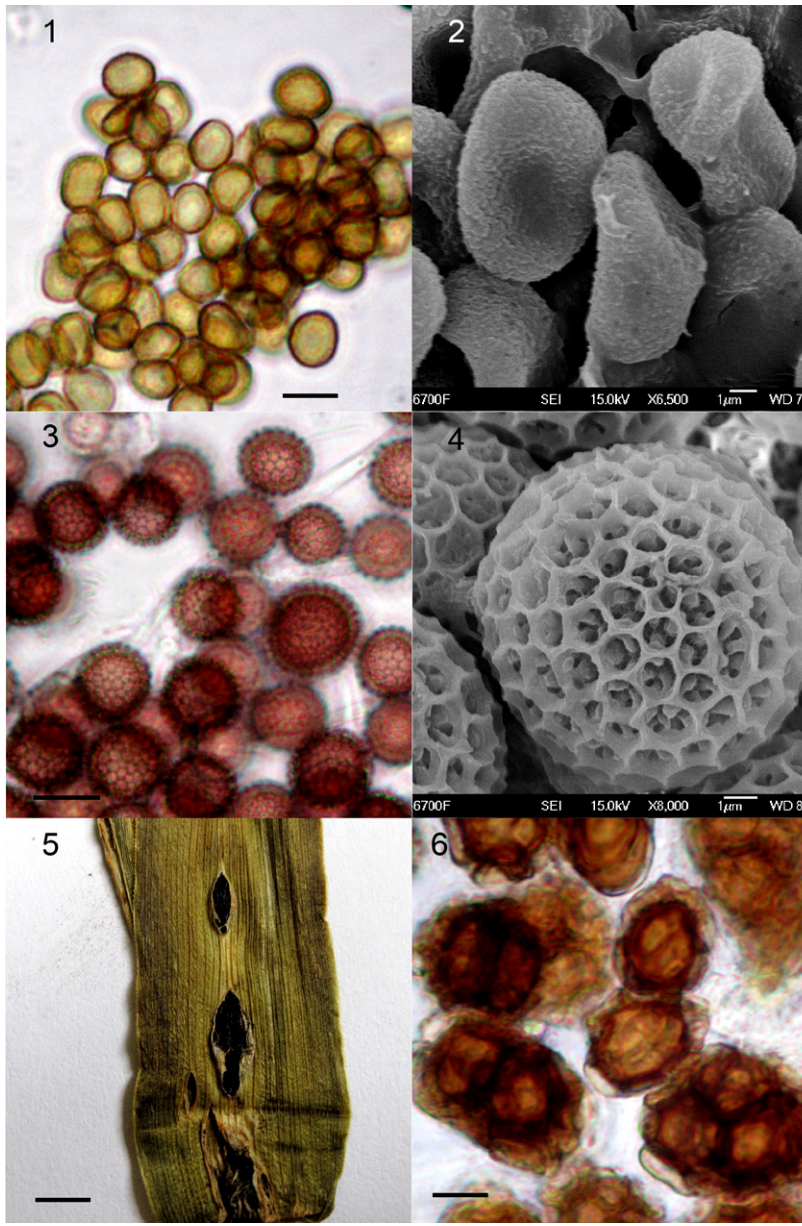
Specimen examined: **ISRAEL. Haifa district**, Carmel National Park, 32°75′79″N, 35°01′50″E, on *Muscari comosum* (L.) Mill., 2.II.2011, leg. K.G. Savchenko (HAI 2857).

Note. The genus *Antherospora* R. Bauer et al. consists of eight species of smut fungi that infect the anthers and inner floral organs of host plants in the *Hyacinthaceae* (*Liliaceae* s.l.) (Vánky 2009). The genus differs from all other taxa of *Urocystales* by the organogenic specialization, lack of sterile cells, and development of single spores (Bauer et al. 2008). Most of its species are highly specialized parasite restricted to certain host plant genera. Only one other *Antherospora* species, *A. urgineae* (Maire) R. Bauer et al. on *Urginea maritima* (L.) Baker, is known to occur in Israel (Săvulescu & Rayss 1935, Savchenko et al. 2010). *Antherospora vaillantii* is easily distinguishable from *A. urgineae*, which has smaller spores (9.5–15(–17.5) × 7–12 µm in diam.) and hosts in different genera.

Microbotryum holostei (de Bary) Vánky, Mycotaxon 67: 44 (1998) Figs. 3–4

Sori in ovules, fill the capsules with a powdery reddish brown spore mass. Infection systemic. Spores reddish-brown, globose, sometimes ovoid, 9–14 × 11–14 µm. Spore wall reticulate, 4–6 meshes per spore diam., meshes 1.2–2.4 µm in diam.; the bottom of the meshes with conspicuous round low protuberances.

Distribution: Europe, Asia.



Figs. 1–6. **1–2**: spores of *Antherospora vaillantii* in flowers of *Muscari comosum*. **3–4**: spores of *Microbotryum holostei* in flowers of *Holosteum umbellatum*. **5–6**: sori and spores of *Urocystis muscaridis* on leaves of *Muscari comosum*. 1, 3, 6 = LM; 2, 4 = SEM. Scale bars: 1, 3, 6 = 10 μm; 2, 4 = 1 μm; 5 = 3 mm.

Specimen examined: **ISRAEL. Haifa district**, Carmel National Park, 34°74′97″N, 35°03′01″E, on *Holosteum umbellatum* L. (*Caryophyllaceae*), 3.II.2011, leg. K.G. Savchenko (HAI 2858).

Note. Only three species of *Microbotryum* Lév. were reported from Israel before our investigations: *M. cordae* (Liro) G. Deml & Prillinger on *Polygonum acuminatum* Kunth (*Polygonaceae*), *M. jehudanum* (Zundel) Vánky on *Silene apetala* Willd. (*Caryophyllaceae*), and *M. scorzonerae* (Alb. & Schwein.) G. Deml & Prillinger on *Scorzonera papposa* DC. (*Asteraceae*) (Rayss 1952, Rayss & Zwirn 1944, Savchenko et al. 2010). All three are typical ovaricolous species. Israel has a great diversity of potential hosts for smuts from *Microbotryum*, especially those parasitizing *Caryophyllaceae* (43 *Silene* species grow in the country; Feinbrun-Dothan & Danin 1998). *Microbotryum holostei* has probably been overlooked because of the inconspicuous symptoms of infection and prevernal development. To our knowledge, *M. holostei* has never been reported from Asia.

Urocystis magica Pass., in Thümen, Mycoth. Univ. 3: no. 223 (1875) Figs. 7–9

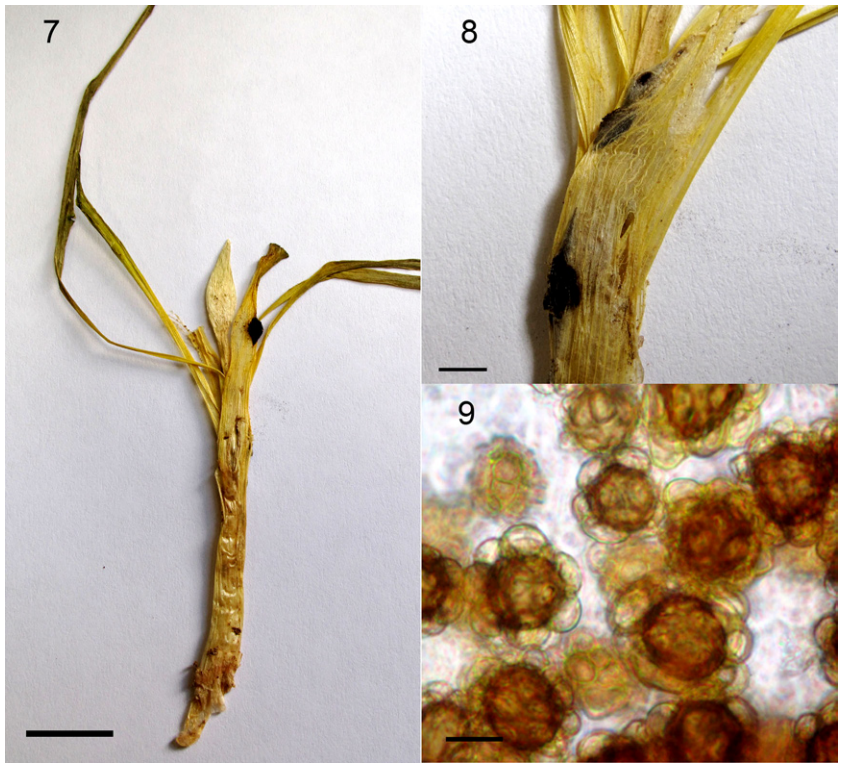
Sori as pustules in leaves and bulbs, initially covered by an epidermis that later ruptures to expose the black mass of spore balls. Spore balls globose to ovoid, 18–25 × 20–40 µm in diam., composed of 1 (90%) to 2 (10%) central spores and continuous layer of peripheral sterile cells. Spores globose, subglobose, ovoid, 10–15 × 12–16 µm in diam., dark reddish-brown. Spore wall ca. 1 µm thick. Sterile cells globose, ovoid, irregular, 4–13 µm in diam., pale yellowish-brown.

Distribution: Europe, Asia, North America, South America, Africa, Oceania.

Specimen examined: **ISRAEL. South district**, Judean Desert, near Arad, Wadi Kidot, 31°15′73″N, 35°13′59″E, alt. 569 m., on *Allium rothii* Zucc. (*Alliaceae*), 15.III.2011, leg. K.G. Savchenko (HAI 2860).

Note. During a collection trip to the Judean Desert in March 2011, one *Allium rothii* plant was found infected by a smut fungus. *Allium rothii* belongs to the subgenus *Melanocrommyum* and is distributed in Israel in the Judean Desert, North and South Negev, and the Dead Sea area on rocky slopes between shrubs (Kamenetsky 1994). Microscopic examination revealed that the smut was *U. magica* s.l., not previously recorded in Israel (Savchenko et al. 2010). *Allium rothii* represents a new host plant for this fungus.

Allium L. is a major genus of the monocot family *Alliaceae* naturally distributed throughout the northern hemisphere that is represented by ca. 750 species worldwide (Stearn 1992). Almost 40 species are known in Israel (Feinbrun-Dothan & Danin 1998). According to recent taxonomical changes based on nrDNA ITS sequence analyses, *Allium* is divided into 15 well-delimited monophyletic subgenera (Friesen et al. 2006). Species from



Figs. 7–9. *Urocystis magica* on *Allium rothii*. **7**: infected plant; **8**: sori: **9**: spore balls (in LM). Scale bars: 7 = 1 cm; 8 = 3 mm; 9 = 10 µm.

six subgenera —*Allium, Amerallium, Cepa, Melanocrommyum, Polyprason, Rhizirideum*— have been found as hosts for *Urocystis* Rabenh. ex Fuckel. At least five different *Urocystis* taxa have been described from onion plants during the last two centuries (see Vánky 1994): *U. magica*, *U. cepulae* Frost, *U. colchici* f. *allii-subhirsuti* Beltrani, *U. allii* Schellenb., and *Tuburcinia oblonga* Massenot (≡ *U. oblonga* (Massenot) H. Zogg). As these taxa are not easily distinguished from one another, they have been treated as a single taxon, *U. magica* s.l. However, these taxa were described from different subgenera of *Allium*: *U. magica* s.str. from subg. *Melanocrommyum*, *U. cepulae* from subg. *Cepa*, *U. colchici* f. *allii-subhirsuti* from subg. *Amerallium*, and *U. allii* and *T. oblonga* from subg. *Allium*. Specialization on certain host plant subgenera or even species is not unusual among smut fungi (cf. *Entyloma* species on *Eryngium* L.; Vánky 2009). Thus, it is not inconceivable that these *Urocystis* taxa may be recognized as "good" or at least "cryptic" species after intensive molecular-phylogenetic research.

Urocystis muscaridis (Niessl) Moesz, Kárpát-mend. Üszög.: 199 (1950) Figs. 5–6

Sori in leaves as ellipsoidal pustules, variable in size, visible on the outer surface along the viens, filled by a black powdery mass of spore balls. Spore balls globose, subglobose, ovoid to irregular, 18–40 × 20–45 μm in diam., composed of 1–7(–8) spores surrounded by almost a continuous layer of sterile cells. Spores globose, ovoid to irregular, 9–17(–18) × 10–20(–21) μm in diam., dark reddish-brown. Spore surface smooth. Sterile cells variable in shape and size, globose, ovoid to irregular, 4–9 × 5–14 μm, yellowish-brown.

Distribution: Europe, Asia.

Specimen examined: **ISRAEL. Haifa district**, Carmel National Park, 32°75′25″N, 35°02′50″E, on *Muscari comosum* (L.) Mill., 18.III.2011, leg. K.G. Savchenko (HAI 2862).

Note. *Urocystis muscaridis* infects different species of *Muscari* Mill. in Europe and Asia (Vánky 1994). *Muscari comosum*, a principal host for this smut, is quite common in Mediterranean forests and semi-steppe shrub lands of Israel. In March 2011 we examined a large *M. comosum* population in Carmel National Park and found one plant with leaves bearing several swollen sori produced by *U. muscaridis*. It is interesting that only a single plant in the whole population was found to be affected. In the Middle East *U. muscaridis* is also known from Iran (Ershad & Deghani 2001).

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