First record of *Plasmopara obducens* on *Impatiens walleriana* in Taiwan: a destructive disease or chance of limiting the competitive ability of an invasive plant?

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The downy mildew *Plasmopara obducens* is recorded from *Impatiens walleriana* in Taiwan for the first time. Observation of infected plants indicates that infection spreads quickly and leads to 100% mortality in the population of planted *I. walleriana*. The micromorphology is described and illustrated. In Taiwan, the host plant is not only an important ornamental flower, but also an invasive weed. The pathogen might spread to naturalized populations of *I. walleriana* and limit their competitive ability.

Key words – Balsaminaceae – Chromista – invasive plants – Peronosporales – Oomycota – Straminipila

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Introduction

Impatiens walleriana Hook f. (Balsaminaceae) is an ornamental flower originating from Africa, but is planted worldwide. In most countries, *I. walleriana* is, therefore, considered a positive complement to the market of ornamental plants. In Taiwan, after its introduction in 1966 (Wu et al. 2010), the species is also widely sold and cultivated as outdoor ornamental plant in flower beds and pots. In addition, however, *I. walleriana* escaped from cultivation and became an invasive naturalized weed in some countries (ISC 2013), including Taiwan with first record in 1999 (Wu et al. 2010). Since *I. walleriana* is considered one of the two most severe invasive weeds in the Yangmingshan National Park, its eradication in the wild is recommended (Hua 2004).

In a university campus in Taiwan, a flower bed planted with *I. walleriana* appeared to be grazed by herbivorous insects due to the lack of leaf laminas, whereas the stems with leaf petioles were still present. Closer examination, however, revealed the presence of a downy mildew. Among several species of downy mildews (Oomycota, Peronosporales) known from *Impatiens* spp., *Plasmopara obducens* appears to be the most virulent and widespread species. Recent observation of downy mildew symptoms in *I. walleriana* hitherto unknown for Taiwan indicated the presence of *P. obducens* which needed verification.

Methods

Diseased leaves were examined with a hand-lens for the presence of mildew symptoms and studied with a dissecting microscope. Fresh material on a living leaf was

mounted in 5-10% aqueous KOH and a polyvinyl alcohol mixture (Kirschner & Chen 2008) complemented with 0.015 g cotton blue in 100 mL for staining. Sizes of sporangia are given as mean value ± standard deviation and extreme values in brackets based on measurements of 30 sporangia. Other values are given only as extreme values. The specimen was deposited at the fungal collection of National Museum of Natural Science, Taichung, Taiwan (TNM).

Results

Within approx. four weeks of March/April during predominantly moist and cool conditions, the population of *I. walleriana* in a flower bed was completely destroyed. Then the downy mildew was found in two flower pods about 10 m apart from the infected flower bed. The mildew could be identified morphologically as *Plasmopara obducens*.

Plasmopara obducens (J. Schröt.) J. Schröt. Figs 1–3

Fig. 1 – Symptoms of *Plasmopara obducens* on *Impatiens walleriana* in Taiwan. Note the lack of leaf laminas at the top of two petioles reminiscent of grazing by herbivorous insects.

Leaf spots absent. Sporulation hypophyllous on green leaf laminas that turn black and fall off, leaving the leaf petioles and stems without infection. Internal hyphae intercellular, 5–12 µm wide, with ellipsoidal or pyriform intracellular haustoria, 6–12 × 5–10 µm formed on a 1–2 × 2 µm stalk. Sporangiophores arising from stomata, forming a dense layer, white, strongly branched up to four levels of main branches, with main branches arising monopodially or up to subtetratomously at almost right angle from an erect, straight main axis above a basally not or slightly inflated trunk (115–160 × 12–17 µm), 285–345 µm high, with branches extending laterally up to as wide as the height of sporangiophore, terminal branchlets 2–4 µm wide, bearing 2–5 sterigmata at slightly inflated or non-inflated ends, sterigmata with slightly inflated tip, 2–10 × 1.5–2 µm. Sporangia obpyriform or broadly ovoid when young, ellipsoidal with broadly rounded ends when detached, (13–)15–19(–21) × (11–)12–14.5(–16) µm, apical papilla 2–3 µm wide, 1 µm thick, inconspicuous and mostly not visible without staining due to being inserted below the surface of the broadly rounded apex, remaining unstained in cotton blue staining of the cytoplasm and then becoming more conspicuous, basal hilum also inconspicuous. Oospores not observed on leaves and defoliated stems.

Fig. 2 – Downy mildew symptoms of *P. obducens* on the lower leaf surfaces of *I. walleriana* (R. Kirschner 3862, TNM).

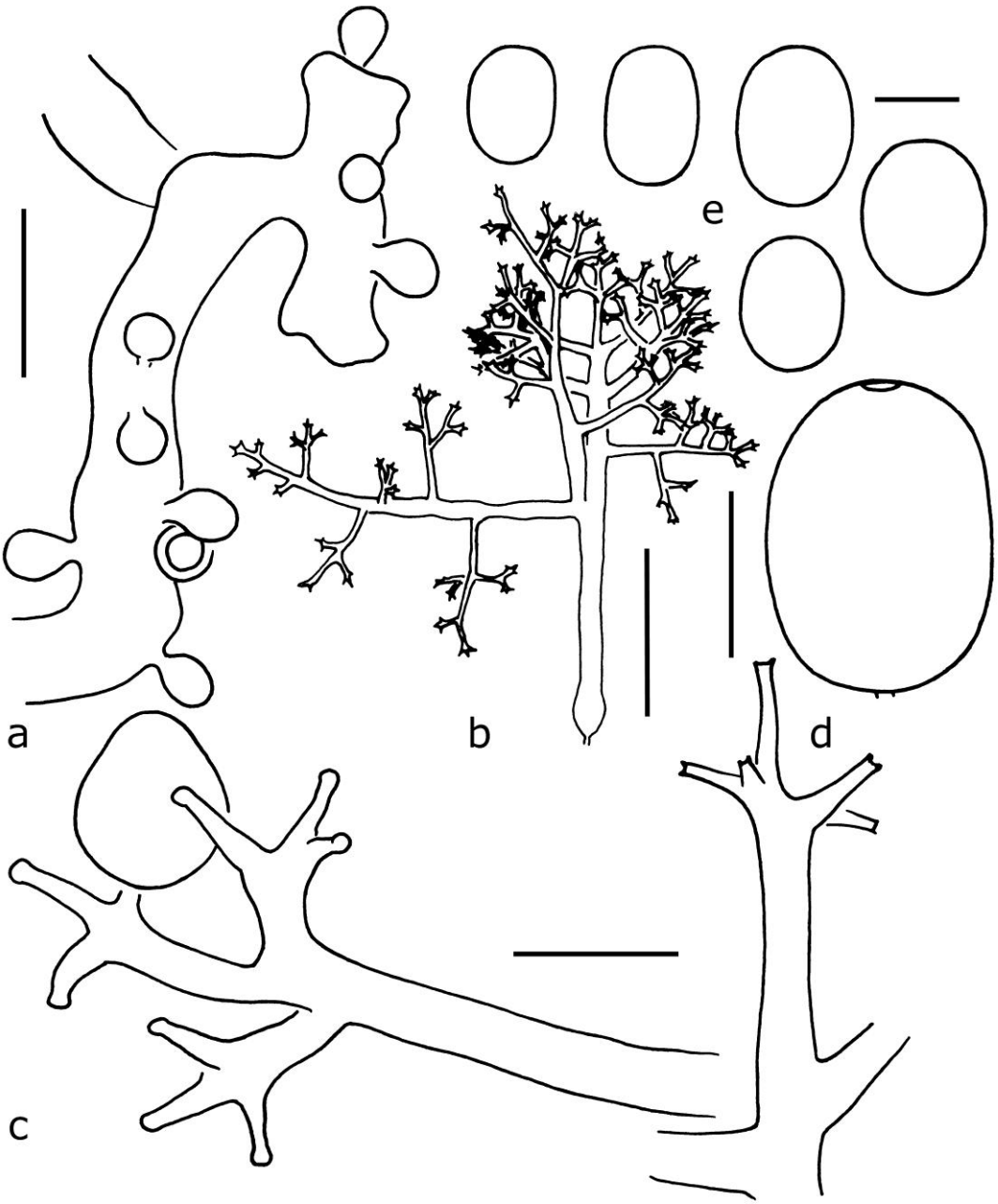

Fig. 3 – Microscopic characteristics of *Plasmopara obducens* (R. Kirschner 3862, TNM). a Internal hypha and haustoria in mesophyll of periclinal leaf section. Scale bar = 20 μm. b Sporangiophore. Scale bar = 100 μm. c Ultimate branchlets of sporangiophores, the left one bearing a young sporangium, the right one representing an older branchlet with collapsed ends. Scale bar = 10 μm. d Detached sporangium with basal hilum and terminal papilla becoming visible after staining with cotton blue. Scale bar = 10 μm. e Detached unstained sporangia. Scale bar = 10 μm.

Known distribution – America, Asia, Australia, and Europe (Lane et al. 2005, CABI 2007, Petróczy et al. 2012), in East Asia known from PR China (on other species than *I. walleriana*, Chen & Wu 2009), Japan (Satou et al. 2013), and Korea (Choi et al. 2009).

Material examined – Taiwan, Taoyuan County, Chungli (= Jhongli) City, National Central University, campus, on flower bed and plant pods exclusively planted with *Impatiens walleriana*, living leaf laminas of *I. walleriana* Hook f., 23 Apr 2013, R. Kirschner 3862 (TNM).

Discussion

Infection experiments and DNA sequence comparisons from several countries confirmed that morphological identification of the downy mildew on *Impatiens* spp. as *P. obducens* and morphological distinction from *P. constantinescui* Voglmayr & Thines (= *Bremiella sphaerosperma* O. Constantinescu) were correct (Constantinescu 1991, Lane et al. 2005, Cunnington et al. 2008, Choi et al. 2009, Petróczy et al. 2012, Satou et al. 2013). Infection experiments and DNA analysis were, therefore, not replicated here. According to previous records, the leaves of *I. walleriana* are affected, but in our observation, only the leaf lamina is infected and after becoming black and falling off, the remaining leaf petioles on still living plants are reminiscent to the appearance of grazing by herbivorous insects. Only at a later stage, the petioles also fall off, and after falling off of all leaf laminas, the whole plant dies.

Though the pathogen has been known from *Impatiens* species other than *I. walleriana* in Mainland China (Chen & Wu 2009), it has only been recently recorded from *I. walleriana* in Korea (Choi et al. 2009) and Japan, and in Japan hitherto only from greenhouses (Satou et al. 2013). In these countries, *P. obducens* is considered a disease with negative impact that requires control. In Taiwan, this impact might be similar, particularly during cool and moist conditions as observed during the observation period in Northern Taiwan. The disease might become less severe during the hot summer months (Schubert 2012). In addition, however, the introduction of *P. obducens* might also be considered beneficial from the view of nature conservation and control of *I. walleriana* as invasive plant. Hitherto the fungus has only been observed in artificial plantation in Taiwan, but it might spread quickly to the naturalized populations and considerably limit the competitive ability of the invasive plant. This possible effect should be observed not only in Taiwan, but also in other countries, where the host plant is invasive.

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