Occurrence of a rust disease of *Fuchsia* caused by *Pucciniastrum epilobii* in Indonesia

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Received: 6 February 2012 / Accepted: 15 August 2012 / Published online: 30 September 2012
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Abstract *Fuchsia* species (Onagraceae) have been introduced into Indonesia as ornamental plants and are cultivated in gardens and parks of mountainous areas. A rust disease was found on leaves of *Fuchsia macrostemma* var. *globosa* at Cipanas, West Java, Indonesia in February 2010. There has been no previous report on the rust disease of *Fuchsia* species in Indonesia. Based on morphological characteristics of the causal rust fungus it was identified as *Pucciniastrum epilobii*. Its occurrence and morphology are reported.

Keywords *Fuchsia* · Rust disease · *Pucciniastrum epilobii*

Introduction

Fuchsia species (Onagraceae) are perennial shrubs mostly originating from South America. About 100 species of *Fuchsia* are distributed world wide and most of them are planted as ornamental plants in gardens and parks or cultured in pots for decoration.

In Indonesia, *Fuchsia* species are mostly cultivated in subtropical hilly areas (av 1.500 m a.s.l.) in West Java

Province. A rust disease was found on *Fuchsia macrostemma* var. *globosa* for the first time at Cipanas, Indonesia in February 2010. This disease occurred in the majority of plants and caused serious damage. There is no report of rust diseases on *Fuchsia* species in Indonesia (Boedijn 1960; Semangun 1992).

Materials and methods

Specimens on *Fuchsia macrostemma* Ruiz et Pavon var. *globosa* Bailey were collected from two different places at Cipanas, Indonesia and kept as dry specimens in Herbarium Balitro (HBI-Bal), Indonesian Medicinal and Aromatic Crops Research Institute, Bogor, Indonesia: HBI-Bal 505 (TSH-R4333), Cibodas Botanical Garden, Cipanas, Cianjur, February 24, 2010, D. Wahyuno, M. Kakishima, Dewi and I. Hidayat; HBI-Bal 512, Gunung Putri, Cipanas, Cianjur, June 15, 2010, D. Wahyuno. The specimens were also deposited in the Mycological Herbarium at the Graduate School of Life and Environmental Sciences, University of Tsukuba, Japan (TSH). For comparative morphology specimens from TSH were used: TSH-R7203, *Uredo fuchsiae* Arthur et Holway on cultivated *Fuchsia* sp., Cardiff, Wales, England, June 2, 1932; TSH-R12804, *Pucciniastrum epilobii* Otth on *Epilobium pyrricholophum* Franch et Sav., Teshirozawa, Oku-kinu, Tochigi Prefecture, Japan, Sept 12, 1963, Sugimoto; TSH-R4285 *P. epilobii* on *Epilobium cephalostigma* Haussk, Kawakami Experimental Forest of University of Tsukuba, Minamisaku-Gun, Nagano Prefecture, Japan, July 30, 1981, Ono Y.

For microscopic observations, hand sections of sori on leaves and urediniospores collected by scraping the uredinia were mounted in a drop of lactophenol solution on glass. The sizes of sori and urediniospores were based on 30 sori and 50 spores, respectively. Germ-pore numbers and

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distribution pattern were observed by aniline blue squash technique (Jennings et al. 1989). For SEM, specimens and urediniospores were attached on specimen holders and coated with platinum-palladium with Hitachi E-1030 Ion Sputter. They were observed under SEM (Hitachi S-4200) operating at 15 kV.

Results

Symptom and sign of the disease

Discoloured or yellow spots appeared on infected leaves which were usually found on the lower or middle parts of plants. Yellow lesions sometimes expanded to cover the leaves. Necrotic spots were also observed in the center of lesions. In severely infected plants, leaves changed colour to yellow or brown and fell prematurely.

The light orange, protruding, uredinial sori were produced on lower leaf surfaces and scattered or clustered (Fig. 1a).

Morphology of rust fungus and its identification

Only the uredinial stage was observed on the lower surface of leaves in specimens of *F. macrostemma* var. *globosa* collected in Indonesia. These uredinia were subepidermal, 105–437 µm in diameter and were covered by thin peridia which ruptured at the apex. Peridial cells were hyaline, hemispherical to irregular in shape and 13–24 µm in diameter (Fig. 1b, c). Ostiolar cells at the apex of peridia were rounded and smooth (Fig. 1d). Urediniospores were pedicelate, oblong to globose, 15–23 × 11–17 µm and their germ-pores were obscure. Cell walls of urediniospores were hyaline, thin with uniform thickness, and echinulate (Fig. 1e, f; Table 1).

Fig. 1 *Pucciniastrum epilobii* on *Fuchsia macrostemma* var. *globosa* (HBI-Bal 505).

a Uredinia on abaxial leaf surface, **b** Vertical section of an uredinium, **c** Vertical section of an uredinium observed by SEM, **d** Surface view of an uredinium observed by SEM. **e** Urediniospores with uniform thickness of cell walls, and **f** Urediniospores observed by SEM

Table 1 Comparative morphology of uredinial stages among specimens

Specimens	HBI-Bal 505 ^{*)}	HBI-Bal 512 ^{*)}	TSH-R4285	TSH-R7203	TSH-R12804
Hosts	<i>Fuchsia macrostemma</i> Ruis & Pavon var. <i>globosa</i>	<i>Fuchsia</i> sp.	<i>Epilobium cepalostigma</i> Haussk	<i>Fuchsia</i> sp.	<i>Epilobium pyrricholophum</i> Franch. et Sav.
Locality	Indonesia	Indonesia	Japan	England	Japan
Uredinia					
Diameter (µm)	105.0 – 437.5	132.5 – 182.5	152.5 – 175.0	165.0 – 212.5	105.0 – 232.5
Peridia	Hemispherical-irregular	Irregular	Hemispherical	Hemispherical-irregular	Hemispherical
Peridial cell color	Hyaline	Hyaline	Hyaline	Hyaline	Hyaline
Peridial cell	Irregularly polygonal	Irregularly polygonal	Irregularly polygonal	Irregularly polygonal	Irregularly polygonal
Peridial cell diam (µm)	13.5 – 24.6	14.5 – 23.5	21.3 – 25.0	17.5 – 25.0	12.5 – 22.5
Urediniospores					
Size (µm)	16.3–23.8×12.5–17.5	15.0 – 22.5×11.3–17.5	15.0–20×11.3–15.0	15.0–22.5×12.5–18.8	15.0 – 20.0×12.5 – 15.0
Thickness (µm)	1.0 – 1.6	1.0–2.0	1.0 – 1.5	1.0 – 1.5	1.0 – 1.7
Shape	Oblong, globose	Oblong	Oblong, globose	Oblong	Oblong
Germ-pore	3–5 (obscure)	3–5 (obscure)	4–6 (obscure)	4–6 (obscure)	3 – 7 (obscure)
Germ-pore distribution	Scattered	Scattered	Scattered	Scattered	Scattered
Color	Hyaline	Hyaline	Hyaline	Hyaline	Hyaline
Surface structure	Echinulate	Echinulate	Echinulate	Echinulate	Echinulate

*) The present fungus

Telia not found in specimens from Indonesia and uredinial morphology was identical with that of the rust genus *Pucciniastrum* (Hiratsuka 1936, 1958; Cummins and Hiratsuka 2003). Comparative morphology of uredinial stage with specimens (TSH-R4285, TSH-R7203, TSH-R12804) and descriptions of *Uredo fuchsiae* Arthur et Holway (Arthur 1924), *Pucciniastrum epilobii* Otth. (Cunningham 1931; Wilson and Henderson 1966),

Pucciniastrum pustulatum (Pers.) Diet. (Arthur 1934; Cummins 1962) and *Pucciniastrum fuchsiae* Hiratsuka, f. (Hiratsuka 1936) showed that morphological characteristics of specimens from Indonesia were similar to those of the above specimens and descriptions (Tables 1 and 2). Therefore, specimens on *Fuchsia macrostemma* var. *globosa* from Indonesia were identified as *Pucciniastrum epilobii* Otth (= *P. pustulatum*, *U. fuchsiae*).

Table 2 Comparative morphology of uredinial stages between present fungus and descriptions

Description	Authors (Year)					
	The present observation (HBI-Bal 505)	Cunningham (1931)	Arthur (1924)	Arthur (1934)	Wilson and Henderson (1966)	Hiratsuka (1936)
Species	<i>Pucciniastrum epilobii</i>	<i>Pucciniastrum epilobii</i>	<i>Uredo fuchsiae</i>	<i>Pucciniastrum pustulatum</i>	<i>Pucciniastrum epilobii</i>	<i>Pucciniastrum fuchsiae</i>
Uredinia						
Diameter (µm)	105.0 – 437.5	100–300	100–200	–	100–250	100–300
Opening apical pore	Exist	Exist	Exist	–	Exist	Exist
Peridia	Hemispherical-irregular	Flattened-globose	Hemispheric	–	Hemispheric	Hemispheric
Peridial cell	Irregularly polygonal	–	Rectangular-rhombic	–	Cubical-smooth (2 µm thick; 1–18 µm long)	Irregularly polygonal 6–8 µm
Urediniospores						
Size (µm)	16.3–23.8×12.5 – 17.5	15 – 24×10 – 15	18 – 24×13–16 x	13 – 23×10 – 14	15 – 23×10 – 15	14.5–24×10–16.5
Thickness (µm)	1.0 – 1.6	1	1–2	1	1–1.5	1–1.5
Shape	Oblong, globose	Obovate-polygonal	Ellipsoid	Obovate-oval	Ovoid-ellipsoid	Subglobose, ovate, oblong
Germ-pore	3–5 (obscure)	4 (obscure)	Obscure	–	–	6–9
Germ-pore distribution	Scattered	Scattered	–	–	–	Scattered
Color	Hyaline	Hyaline	Hyaline	Colorless	Hyaline	Hyaline
Surface structure	Echinulate	Echinulate	Echinulate	Echinulate (finely)	Echinulate-short	Echinulate (finely)

–: no description

Discussion

A rust fungus on *Fuchsia* was first described as *Uredo fuchsiae* Arthur et Holway in 1918 based on the uredinal stage on *Fuchsia splendens* Zucc. collected from Guatemala (Arthur 1918, 1934). Hiratsuka (1927, 1936) transferred this species to the genus *Pucciniastrum* as *P. fuchsiae* Hiratsuka, f. because of its morphological similarity to the uredinal stage of *Pucciniastrum* though the telial stage was not found. Hiratsuka (1958), and Wilson and Henderson (1966) treated this species as a synonym of *Pucciniastrum epilobii* Otth because of morphological similarity and cross inoculation experiments conducted by Gämman in 1942.

Pucciniastrum epilobii has a wide host range in the Onagraceae and has been confused with *Pucciniastrum pustulatum* Dietel. Arthur (1934) considered that these two species were synonymous, and treated *P. pustulatum* as its valid name. *P. epilobii* was considered its valid name by many other authors (Cunningham 1931; Hiratsuka 1936, 1958; Gämman 1959; Wilson and Henderson 1966; Hiratsuka et al. 1992) and has been accepted widely.

Sinclair et al. (1987) reported that *P. epilobii* and *P. pustulatum* are different species and considered *P. pustulatum* is a rust species of *Fuchsia*. They treated *P. epilobii* as a species which is able to infect *Epilobium adenocaulon* and *E. glandulosum* and unable to infect *E. angustifolium* (Sinclair et al. 1987). Gämman (1959) also reported forma specialis in *P. epilobii*. We consider that the above two species are the same species because of morphological similarity and both infect plant species within the same family.

Pucciniastrum epilobii Otth (= *P. pustulatum*, *U. fuchsiae*) has been reported from Central-North America (Hiratsuka 1958; Loring and Roth 1964; Strider and Jones 1978; Farr et al. 1989), Europe (Hiratsuka 1958; Gämman 1959; Wilson and Henderson 1966), and Oceania (McNabb and Laurenson 1965; Dingley 1969; McKenzie 1998), but not from *Fuchsia* spp. in Asia, though its distribution on *Epilobium* and other host plants had been reported from Asia. This is the first report of *P. epilobii* on *Fuchsia* in Indonesia and also Asia.

Recently, *Mikronegeria fuchsiae* P.E. Crane et R. S. Peterson (= *Uredo fuchsiae* (Cooke) Henn, non Arthur et Holway) was reported to produce uredinal and telial stages on *Fuchsia excorticata* (J.R. Forst et G.) L.f. and *F. perscandens* Cockayne et Allan from New Zealand (Crane and Peterson 2007). Its spermogonial and aecial stages are produced on *Phyllocladus* spp. (Crane and Peterson 2007). However, *M. fuchsiae* is quite different from *P. epilobii* in uredinal and telial morphology. Uredinia of *M. fuchsiae*

have no peridium, whereas those of *P. epilobii* have peridia (Fig. 1b, c).

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