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Rediscovery in Singapore of *Fagraea splendens* Blume (Gentianaceae), with notes on propagation

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Abstract. An individual of *Fagraea splendens***,** last collected in 1940 and previously listed as Presumed Nationally Extinct, was rediscovered growing in a wet primary forest in Singapore. It is assigned the national conservation status of Critically Endangered. Propagation by air-layering of this species was successful, and more individuals can be produced for cultivation and conservation.

Key words. *Fagraea splendens*, Gentianaceae, rediscovery, Critically Endangered, Singapore

INTRODUCTION

The genus *Fagraea* Thunb. (after Dr Jonas Theodorus Fagraeus, an 18th century Swedish physician and botanist) in Singapore consists of three species, after the resolution of the *Fagraea* complex into five genera (Wong & Sugumaran, 2012). They are *Fagraea auriculata* Jack, *Fagraea ridleyi* King & Gamble, and *Fagraea splendens* Blume. *Fagraea* is distinguished from the other genera by the smooth to lightly scaly dippled stem bark, copious creamy pale-yellowish latex produced in the fruit epidermis and fruit wall, and ellipsoid-rounded seeds, and includes trees, epiphytes, hemi-epiphytes, and scramblers (Sugumaran & Wong, 2012; Wong & Sugumaran, 2012). A synonym of *Fagraea splendens* used in herbarium specimens sighted was *Fagraea acuminatissima* Merr.

Description. The species description provided here is based on Wong & Sugumaran (2016). *Fagraea splendens* (Latin *splendens*, to shine) (Figs. 1–3) is a small shrub or hemi-epiphyte, growing usually to 3 m tall or 10 m high or more on trees. (However, the individuals encountered in Singapore were epiphytic.) The trunk or stem is up to 10 cm in diameter, and is covered by smooth, grey to dark-brown bark. The opposite, stalked leaves have leaf blades that are entire, elliptic to obovate, (5.5–)10–20(–23) cm long, (2.8–)4–8(–9.3) cm wide, with cuneate to rounded bases, and short cuspidate apices. The upper and lower surfaces are glabrous, with the midrib flat to sunken above and prominent below. There are 5–7 pairs of secondary veins if visible, otherwise they are obscure on both sides. Tertiary and higher order veins are obscure. Leaf stalks are (5–)20–35(–47) mm long, (1.5–)2–3(–4) mm thick, and without auricles. The inflorescence is terminal, consisting of a few- to many-flowered branched cyme, measuring about 5–10 mm long (Fig. 1B). The peduncle is indistinct to 5 mm long and 5 mm across. The flowers are bisexual, with pedicels 2–4 mm long and 2.5–4 mm across (Fig. 2, 3). The calyx is 6–10 mm long (from the base to the lobe apices), glabrous, and not to sometimes lenticellate. The cream to white corolla is broadly infundibular (the mouth more than 3–4 times the width of the lower narrowed part of the tube), The lower subcylindrical part of the corolla tube is 12–18(–20) mm long, 2–4 mm wide basally, and the upper flared part of the tube is slightly inflated, measuring 13–17 mm long, 10–15 mm wide at the top. There are 5 corolla lobes that are broad-obovate to suborbicular, 13–20(–23) mm long, 6–12 mm wide, and overlapping to the right. The 5 stamens have filaments that are 20–25 mm long, protruding to 7–8 mm from the corolla mouth, with versatile anthers that are hastate, 5–6 mm long and 2–2.5 mm wide. Each anther sac is somewhat ellipsoid. The style is shallowly 2-lobed, with the lobes broadly suborbicular and recurving when receptive and the whole sometimes resembling a subpeltate structure 1–2 mm across. The infructescence peduncle is indistinct or to 5 mm long and 4 mm across. The fruit is narrowly ellipsoid, with the apex conspicuously attenuate. When mature it is up to 20–30 mm long and 12–16 mm across. The base is tightly clasped by the calyx lobes. The seeds are numerous in each fruit, ellipsoid to subovoid, measuring 2–2.5 mm long and 1–1.5 mm across. The testa surface is areolate.

Distribution. *Fagraea splendens* occurs naturally from Sumatra to Borneo, and is common in the Malay Peninsula (Wong & Sugumaran, 2016). It is found in habitats from sea level to lower montane forests, peat swamp and freshwater swamp forests.

Past and present records. In Singapore, this species is Presumed Nationally Extinct (Tan et al., 2008; Chong et al., 2009). There were two known collections from Singapore, in 1890, from Kranji and 1940, from Mandai Road, and then a gap of 70 years before the rediscovery in 2010 (Table 1). All recent collections were made in the Nee Soon Swamp Forest, Singapore's last substantial patch of intact freshwater swamp forest (Chong et al., 2016) and its vicinity. *Fagraea splendens* is currently only known from epiphytic populations, so collection of this species has depended upon encountering fallen branches bearing the plants by chance.

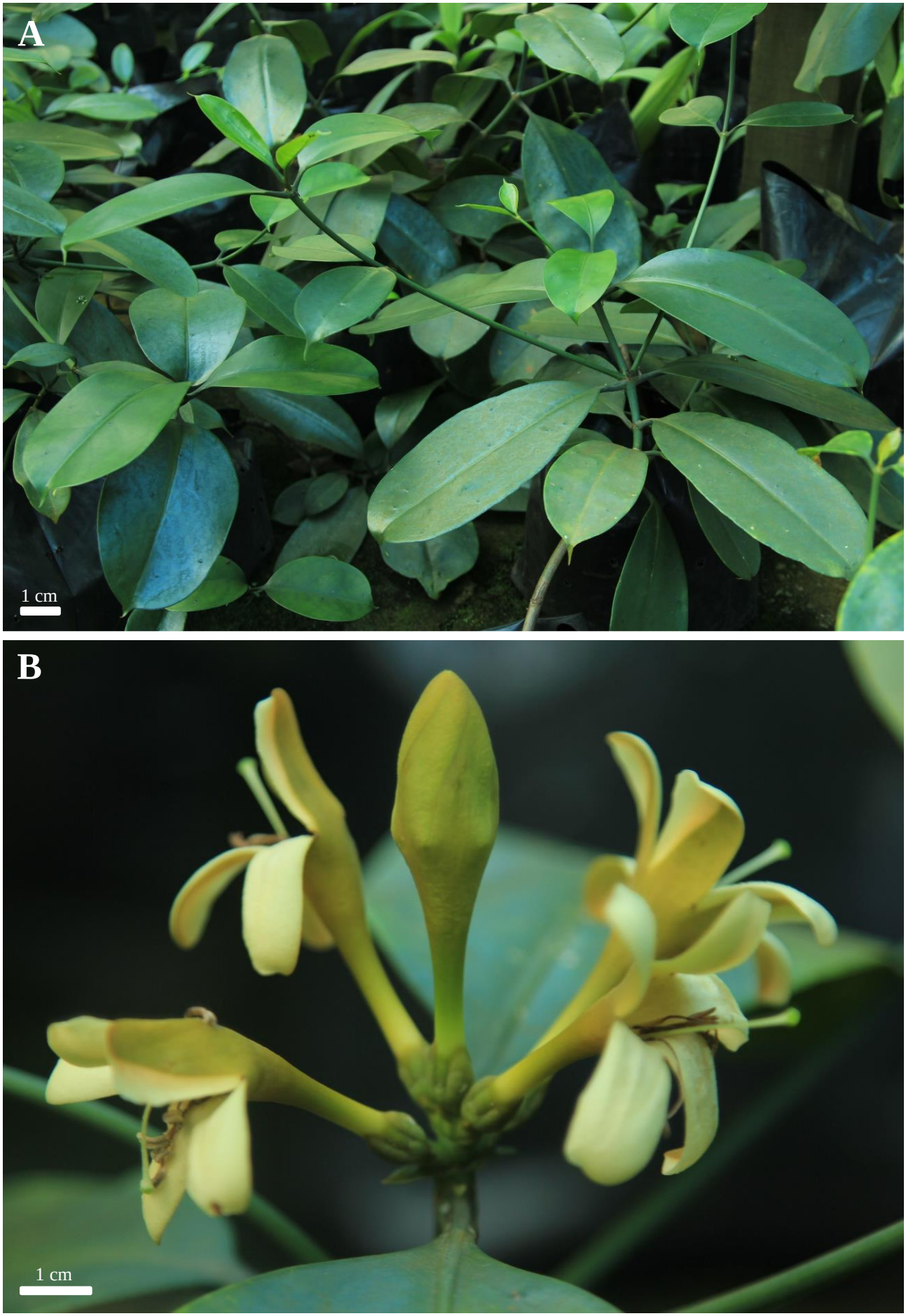

Fig. 1. A, the shoots of rooted cuttings from epiphytic individuals; B, inflorescence. (Photographs by: Wee Foong Ang).

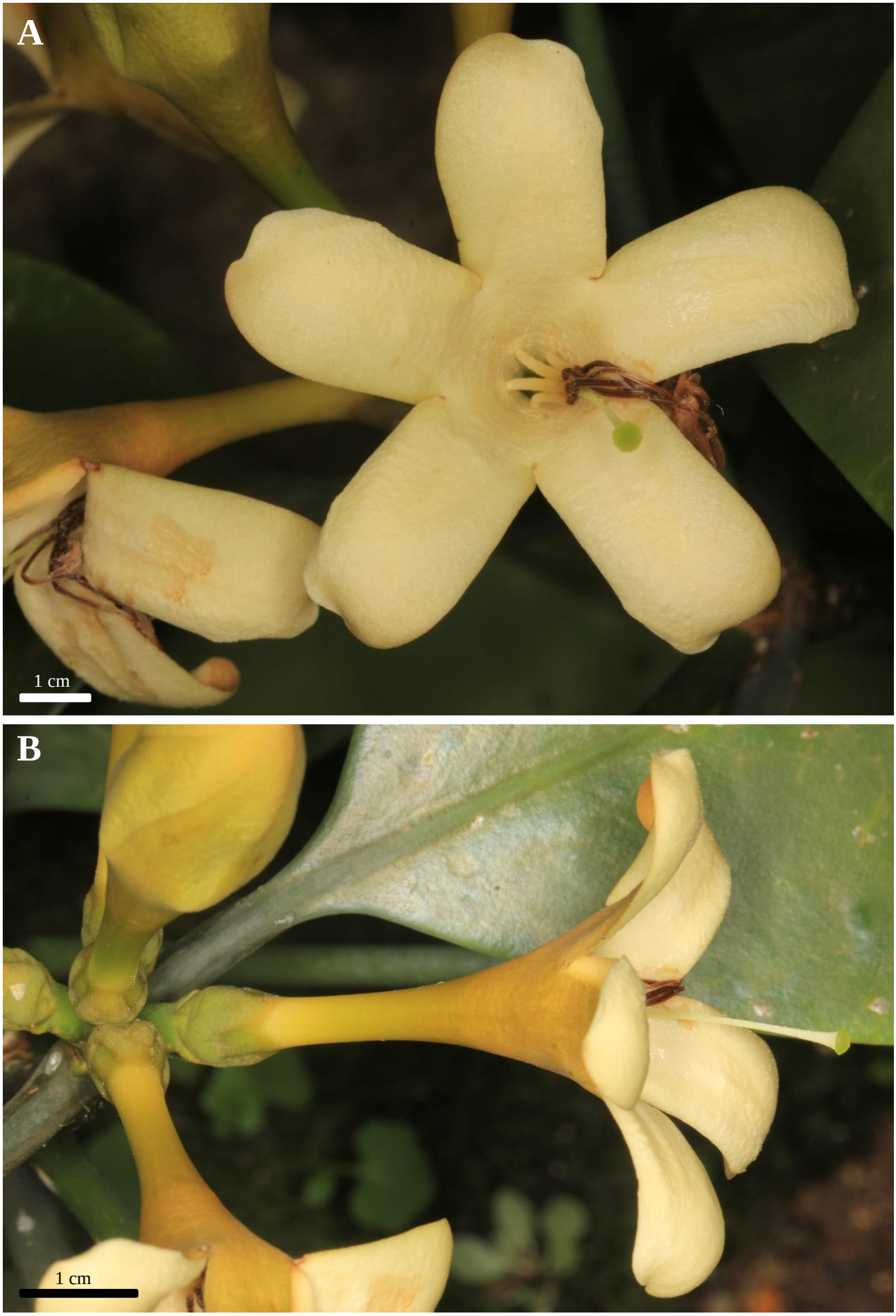

Fig. 2. A, front view of flower; B, side view of flower. (Photographs by: Wee Foong Ang).

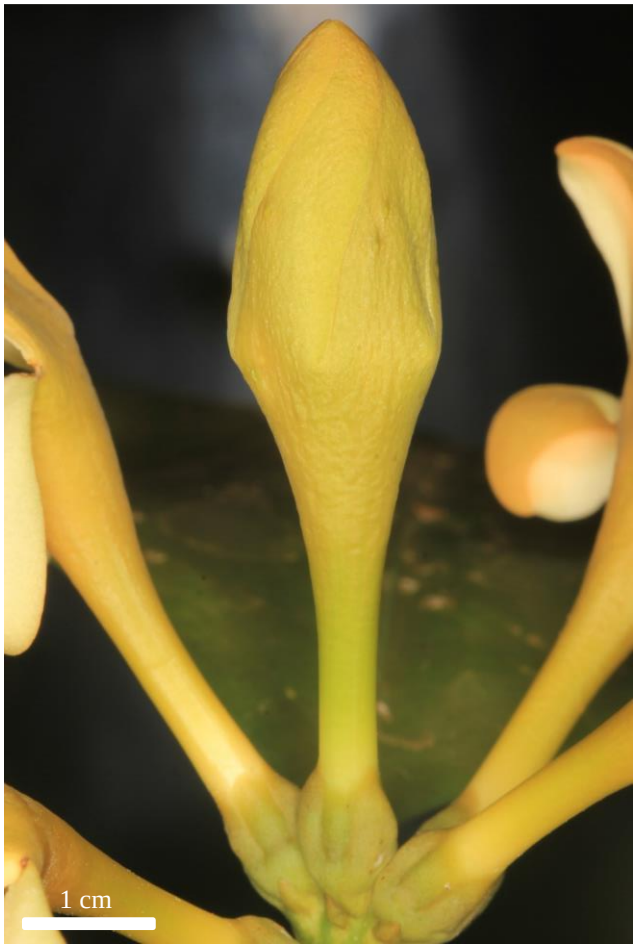

Fig 3. Side view of flower bud. (Photograph by: Wee Foong Ang).

Table 1. Singapore collections of *Fagraea splendens* Blume deposited in various herbaria (KEP = Herbarium, Forest Research Institute Malaysia; SING = Herbarium, Singapore Botanic Gardens; SINU = Herbarium, Lee Kong Chian Natural History Museum, National University of Singapore).

S/No.	Date Collected	Collectors	Collector's No.	Barcode Number	Locality	Herbarium
1.	12 March 1890	J. S. Goodenough	s.n.	SING 0011365	Kranji	SING
2.	12 August 1940	M. S. Kiah & M. R. Henderson	SFN 37739	SING 0011366	Mandai Rd	SING
3.	12 August 1940	M. S. Kiah & M. R. Henderson	SFN 37739	90069	Mandai Rd	KEP
4.	19 September 2010	W. F. Ang, C. K. How, S. Y. Tan & C. K. Yeo	s.n.	2007018358	Nee Soon Pipeline	SINU
5.	October 2010	A. Heyzer, C. Y. Koh, T. J. Li, H. J. M. P. Siow, S. Y. Tan & H. F. Wong	Q7D0-1527	2007020855	Nee Soon Swamp Forest	SINU
6.	27 April 2012	C. K. Yeo, D. Austin & X. Y. Ng	2012-155	SING 0177804	Nee Soon Firing Range	SING
7.	27 April 2012	C. K. Yeo, D. Austin & X. Y. Ng	2012-155	SING 0182089	Nee Soon Firing Range	SING
8.	27 January 2016	P. Leong, H. K. Lua, T. W. Yam, I. Hassan, K. H. W. Ng & S. K. Ngon	SING 2016-022	SING 0232213	Nee Soon Pipeline	SING

PROPAGATION AND CULTIVATION

The genus *Fagraea* can be propagated by a variety of methods—seeds, stem cuttings, or air-layering. Air-layering, a method of vegetative propagation, has been used successfully to propagate species that have infrequent flowering as well as those that are difficult to root by stem cuttings. It was shown to be highly successful in propagating another Critically Endangered species in Singapore, *Fagraea auriculata* (Yeo et al., 2011). Twelve air-layerings (Figs. 4–6) were performed on semi-woody stems across eight individuals on 21 November 2016, and all successfully rooted three months later. Air-layering *Fagraea splendens* involves cutting a 5 cm ring around the stem and removing cleanly the

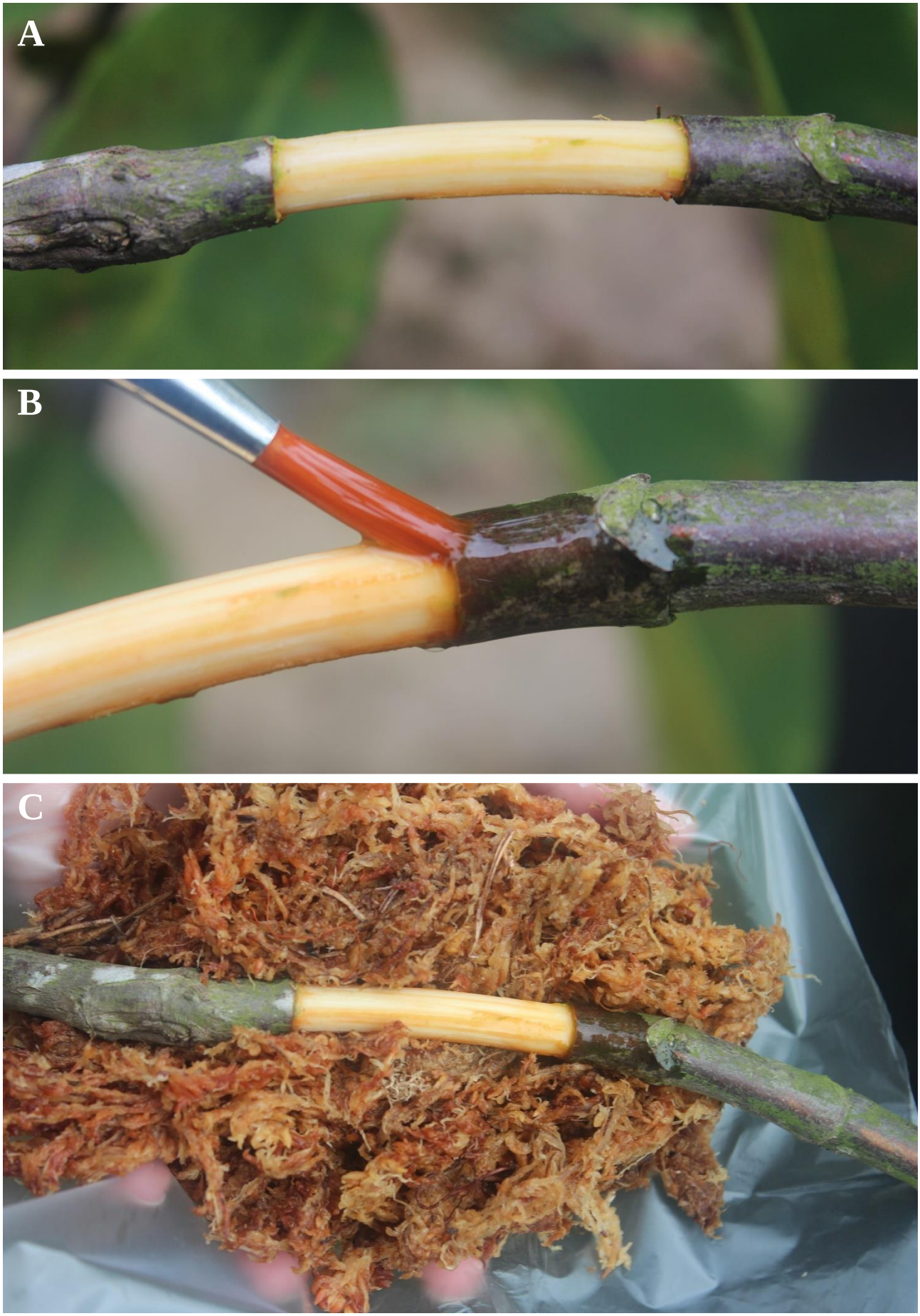

Fig. 4. A, Air-layering with a section of bark removed; B, Rooting hormone gel applied to the cut section; C, The cut section wrapped in moist sphagnum moss. (Photograph by: Xin Yi Ng).

Fig. 5. A, The cut section wrapped in moist sphagnum moss and secured with cable ties; B, Rooting can be observed through the clear polythene wrapping. (Photographs by: Xin Yi Ng).

Fig 6. Established rooted stem cuttings of *Fagraea splendens* being hardened in full sun conditions. (Photograph by: Xin Yi Ng).

entire ring of vascular cambium and phloem (Fig. 4A). The top of the ring is coated with the CLONEX® Rooting Hormone Gel Red formulation, which contains 8g L^{-1} indole-butyric acid (IBA) to promote rooting (Fig. 4B). The cut stem is then wrapped in moist sphagnum moss, secured by clear polythene wrapping and cable ties (Fig. 4C). The branches were checked weekly for any signs of rooting (Fig. 5). Once the roots were clearly visible through the plastic wrapping, the rooted stems were cut below the ringed area and planted in a sand-soil mix. The rooting process took approximately 3 months. The rooted cuttings were kept in a moist and cool misting house with regular misting to ensure their survival before progressively being hardened to full sun conditions (Fig. 6).

CONCLUSIONS

Many recent rediscoveries of plant species formerly thought to be extinct (see Chong et al., 2012) and new records (e.g., Rodda & Ang, 2012) were from the Nee Soon Swamp Forest and its vicinity, which testify to the site's conservation value and the need to better document its biodiversity. *Fagraea splendens* has high ornamental potential with its large, attractive foliage and large, fragrant, striking flowers, while its terrestrial and epiphytic habits allow it to be widely used in landscaping. The moderate ease in propagating it ensures that sufficient numbers can be produced in a short time, and provides yet another native *Fagraea* species that can be introduced to suitable habitats for *ex situ* conservation, in a similar fashion to *Fagraea auriculata* (Yeo et al., 2011), to safeguard the future of this species in Singapore.

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