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STATUS AND DISTRIBUTION IN SINGAPORE OF *FICUS KERKHOVENII* KOORD. & VALETON (MORACEAE)

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ABSTRACT. — In Singapore, the Johor fig, *Ficus kerkhovenii* Koord. & Valeton (Moraceae), is a nationally critically endangered species whose large trees can now only be found in Changi, D'Leedon condominium, Pulau Ubin, Sentosa, and the Singapore Botanic Gardens' Jungle. It is an immense, magnificent tree well worth propagating and cultivating more extensively in Singapore, where it can be grown in parks, large gardens, and other sites to enhance the native biodiversity since it supports many insect and frugivorous bird species.

KEY WORDS. — *Ficus kerkhovenii*, Moraceae, Singapore

INTRODUCTION

The Johor fig, *Ficus kerkhovenii* [Latin *ficus*, a fig tree; *kerkhovenii*, after E. J. Kerkhoven, 1834–1905, a Dutch estate manager and entomologist who worked in Indonesia (Kochummen, 1978)], is an immense, deciduous, monoecious, latex-containing, hemiepiphytic or terrestrial tree (Figs. 1–4) that can grow up to 45 m tall (Corner, 1988; Kochummen, 1978; Berg & Corner, 2005; Ng et al., 2005) with a crown area of up to 3,000 m^2 (Harrison, 2005). It is in the same subsection of the genus (*Conosycea*) as the more familiar *Ficus benjamina* and *Ficus microcarpa*. It has buttresses and aerial, contractile roots which start as loose, hanging, narrow strands that eventually become so taut that they can be strummed (see video here) once their tips anchor into the ground. They then significantly thicken with secondary growth (Fig. 5). Aerial roots are less frequent in terrestrial trees. It is a true strangler which eventually kills and replaces

Fig. 1. Johor fig (*Ficus kerkhovenii*) Heritage Tree (Reference no. HT 2003-135), a terrestrial tree growing besides the Sentosa Development Corporation Office, Artillery Avenue, Sentosa. (Photograph by: Ang Wee Foong).

Fig. 2. Johor fig Heritage Tree (Reference no. HT 2003-65) along Catterick Road near Fairy Point Chalet 3, Changi. (Photograph by: Ang Wee Foong).

Fig. 3. Johor fig tree at Cranwell Bungalows, Cranwell Road, Changi. (Photograph by: Ang Wee Foong).

Fig. 4. Johor fig tree in the vicinity of the recently rediscovered Keppel Hill Reservoir, beyond the end of Wishart Road. (Photograph by: Angie B. C. Ng).

Fig. 5. Roots of a tree cultivated near the Visitor Centre of the Singapore Botanic Gardens, Nassim Gate, Cluny Road. (Photograph by: Ang Wee Foong).

Fig. 6. Johor fig epiphytic saplings. A, Young sapling in the gap in a tree trunk. B, Young tree growing on the trunk of a tembusu (*Cyrtophyllum fragrans*) tree. (Photographs by: Ang Wee Foong).

Fig. 7. A young tree that grew out from the cracks between concrete blocks at the Singapore Mass Rapid Transit (SMRT) Circle Line's Telok Blangah Station work site in May 2011. In order not to waste this rare plant, which would have been removed with the completion of the works, permission was obtained from the Singapore Land Transport Authority (LTA) to access the site and take cuttings which were then propagated in a nursery at the National University of Singapore (NUS). Most of the rooted cuttings were given to the National Parks Board (NParks). This plant was probably the progeny of the recently discovered Keppel Hill Reservoir tree (see Fig. 4). (Photograph by: Ang Wee Foong).

Fig. 8. A leafy branch of a young sapling showing the underside of the leaves that are backlit to show the venation. Stipular scars are ring-like on the stem (red arrows) and white latex is produced when a leaf is removed (blue arrow) or when other parts of the plant is damaged. (Photograph by: Louise Neo).

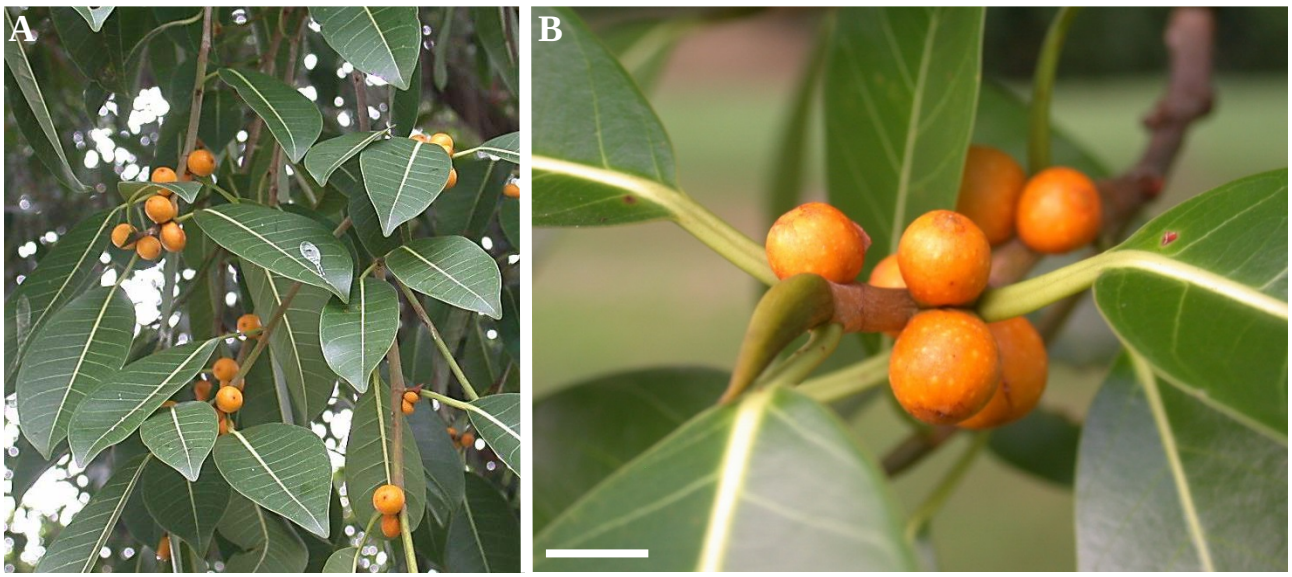

Fig. 9. Nearly ripe, orange syconia. A, on pendulous leafy twigs of the large tree found at the western boundary of D'Leedon condominium, beyond the end of Cornwall Gardens. B, on a leafy twig showing the stipule-covered tip. Scale bar = 1 cm. (Photographs by: Angie B. C. Ng).

Fig. 10. Nearly ripe, orange and ripe, deep rose-red syconia on leafy twigs. (Photography by: Angie B. C. Ng).

its host, resulting in a free-standing tree that started life as an epiphyte (Harrison et al., 2003). Seeds appear never to establish directly in the ground, although this species can be grown from stem cuttings. Its trunk is covered with pinkish brown bark and its smooth, hairless twigs bear spirally arranged, stalked leaves that have leathery, glabrous leaf blades that are oblong or somewhat egg-shaped, 6–18 cm long by 2–8 cm wide, with a pointed tip and rounded or wedge-shaped base (Berg & Corner, 2005). The leaf blade has 7–12 pairs of lateral veins which are raised on the underside like the midrib. Withering leaves are yellow becoming light brown when dried. The leaf stalk is distinctly flattened and

Fig. 11. Syconia cut open to show the fruits within, and upper and lower sides of senescing leaves. Scale bar = 1 cm. (Photograph by: Angie B. C. Ng).

grooved, and about 2–4 cm long and 2–4 mm wide. The stipules are usually 1–2 cm long and are shed quickly to leave ring-like scars on the twigs. The stalkless syconia are usually paired or sometimes single, usually in the axils of the leaves (Fig. 9) and they bear three very tiny bracts at the base, one of which is almost absent. The somewhat round syconia are 8–12.5 mm across. When ripe, the syconia turn yellow to orange and purple-red, and each with an ostiole 1.5–2 mm across that is covered by three barely visible bracts (Figs. 10, 11). According to Corner (1988), the Johor fig seldom produces syconia, and can grow up to six years without any but from our observations, this species produces syconia more or less annually, e.g., the Heritage Tree Johor fig strangling an *Artocarpus kemando* tree in the Singapore Botanic Gardens' Jungle (Reference no. HT 2012-195) fruits almost every year. Harrison (2005) recorded 0.75 crops per tree per year at Lambir, Sarawak.

The Johor fig is naturally distributed in low-altitude forests in Sumatra, the Malay Peninsula, Java, Borneo, and the Philippines (Berg & Corner, 2005).

In Singapore, the ripe syconia of the Johor fig has been recorded to be eaten by the blue-crowned hanging parrot (*Loriculus galgulus*; Wells, 1999) and Oriental pied hornbill (*Anthracoceros albirostris*; Lok et al., 2013; Wee, 2013). ABCN has also observed the green pigeon (*Treron vernans*) feeding on the ripe syconia. Its fig wasp pollinator is *Eupristina leightoni* Wibes (Agaonidae) (Wiebes, 1994), which was captured in a sticky trap on Kent Ridge, a long way from any known adult tree (Jeevanandam & Corlett, 2013).

PAST AND PRESENT RECORDS

The Johor fig was first collected in Singapore in the late 19th century (Table 1). It was found on islands such as Pulau Merambong, Pulau Sakijang Bendera (St. John's Island), Pulau Ubin, and Pulau Sakijang Pelepah (Lazarus Island; our observations). Singapore Island localities included Bukit Timah, Mandai Road, Nassim Road, Tanglin, Upper Peirce Reservoir, Upper Seletar Reservoir, and Dover Forest (Neo et al., 2013). It appears to be an inland and coastal species. Sites with large trees include Changi, D'Leedon condominium, Pulau Ubin, Sentosa, and Singapore Botanic Gardens' Jungle. A 20-m tall tree (Fig. 4) and two saplings (1 m and 4 m tall) grow near the newly re-discovered Keppel Hill Reservoir in Mount Faber forest just beyond Wishart Road's end. A 2-m tall sapling has also been observed at Pulau Tekukor. This species is listed as nationally critically endangered because of its rarity here (Tan et al., 2008; Chong et al., 2009) but the saplings on trees and elsewhere are an encouraging sign of recruitment.

Ten Johor fig trees have been designated Heritage Trees by the National Parks Board under their Heritage Trees Scheme and listed in their Heritage Trees Register as below with the details consecutively arranged as locality, reference number, and geographical coordinates:

1. Singapore Island
    a. Changi
        i. On the sandy beach below Fairy Point Chalet 6; Reference No. HT 2003-63; 1°23'23.2"N 103°58'25.8"E

Table 1. Singapore collections of *Ficus kerkhovenii* Koord. & Valeton deposited in the Herbarium, Singapore Botanic Gardens (SING; with bar code no.) and Herbarium, Lee Kong Chian Natural History Museum (SINU; with accession no.).

S/No.	Herbarium	Accession or Barcode No.	Collector(S)	Number	Date Collected	Locality
1.	SING	0042064	H. N. Ridley	378	Mar.1890	Pulau Ubin
2.	SING	0042014	H. N. Ridley	5612	1893	Tanglin
3.	SING	0042063	E. J. H. Corner,	33594	21 Jul.1900	Bukit Timah
4.	SING	0014026	H. N. Ridley	s.n.	1901	Pulau Ubin
5.	SING	0011720	Mohd Nur	s.n.	20 Aug.1918	Nassim Road
6.	SING	0041674	E. J. H. Corner	SFN 28673	20 Jan.1935	Mandai road
7.	SING	0014027	E. J. H. Corner	s.n.	29 Sep.1935	Pulau Merambong
8.	SING	0041675	Anonymous	SFN 33591	15 Jul.1937	Bukit Timah
9.	SING	0042065	I. Ngadiman	SFN 33591	15 Jul.1937	Bukit Timah
10.	SING	0014024	E. J. H. Corner	SFN 33591	15 Jul.1937	Bukit Timah
11.	SING	0014025	Anonymous	SFN 33594	21 Jul.1937	Bukit Timah
12.	SINU	2007007067	H. T. W. Tan, A. H. B. Loo & E. E. L. Seah	L 1009	26 Aug.1996	Pulau Sakijang Pelepah (Lazarus Island)
13.	SINU	2007007206	H. T. W. Tan, Ali bin Ibrahim, A. H. B. Loo & E. E. L. Seah	L 2048	3 Sep.1996	Pulau Sakijang Pelepah (Lazarus Island)
14.	SING	0052002	A. T. Gwee, A. Samsuri, P. Leong & C. Tong	GAT 45	29 Oct.2002	Pulau Ubin, Chek Jawa
15.	SING	0042383	A. T. Gwee, A. Samsuri, P. Leong, S. Saiffudin & R. Kiew	GAT 104	5 Nov.2002	Pulau Ubin, Chek Jawa
16.	SING	0043728	A. T. Gwee, A. Samsuri, P. Leong & Ali bin Ibrahim	GAT 270	25 Feb.2003	Pulau Ubin
17.	SINU	2007007205	S. Sim & C. K. Yeo	s.n.	2003	Pulau Sakijang Pelepah (Lazarus Island)
18.	SINU	2007007204	C. K. Yeo	s.n.	10 Jun.2004	Pulau Sakijang Bendera (St. John's Island)
19.	SING	0106385	C. Chia	SING 2007-317	4 Jun.2007	Changi
20.	SING	0116755	A. F. S. L. Lok	s.n.	12 Dec.2007	Upper Seletar Reservoir
21.	SING	0041676	R. W. Hullett	205	Undated (before Oct.1954)	No locality provided
22.	SING	0142506	A. G. Alphonso	s.n.	Undated	Singapore Botanic Gardens

ii. Along Catterick Road near Fairy Point Chalet 3; Reference No. HT 2003-65; 1°23'28.8"N 103°58'33.6"E

iii. At Andover Road Fairy Point Chalet 7; Reference No. HT 2005-137; 1°23'25.8"N 103°58'27.7"E

b. Singapore Botanic Gardens' Jungle

i. Tag #8; Reference No. HT 2012-195; 1°18'46.3"N 103°48'57.1"E

2. Sentosa

a. 2nd Tree beside Sentosa Development Corporation Office; Reference No. HT 2003-62; 1°14'51.1"N 103°49'41.0"E

b. Capella Hotel, near Garden Villa Unit 27; formerly within The Knolls Hotel Development; Reference No. HT 2007-155; 1°15'00.7"N 103°49'24.8"E

c. 1st Tree beside Sentosa Development Corporation Office; Reference No. HT 2003-135; 1°14'52.5"N 103°49'40.6"E

d. Behind the junction of Allanbrooke Road and Bukit Manis Road; Reference No. HT 2005-66; 1°14'51.1"N 103°49'37.2"E

Fig. 12. Young Johor fig tree (arrowed) cultivated with other native coastal plants at Kent Ridge Campus of the National University of Singapore, Lower Kent Ridge Road. (Photograph by: Reuben Lim Chong Jin).

e. Capella Hotel, Garden Villa Unit 1, formerly, beside Ficus station; Reference No. HT 2003-67; 1°14'57.5"N 103°49'30.9"E

3. Pulau Ubin
   a. Within the National Police Cadet Corps camp site; Reference No. HT 2003-64; 1°25'06.4"N 103°58'22.0"E

DISCUSSION

The loss of more than 99% of the primary inland and coastal forests, the principal habitats of the Johor fig, since the founding of modern Singapore owing to the cultivation of gambier, coconut, tapioca, pineapple, and rubber and subsequent development (Yeo et al., 2011), may have resulted in the Johor fig becoming so rare here. Giant hemi-epiphytic figs live at naturally low densities in forests (0.27 ha^{-1} at Lambir, Sarawak; Harrison, 2003), making them particularly vulnerable to deforestation. On the other hand, the wide dispersal of their wasp pollinators probably connects the Singapore population of this fig species with a wider, regional population (Jeevanandam & Corlett, 2013).

Although each *Ficus* species has one to four pollinator fig wasp species (but one in the case of the Johor fig), it may also support up to 30 non-pollinating wasp species (Cook & Segar, 2010) so the Johor fig may potentially support many insect species. Some Lepidoptera species may also depend on the Johor fig as a food plant. If the predators of these wasps are also included which may be insectivorous birds or insects (Bronstein, 1988; Schatz et al., 2008), even more wildlife is supported by this plant.

The number of frugivorous birds recorded to feed on the syconia of the Johor fig in Singapore is small, but this almost certainly reflects its rarity. It is likely that all frugivorous birds whose gape sizes are suitable for this plant's ripe syconia (8–12.5 mm) would feed on it, and it is probably also consumed by fruit bats and civets. Planting the Johor fig and other native *Ficus* species may thus enhance the native bird and insect biodiversity in urban parks and gardens (Fig. 12), and in the case of the immense and magnificent Johor fig, also significantly beautify the site.

CONCLUSIONS

The Johor fig population consists only of a few large individuals in Changi, D'Leedon condominium, Pulau Ubin, Sentosa, and Singapore Botanic Gardens' Jungle, so its nationally critically endangered status, as defined by Davison (2008), is confirmed as there are fewer than 50 mature individuals here. It can be propagated by seed as well as by air-layering or stem cuttings, so as to increase the number of individuals in Singapore.

When mature, it has an immense, spreading crown that is a magnificent sight to behold. That it can grow among rocks on the edge of the sea at Changi suggests that it will be able to withstand the similar conditions of urban sites, so it should be cultivated in parks and large gardens for its beautiful form and large size which can provide much shade and enhance the animal life at the site.

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