

CASUAL ESTABLISHMENT OF SOME CULTIVATED URBAN PLANTS IN SINGAPORE

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INTRODUCTION

Humans are the principal global disperser of plants, and are often responsible for introducing them outside their native range (Mack & Lonsdale, 2001). In Singapore, exotic plant introductions have been contributed largely from ornamentals used for streetscapes or the landscaping of built-up areas (Lok et al., 2010). Some have become invasive — spreading into natural habitats and displacing native plant species. It is therefore imperative to monitor the status of the current ‘cultivated only’ exotic plants (see Table 1) so that methods of intervention can be implemented before they cause any significant impact to the natural environment. With this in mind, this article aimed at updating the statuses of such species in the recently compiled checklist of total vascular plant flora of Singapore (Chong et al., 2009).

MATERIAL AND METHODS

Plant surveys were conducted in residential estates and parks within Jurong, Kallang, Queenstown, Sengkang and Punggol, and secondary forests off Commonwealth Avenue, Jurong Town Hall Road, the seaward end of Punggol Road, and Berlayer Creek from Mar.2010 to Aug.2010. All spontaneous plants were recorded and subsequently compared with the statuses indicated in Chong et al. (2009). Seven exotic plants were found to have become ‘casual’ from ‘cultivated only’. We provide short descriptions of their native range, morphology, their earliest date of introduction, and where they can be found growing spontaneously in Singapore to the best of our knowledge.

Table 1. Definitions of exotic plants and various nested categories. Adapted from Chong et al. (2009).

Status	Categories	Definitions
Exotic		Species whose presence is a result of either intentional or unintentional human involvement.
	Cultivated Only	Exotic species that can only be found in cultivation or under direct human care.
	Spontaneous	Exotic species that survive outside cultivation or without direct human care.
	Casual	Exotic species that do not form self-replacing populations and rely on repeated introductions or limited asexual reproduction for persistence.
	Naturalised	Exotic species that form self-replacing, usually sexually reproducing populations.

RESULTS

The following seven angiosperm tree species were encountered in our surveys and considered to have casually established themselves in Singapore.

1. *DALBERGIA LATIFOLIA* ROXB. (FAMILY: FABACEAE)

Native range. – Nepal to Indian and also in Java (Lemmens, 2008).

Description. – *Dalbergia latifolia* is a deciduous tree that can grow up to 20–40 m tall. The alternate, imparipinnate leaves bear 11, 13, or 15 leaflets that are broadly obtuse and wavy at the leaflet blade margins. The flowers are small,

white, and borne in axillary panicles. The brown legumes do not open at maturity and contain 1–4, smooth seeds. More detailed descriptions are available from National Parks Board (2009).

Comments. – There are seven exotic species of *Dalbergia* cultivated in Singapore, all of which are listed as ‘cultivated only’ by Chong et al. (2009). Spontaneously growing, second-generation crops of *Dalbergia latifolia* have been observed in the Singapore Science Centre area (Jurong Town Hall Road), and Sengkang East Way (Fig. 1). All observed were saplings and located directly beneath cultivated, conspecific trees.

2. *FAGRAEA CRENULATA* MAINGAY EX C.B. CLARKE (FAMILY: GENTIANACEAE)

Native range. – Indochina to Malaya, Sumatra and Kalimantan (Corner, 1988a; Wong & Sugau, 1996)

Description. – *Fagraea crenulata* is a tree that can grow up to 25 m tall. The trunk possesses short prickles that disappear when the tree matures. The characteristic tiered-branching (pagoda-shaped crown) and broadly obovate leaves are reminiscent of the sea almond, *Terminalia catappa*, except for its larger leaves. The flowers are cream-coloured turning yellow with age. The fruits are many-seeded berries that are oblong and green. More detailed descriptions are available from Leenhouts (1982), Rao & Wee (1989), Wee (2003), and National Parks Board (2009).

Comments. – The earliest record of this tree being cultivated was in 1959 in the then University of Malaya campus (now known as the Bukit Timah Campus of the National University of Singapore). A voucher specimen of this individual was deposited in the Singapore Botanic Gardens Herbarium (SING). It is now commonly planted along highways, smaller roads, and parks. Two individuals about 5 m and 8 m tall were found along the fringe of the mangrove forest fragment at Berlayar Creek (Fig. 2). Two saplings were also observed beneath each of the trees. No cultivated stands of *Fagraea crenulata* were seen in the vicinity. The saplings are almost certainly spontaneous and we suspect that the larger individuals are also spontaneous, because of the secluded location and their isolated occurrence.

3. *HYMENAEA COURBARIL* L. (FAMILY: FABACEAE)

Native range. – Tropical America (Corner, 1988a).

Description. – *Hymenaea courbaril* is a large tree growing up to 40–50 m tall. The trunk is cylindrical and smooth and the branches bear pairs of pinnate leaves with sickle-shaped leaflets. The flowers are white, occur in small clusters, and smell sour. Flowering is seasonal and occurs around June in Singapore. The fruits take about 10–11 months to mature and the seeds are covered with a smelly pulp within the hard woody legume. In its native habitat, the agouti and the



Fig. 1. Young *Dalbergia latifolia* sapling in Sengkang East Way. Scale bar = 5 cm. (Photograph by: Teo Siyang).



Fig. 2. Two tall *Fagraea crenulata* individuals, with two saplings (arrowed) beneath each tree. Scale bar = 1.5 m. (Photograph by: Teo Siyang).



Fig. 3. Some young plants of *Hymenaea courbaril* in Jurong Lake Park. One seedling that had newly germinated, showing the first foliage leaves (a). Cluster of saplings (b). Scale bars = 6 cm and 10 cm respectively. (Photographs by: Teo Siyang).

peccary are able to crack open the valves of the legume to feed on the pulp to disperse the seeds in the process. However, in the Caribbean, gravity is the main means of dispersal (Orwa et al., 2009). More detailed descriptions are available from Corner (1988a), and Wee (2003).

Comments. – This species was first introduced in the 1875 to the Singapore Botanic Gardens (Rao & Wee, 1989). While its natural dispersers are not found here, it was reported by Corner (1988a) that “squirrels and monkeys may also eat out the pod before it is ripe and too hard to be attacked.” Only saplings were observed at Jurong Lake Park, located beneath a group of mature, cultivated individuals (Fig. 3). They were likely to have germinated after the valves of the woody legume had rotted away, as suggested by Wee (2003).

4. *IXORA FINLAYSONIANA* WALL. EX G. DON (FAMILY: RUBIACEAE)

Native range. – India, Siam and Indochina (Corner, 1988b).

Description. – *Ixora finlaysoniana* is a shrub or small tree that grows to 4–6 m tall. The opposite leaves have leaf blades that range from elliptic to narrowly obovate while their apices are mostly blunt. The petiole of young leaves is also often reddish. The erect inflorescences bear white flowers with short corolla tubes. While the literature is unavailable for its dispersal mode, we speculate that birds and small mammals may feed on its berries and so aid in dispersal of the seeds. Detailed descriptions are available in Corner (1988b), Smith & Dawin (1988), and Puff (2007).

Comments. – While the fruiting of *Ixora finlaysoniana* was not observed by us, many saplings were observed beneath cultivated shrubs of the same plant in Pearl’s Hill City Park (Fig. 4a). In the secondary forest fringe at the seaward end



Fig. 4. Numerous saplings of *Ixora finlaysoniana* in Pearl’s Hill City Park (a) and Punggol Road (b). Scale bars = 15cm and 4cm respectively. (Photographs by: Teo Siyang).



Fig. 5. A 30 cm tall sapling of *Khaya senegalensis* along Lorong 3 Geylang. (Photograph by: Teo Siyang).

of Punggol Road, a flowering individual of about 4 m tall (probably spontaneous) was observed together with several saplings beneath them (Fig. 4b). Some saplings were dug out to verify that they were separate individuals and not root sprouts from the adult individual.

5. *KHAYA SENEGALENSIS* (DESR.) A. JUSS. (FAMILY: MELIACEAE)

Native range. – Tropical Africa (Mauritania and Senegal to northern Uganda) (Nikiema & Pasternak, 2008).

Description. – *Khaya senegalensis* is a large tree growing up to 30 m tall. The pinnate leaf bears 3–7 pairs of leaflets. The terminal leaflet may or may not be present. The flowers are small, creamy-white and occur in clusters. Flowering is seasonal and occurs at the end of the dry season or at the start of the rainy season. The fruits mature after 3–5 months, and are woody capsules, each splitting into 3–4 valves when ripe, releasing numerous, large-winged seeds. These are dispersed by wind but normally fall close to the parent tree. More detailed descriptions are available from National Parks Board (2009), and Nikiema & Pasternak (2008).

Comments. – Introduced in the late 1970s, this is the 5th most widely planted tree species with more than 15,000 individuals along the roadsides and in parks, because of its high survival rate from stem-cuttings to produce ‘instant trees’ (National Parks Board, 2001; Tan et al., 2009). Numerous saplings were documented at Lorong 3 Geylang, in Sungei Gedong Camp, and Loyang Avenue. All saplings were observed to be beneath cultivated mature trees.

6. *OCHNA KIRKII* OLIV. (FAMILY: OCHNACEAE)

Native range. – Tropical Africa (Tanganyika and eastern Kenya) (Robson, 1963).

Description. – *Ochna kirkii* is a shrub or small tree growing up to 6 m tall. The glabrous leaves colourful generally have elliptic or oblong leaf blades with slightly cordate bases. Short bristles also line the leaf margins. The bisexual flowers develop on a raceme and bear five yellow petals. Upon fertilisation, the sepals turn from green-yellow to bright red when ripe and which encircle the black drupelets on a pink receptacle. Flowering and fruiting occurs all year round. From the colourful display of the fleshy fruits, the seeds are probably bird-dispersed (US Forest Service, Pacific Island Ecosystems at Risk, 1999a). More detailed descriptions and illustrations are available from Oliver (1868), Robson (1963), and Keng (2003), respectively.



Fig. 6. Some spontaneous individuals of *Ochna kirkii*. A fruiting individual in Pulau Ubin (a) (Scale bar = 4 cm), and another growing about a metre tall along the edge of MacRitchie Nature Trail (b). (Photographs by: Teo Siyang).

Comments. – The earliest record of *Ochna kirkii* in Singapore was in 1933 in the Singapore Botanic Gardens (specimens deposited at SING). Currently, it is observed growing spontaneously in the urban districts of Hougang, Queenstown, Kallang, and Jurong East. Past observations from the authors and others (R. Tan, pers. comm.; W. F. Ang, pers. comm.) have also noted their presence in other built-up areas and also in natural habitats, i.e., wasteland vegetation in Pulau Ubin (Fig. 6a), mangrove forest fragments in Sungei Serangoon, coastal forest in Coney Island, and secondary forest in the Central Catchment Nature Reserve (along the MacRitchie Nature Trail; Fig. 6b) — but they are always observed along the edges of these forests. Almost all of the spontaneous individuals were observed flowering or fruiting. In particular, two fruiting individuals with over 50 saplings within the vicinity were also observed along Sungei Loyang, at the edge of a wasteland vegetation.

7. *TABEBUIA PALLIDA* (LINDL.) MIERS (FAMILY: BIGNONIACEAE)

Native range. – Endemic to the Lesser Antilles (Gentry, 1989).

Description. – *Tabebuia pallida* is a tree about 5–10 m tall, with fissured bark on its trunk. The palmate leaves consist of 3–5 stalked leaflets and the inflorescences are terminal panicles bearing pink to nearly white flowers. Typical of other species in this family, the fruits are narrow, cylindrical follicles that contain many winged seeds that are wind-dispersed. More detailed descriptions are available from Rao & Wee (1989), and US Forest Service, Pacific Island Ecosystems at Risk (2007).

Comments. – This tree was introduced around the 1980s (Rao & Wee, 1989). Numerous saplings were observed in the built-up area at Upper Boon Keng Road, near several mature individuals of the same species (Fig. 7).

DISCUSSION

In a study of invasion success of woody exotic plant species in the Czech Republic, Pyšek et al. (2009) found that both the probability of escaping from cultivation (i.e., becoming a casual) and the probability of naturalisation were most strongly determined by planting intensity firstly, followed by the time since introduction. Hence in the early stages of exotic species establishment, if the propagule pressure from planting is high enough, species will escape from cultivation irrespective of other biological traits. Given sufficient time and high planting frequencies, these exotic species will have a good chance of becoming naturalised. Our experience with spontaneous exotic species in tropical Singapore appears to corroborate these findings.

The “escape” of *Khaya senegalensis* from cultivation is hence within expectations as it is the 5th most commonly cultivated tree species in Singapore, together with *Albizia saman* (most common), and *Tabebuia rosea* (6th most common) (Tan et al., 2009). The latter two species have already been listed by Chong et al. (2009) as casuals, and escaped seedlings or saplings are often encountered in less well-manicured locations where weeding or grass-cutting has been neglected. Spontaneous individuals of the congener *Tabebuia pallida*, on the other hand, are rarely seen because its adult plants are also less commonly planted. However, Weber (2003) classified it as a potentially invasive



Fig. 7. Saplings of *Tabebuia pallida* beneath clumps of MacArthur's palm (*Ptychosperma macarthurii*) in Kallang. Scale bar = 10 cm. (Photograph by: Teo Siyang).

species that “establishes well in disturbed sites and forms dense thickets that shade out native plants and strongly reduce species richness”. They are also recorded as invasive in some islands at the Indian Ocean (PIER, 2007). It would therefore be advisable for planting intensities of *Tabebuia pallida* to continue to be kept low.

Among the seven species of casual species, *Ochna kirkii* has the most wide-spread and numerous spontaneous populations in Singapore. This is not surprising considering that it was introduced more than 70 years ago, reaching the reproductive state when it is only about 1 m tall, and flowers and fruits year-round. Its dispersal by birds facilitates its spread from the built-up environment to natural and semi-natural habitats. It is also commonly cultivated as a hedge plant. While it is difficult to determine its impact or its potential invasiveness, this species is likely to become naturalised in the near future. Already, PIER (2007) has reported it as an invasive species in Raiatea Island (part of the French Polynesia Society Islands). Two congeners — *Ochna serrulata* (Hochst.) Walp., and *Ochna thomasiana* Engl. & Gilg. are also classified as high-risk weed species in the Pacific Island region (US Forest Service, Pacific Island Ecosystems at Risk, 1999b; US Forest Service, Pacific Island Ecosystems at Risk, 2006).

For *Hymenaea courbaril*, *Dalbergia latifolia*, *Ixora finlaysonianana*, and *Fagraea crenulata*, we are unable to speculate about their future statuses, but from our evidence that they are capable of escaping from cultivation, we recommend that they should continue to be less frequently used in horticultural landscaping, as with *Tabebuia pallida*.

ACKNOWLEDGEMENTS

We thank Serena Lee and Chua Keng Soon for kindly providing details of specimens in the Singapore Botanic Gardens Herbarium (SING) and the Herbarium, Raffles Museum of Biodiversity Research (SINU), respectively. We are also grateful to Ang Wee Fong, and Ria Tan for sharing their sightings of spontaneously growing *Ochna kirkii* in Singapore as well as Wilson Zhang for his help in compiling the numbers for the most commonly planted trees in Singapore. This research was funded by the Ministry of National Development Research Fund for the Built Environment through the research grant for the project “Planning and Development for Sustainable High Density Living Project 3: Urban Greenery Studies” in collaboration with the Centre for Urban Greenery and Ecology of the National Parks Board, Housing and Development Board, and the Urban Redevelopment Authority.

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