

THE SPREAD OF *JACARANDA OBTUSIFOLIA* HUMB. & BONPL. (BIGNONIACEAE) INTO THE CENTRAL CATCHMENT NATURE RESERVE, SINGAPORE

A. F. S. L. Lok¹, K-x. Tan¹, X. Giam¹, T. P. Ng² and H. T. W. Tan^{1*}

¹Department of Biological Sciences, National University of Singapore

14 Science Drive 4, Singapore 117543, Republic of Singapore

²National Parks Board, Headquarters (Raffles Building)

Singapore Botanic Gardens, 1 Cluny Road, Singapore 259569, Republic of Singapore

(*Corresponding author: dbsttw@nus.edu.sg)

INTRODUCTION

Exotic plants have been introduced to Singapore for the last 190 years or so, but only a small percentage of them have become naturalised. Although the majority of these naturalized plants are herbs or climbers, aliens also include several species of trees that were introduced as ornamentals such as *Acacia auriculiformis*, *Falcataria moluccana* (= *Paraserianthes falcataria*), and *Spathodea campanulata*, or as crops, including *Leucaena leucocephala* (Corlett, 1988; Rao & Wee, 1989). All these trees are sun-loving species, usually growing only in bright open areas, and can be seen dominating most of the wasteland vegetation and forest edges in Singapore. However, no tree species has yet been able to penetrate the primary forests of Bukit Timah and the Central Catchment Nature Reserves, until recently.

This paper describes the spread of *Jacaranda obtusifolia* Humb. & Bonpl. ssp. *rhombofolia* (G. Mey.) A. Gentry, a new potentially invasive tree species in the Central Catchment Nature Reserve of Singapore. It belongs to a neotropical genus of 49 species in the tribe Tecomeae and of the family Bignoniaceae (Gentry, 1980). This subspecies is native to Venezuela, Guyana, Suriname, French Guiana and Brazil, growing in savannah forest and is also known by the following synonyms, *Bignonia filicifolia*, *Jacaranda filicifolia*, *Jacaranda filicifolia* var. *rhombofolia* and *Jacaranda rhombifolia* (Gentry, 1992).

MATERIAL AND METHODS

Three populations in the forest surrounding MacRitchie Reservoir, Singapore, were studied (Fig. 1). Height and diameter at breast height (dbh) measurements were taken for all the individuals found in Populations 1 and 2 using a

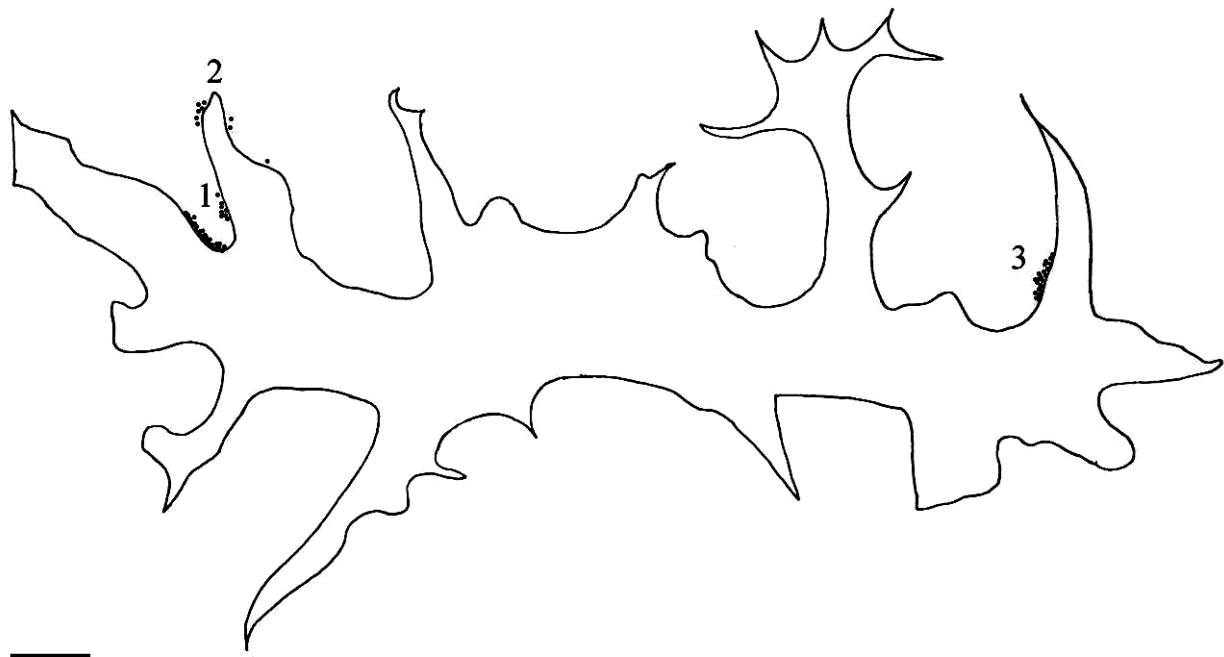


Fig. 1. Map of MacRitchie Reservoir showing the three populations of *Jacaranda obtusifolia* ssp. *rhombofolia*. Scale bar = 0.1 km.

dbh tape. Individuals in Population 3 were not measured as they only contained a small number of germinating seedlings. Only the histogram for number of individuals versus dbh values of Populations 1 and 2 combined, was plotted. Plant height data were excluded because plant height had to be estimated and not accurately measured, as the tops of the crowns of most of the larger individuals were not clearly visible and also because many of the larger specimens were leaning owing to weak wood and roots. The voucher specimens from three of the MacRitchie populations were deposited in the Herbarium, Raffles Museum of Biodiversity Research, National University of Singapore (SINU), namely, accession nos. 2007015505 (Population 1), 2007015506 (Population 2) and 2007015507 (Population 3).

RESULTS, OBSERVATIONS AND DISCUSSION

Jacaranda obtusifolia ssp. *rhombifolia* is a medium-sized, deciduous tree (4–18 m tall) with a variably shaped crown. The bark is grey, flaky resulting in mottling with drab green and cream. It has bipinnate leaves with opposite rhomboidal pinnules. The flowers are borne in short, dense clusters and the corolla is bluish lilac, funnel-shaped, 3–5 cm long (Fig. 2) and last only a few hours, dropping off soon after noon. This short blooming period was also reported by Rao & Wee (1989). The fruits are strongly flattened, oblong capsules. The seeds are thin with brownish or hyaline membranous wings, suggesting wind dispersal. The mildly fragrant flowers are contradictory to observations made by Corner (1988), who reported odourless flowers in this subspecies.

According to Corner (1988), *Jacaranda obtusifolia* ssp. *rhombifolia*, in a monsoon climate, is completely deciduous and flowers with or before the new leaves emerge. However, as observed in aseasonal Singapore, only a few leaves are shed before flowering occurs (Fig. 3). Flowering times vary between individuals, but in general, flowers open in the early morning, and wither by the afternoon.

This subspecies was not recorded by Corlett (1988), who instead noted another Bignoniaceae family member, *Spathodea campanulata* which is predominantly found in open, waste land areas in Singapore over rich soils. The absence from Corlett (1988) is probably because *Jacaranda obtusifolia* ssp. *rhombifolia*, has only recently been observed in these localities owing to the inaccessibility of the site, and has since increased in numbers with many seedlings and saplings being recruited. This is of concern, as it could possibly be the start of the invasion, as another congener, *Jacaranda mimosifolia*, has already become an invasive in Queensland (Australia), Pretoria (South Africa) and Miami-Dade County, Florida, and Hawaii (U.S.A.).



Fig. 2. An inflorescence of *Jacaranda obtusifolia* ssp. *rhombifolia* consisting of flowers with lilac corollas. Scale bar = 2 cm.



Fig. 3. Tree flowering with minimal leaves shed.



Fig. 4. Sapling growing in deep shade of the forest floor.

In Queensland, *Jacaranda mimosifolia* is an invasive tree which excludes native species, by consuming a lot of soil water. In South Africa, it was introduced in 1880 as an ornamental and after a hundred years, has invaded most of the country where there are an estimated 50,000 trees (Marshall, 2005). Pretoria, the administrative capital of South Africa, is now also called Jacaranda City because of the predominance of this tree in its landscape (Mosomane, 2007).

Jacaranda obtusifolia ssp. *rhombifolia* was first observed at MacRitchie Reservoir on 13 Feb.2007, Lower Peirce Reservoir on 5 Mar.2007, Upper Pierce Reservoir on 5 Sep.2007 and Upper Seletar Reservoir on 10 Jan.2008. This subspecies was discovered at MacRitchie Reservoir at three main sites (Fig. 1). Population 1, being the most established population, is located at the opening of a remote reservoir inlet near the ruins of Syonan Jinja, an Imperial Japanese Army Shinto Shrine, at the northwest of the Reservoir, opposite the Singapore Island Country Club (SICC) Sime Road Golf Course. This population contains many large mature individuals as well as many seedlings and saplings (Fig. 4). Population 2 is located at the same inlet as the first population, but towards the end of the inlet instead of near the opening. This population contains large individuals with some saplings, but the population is not as large as compared to that of population 1 (Fig. 1). Population 3, is located in the northeast of the reservoir at the mouth of an inlet, opposite to the floating pontoons for canoe launching, and contains only very young seedlings and saplings but no adult trees in the vicinity and is very distant from the other two populations. The plants found at the Upper Pierce Reservoir as well as Upper Seletar Reservoir, appear to be isolated individuals with no saplings or seedlings found around the adult tree. At Lower Peirce Reservoir, a recent visit revealed an increase in population, with many seedlings and saplings being found under and around the parent tree. The Lower Peirce Reservoir population is located at the cascade outflow where water discharges from Upper Seletar Reservoir via the Nee Soon pipeline.

The wide distance (1.9 km) between Population 3 and the other two populations is difficult to explain as the seeds are probably wind-dispersed (Fig. 1). Population 2 probably arose from Population 1 which is only 340 m away. This is comparable to studies done by Jones et. al. (2005) who noted seed dispersal of *Jacaranda copaia* up to 700 m from the parent tree. The seed dispersal range of *Jacaranda copaia* as reported by Jones et. al. (2005) is considerably shorter than the distance between Population 3 and the other two populations at MacRitchie Reservoir because that study was done in closed contiguous forest whereas the conditions at MacRitchie Reservoir are open, allowing seeds to be dispersed over a longer distance. The origins of the trees at MacRitchie Reservoir are unknown. Records from the National Parks Board (NParks) shows that the closest *Jacaranda obtusifolia* ssp. *rhombifolia* population is at Clover Way, which is 1.3 km away from the MacRitchie Reservoir populations, followed by Adam Park (1.73 km away) and Watten View (1.78 km away). It is possible but unlikely that the trees at MacRitchie Reservoir established as a result of seeds blown in from street or park plantings as the trees planted by the NParks are seemingly much younger than those found at the Reservoir (shorter in stature and narrower in crown diameter). The MacRitchie Reservoir populations are

therefore possibly originated from plantings along a drain leading to Syonan Jinja when it was used, as the largest number of trees and the largest/oldest trees are found close to the shrine.

Unlike the other invasive tree species of Singapore so far, only *Jacaranda obtusifolia* ssp. *rhombofolia* seems to be able to penetrate the forest at the Central Catchment Nature Reserve. Individuals seen at Lower and Upper Pierce Reservoirs as well as Upper Seletar Reservoir were all found closer to the shoreline in brightly lit conditions. However, Populations 1 and 2 at MacRitchie Reservoir appeared to have successfully established themselves under the forest canopy with seedlings and saplings being found in deep shade (Fig. 3). Additionally, the edge vegetation at these localities are by no means open and are dominated by a thick mature *Dillenia suffruticosa* screen along the water's edge, followed by older secondary forest vegetation with rattan palms along the fringes. This subspecies has been so successful that it has been able to grow further away from the forest edge, with large individuals found approximately 25 m from the water's edge under thick canopy cover.

The reproductive plants observed at Populations 1 and 2 of MacRitchie Reservoir have been observed to flower without much leaves or branches being shed (Fig. 4) and as such, flowers with much less profusion than in their native geographical range. The flowers of this subspecies are visited by *Xylocopa* bees, mainly *Xylocopa latipes* and *Xylocopa confusa*, which seem to be the main pollinators of the flowers here. Ramirez (2004) also reported these plants to be bee-pollinated in the tropical Venezuelan Savannah. Sunbirds such as the olive-backed sunbird (*Nectarinia jugularis*) and the crimson sunbird (*Aethopyga siparaja*) have also been observed visiting the flowers for nectar, but it is not certain if they effectively pollinate the flowers.

Another interesting observation is that this subspecies has been found to be able to reproduce vegetatively by natural layering. A specimen in Population 1 was observed to have successfully layered itself, when the tip of a drooping branch rooted and successfully formed a new tree at the point of contact (Fig. 5).

The graph of number of individuals versus diameter at breast height for Populations 1 and 2 combined, was plotted (Fig. 6) and showed a 'reverse J' or positive stand table. This indicated that Populations 1 and 2 are established reproductive populations, with only a few mature individuals with an extremely high percentage of the population being seedlings or saplings indicating strong recruitment. Based on these data, it is important that the NParks takes immediate action in controlling this newly established invasive population of *Jacaranda obtusifolia* ssp. *rhombofolia* before it spreads further into the Central Catchment Nature Reserve and displaces the native forest species.



Fig. 5. Vegetative reproduction of *Jacaranda obtusifolia* ssp. *rhombofolia*, showing a new plant resulting from natural layering of a drooping branch from the parent tree.

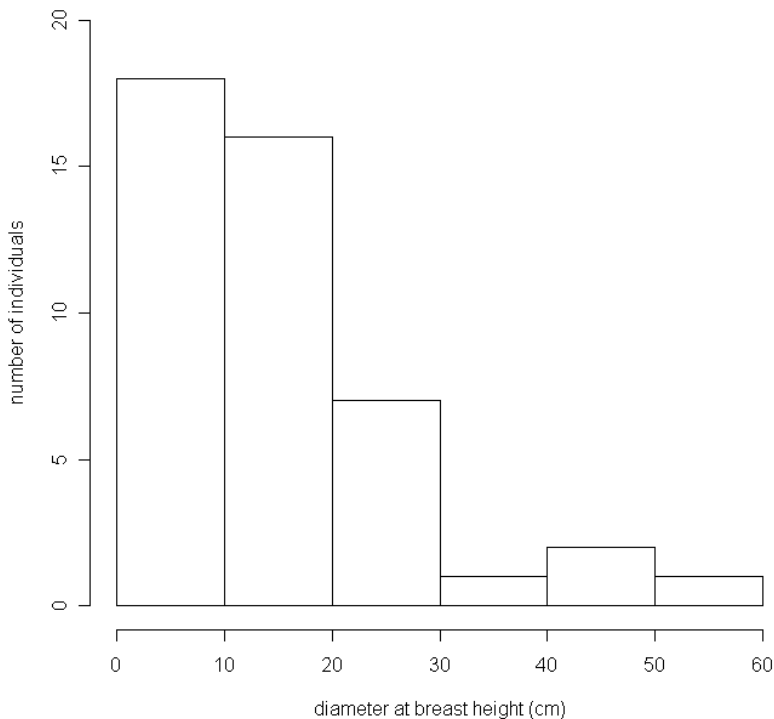


Fig. 6. Number of individuals versus diameter at breast height (stand table) of Populations 1 and 2 combined.

ACKNOWLEDGEMENTS

We would like to thank the Public Utilities Board for generously supporting this study and the National Parks Board for providing the relevant collection permits.

LITERATURE CITED

- Corner, E. J. H., 1988. *Wayside Trees of Malaya. Volume 2*. The Malayan Nature Society, Kuala Lumpur. 385 pp.
- Gentry, A. H., 1980. *Flora Neotropica. Bignoniaceae — Part 1. (Crescentieae and Tourrettieae)*. Monograph 25. The New York Botanical Garden, New York. 131 pp.
- Gentry, A. H., 1992. *Flora Neotropica. Bignoniaceae. Part 2. (Tribe Tecomeae)*. Monograph 25. The New York Botanical Garden, New York. 370 pp.
- Jones, F. A., J. Chen, G.-J. Weng & S. P. Hubbell, 2005. A genetic evaluation of seed dispersal in the Neotropical tree *Jacaranda copaia* (Bignoniaceae). *The American Naturalist*, **166**(5): 543–555.
- Ramirez, N., 2004. Ecology of pollination in a tropical Venezuelan Savanna. *Plant Ecology*, **173**(2): 171–189.
- Rao, A. N. & Y. C. Wee, 1989. *Singapore Trees*. Singapore Institute of Biology, Singapore. 356 pp.
- Mosomane, L. 2007. *City of Jacaranda Trees*. <http://bcb722.blogspot.com/2007/01/city-of-jacaranda-trees.html>. (Accessed 18 Sep.2008).
- Marshall, L., 2005. *Invasive Weed Threatens South Africa Rhino Sanctuary*. http://news.nationalgeographic.com/news/2005/09/0916_050916_triffidweed.html. (Accessed 18 Sep.2008).