

THE STATUS OF *CAESALPINIA BONDOC* (L.) ROXB. IN SINGAPORE

Alvin Francis S. L. Lok, W. F. Ang, K. Y. Chong, P. X. Ng, S. Teo, T. K. Yee, C. K. Yeo and Hugh T. W. Tan *

Department of Biological Sciences, National University of Singapore

14 Science Drive 4, Singapore 117543, Republic of Singapore

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

INTRODUCTION

This paper seeks to document the distribution and status of *Caesalpinia bonduc* (L.) Roxb. (Fig. 1) in Singapore. *Caesalpinia* is a relatively large genus with an estimated 100 species, occurring throughout Malesia (Hou et al., 1996). Formerly from the family Caesalpiniaceae, *Caesalpinia bonduc* now belongs to the family Fabaceae, which all legumes fall under today.

Caesalpinia bonduc has a pantropical distribution. In the Malesian region, this taxon is widespread although it is relatively rare in the rainforests of Sumatra, Borneo, the Philippines, and western New Guinea. Although the typical habitat for this species is the coast, it is reported to be growing inland in secondary forests in eastern Malesia, up to an altitude of 850 m (Tomlinson, 1986; Keng, 1990; Hou et al., 1996). *Caesalpinia bonduc* grows in full sun and is intolerant of shade, but can withstand areas with partial shade (Francis, 2000). It tolerates salt spray, saline soils, occasional flooding with seawater, and grows in a wide range of soil pH, from mildly acidic to alkaline soils. *Caesalpinia bonduc* is commonly found in beach vegetation, on coastal dunes (Fig. 2), and at better-drained edges of mangrove forest, but also grows inland in disturbed areas. It competes well against grass and herbs, and scrambles onto the crowns of low trees and shrubs (Fig. 1).



Fig. 1. *Caesalpinia bonduc* climbing over a *Ximenia americana* shrub on Pulau Sakijang Pelepah (Lazarus Island). (Photograph by: Alvin Francis Lok Siew Loon).



Fig. 2. Plant growing on coastal dunes in the Barbados. (Photograph by: Richard A. Howard).

Caesalpinia bonduc is reported to be free-flowering and free-fruiting, with both events occurring together and without periodicity (Hou et al., 1996). The seeds of this species are borne in a pod, with usually two seeds each, but on rare occasions three have been observed. The round marble-sized seeds are around 2 cm long and are drab-olive. Exposure of the seeds to the sun bleaches the seeds light grey. These seeds are released when the pods dry and split open (Fig. 3). The seeds are water-dispersed and float very well; seeds that stay afloat for years before being deposited on shore have been recorded, thus explaining its wide range (Francis, 2000). Seeds of this species found on beaches in northern Scotland have been reported to be able to float in seawater for as long as 19 years (Markland, 2002). Once the seeds reach shore, the scarifying action of sand, weathering, insects, or rodents eventually allows water to enter the seeds, allowing them to germinate and establish themselves. These hardy seeds are also frost-tolerant as demonstrated by a seed collected at Macquarie Island (Antarctica), estimated to be adrift for more than a year, germinating after being scarified and allowed to imbibe water (Costin, 1965). In a germination experiment, Francis (2000) collected seeds from Puerto Rico weighing an average of 2.444 ± 0.034 g seed⁻¹ (or 409 seeds kg⁻¹). In his experiment, 100 seeds (four batches of 25 seeds) were subjected to different treatments: weathered-scarified (by nicking), weathered-unscarified, fresh-scarified, and fresh-unscarified treatments. These seeds were then incubated in plastic bags of moist potting mix for germination. His results showed that most of the scarified seeds (both weathered and fresh) germinated within a few days and the rest germinated within one year. Germination of unscarified seeds showed the largest contrast, with 23 fresh unscarified seeds germinating while only one of the weathered unscarified seeds germinating after 16 months. This demonstrated the requirement of its seeds to undergo scarification prior to germination. *Caesalpinia bonduc* is also able to reproduce asexually through layering and stem cuttings (Francis, 2000).

PAST AND PRESENT RECORDS

Caesalpinia bonduc is a climber with a spiny stem and bipinnate leaves up to 1 m long, with stipules located at the base of the leaf-stalk (Fig. 4). Each bipinnate leaf has a main leaf axis of 80–100 cm long, with 7–8 pairs of pinnae that are 10–20 cm long, each pinna with 7–11 asymmetric, ovate-oval, nearly opposite pinnules. These leaflets are 5–6 cm long and 4–5 cm wide, and are covered with yellow hairs when young, gradually becoming smooth as they mature (Fig. 5). The inflorescences are yellow and occur in simple (Fig. 6) or branched racemes (Fig. 7) up to 50 cm long, originating from the leaf axils. The flowers are reportedly unisexual by abortion (Tomlinson, 1986). Plants are dioecious with male and female flowers occurring on separate plants. The pods are flattened and ellipsoidal, 5–7 cm long and 3–5 cm wide,



Fig. 3. A close-up view of the open pods of a plant in the Barbados. (Photograph by: Richard A. Howard).



Fig. 4. A close-up view of the leaf stipules of the plant in Pulau Sakijang Pelepah. (Photograph by: Alvin Francis Lok Siew Loon).



Fig. 5. The mature bipinnate leaves of the plant in Pulau Sakijang Pelepah. (Photograph by: Alvin Francis Lok Siew Loon).



Fig. 6. The unbranched inflorescence of the *Caesalpinia bonduc* plant found on Lazarus Island. (Photograph by: Alvin Francis Lok Siew Loon).



Fig. 7. A branched inflorescence of *Caesalpinia bonduc* plants found at Hana, Maui, Hawaii. (Photograph by: Forest and Kim Starr).

Table 1. Previous Singapore collections of *Caesalpinia bonduc* (L.) Roxb. deposited in the Herbarium, Singapore Botanic Gardens (SING).

S/No.	Accession/ Bar Code No.	Herbarium	Collector	Collector's No.	Date	Locality
1.	0018354	SING	J. Sinclair	38886	13 Mar.1950	Pulau Senang
2.	2007004784	SINU	H. T. W. Tan, Ali bin Ibrahim, P. T. Chew, J. Lai, A. H. B. Loo, E. E. L. Seah & B. C. Soong	L. 2030A	3 Sep.1996	Pulau Sakijang Pelepah (Lazarus Island)
3.	2007004783	SINU	H. T. W. Tan, Ali bin Ibrahim, A. H. B. Loo & E. E. L. Seah	S 1019	27 Sep.1996	Pulau Semakau

and are densely covered with rigid thorns, 8–10 mm (Fig. 3). Each pod usually contains 1–2 light grey seeds (Fig. 3), but on occasion three seeds per pods have been encountered.

Caesalpinia bonduc is critically endangered in Singapore (Tan et al., 2008), with only three plants presently known from the Republic. Two are growing in the southern islands, with a male plant growing on Pulau Sakijang Pelepah (Lazarus Island) and a female plant growing on Pulau Semakau. In early Feb.2011, another plant was discovered on Punggol Beach at the end of Punggol Road, 50 m west of the jetty, but the plant was then severely pruned by maintenance workers (R. K. H. Yeo, pers. comm.). Historical records show that *Caesalpinia bonduc* was once collected from Pulau Senang (Table 1), but as this island is now under the protection of the Singapore Armed Forces, we are unable to verify if this plant still persists at that locality.

Interestingly, even though the male and female plant of this species are separated by 10.6 km of water (the distance between Pulau Semakau, and Lazarus Island), seed pods have been reported on the female plant on Pulau Semakau (J. Lai, pers. comm.). Here, we postulate four hypotheses as to how the female plant on Pulau Semakau was able to set seed. The first hypothesis is that there is a strong, flying pollinator that is able to traverse the 10.6 km distance between the two known male and female plants. Possible pollinators are *Apis* bees or the much larger *Xylocopa* bees, with stronger evidence pointing to an *Apis* species, as *Apis dorsata* has been known to visit flowers of *Caesalpinia bonduc* in the Nallamalai forest, Andhra Pradesh, India (Daehler, 2005). Although we have never observed pollinators visiting the plant on Lazarus Island, the size of its flowers suggests that the flowers are unlikely to be visited by bees as large as *Xylocopa latipes*, or *Xylocopa confusa*. The second hypothesis is that the plant previously collected from Pulau Senang, still persists today and is a male plant. The existence of a putative male plant much closer (4.9 km) to the female plant on Pulau Semakau could explain the pollination of the female plant there. The third hypothesis is that Pulau Semakau has both male and female plants, with the male plant being overlooked because of the scrambling and creeping nature of this species. The last possibility is that the plant on Pulau Semakau had spontaneously adapted in the absence of a male plant to become bisexual and self-compatible or has evolved to undergo apomixis. Tomlinson (1986) reported that this taxon has unisexual flowers owing to spontaneous abortion, while Daehler (2005) did not rule out apomixis or self-compatibility in this taxon, indicating the plant on Pulau Semakau could have possibly failed to undergo abortion resulting in bisexual self-compatible flowers.

CONCLUSIONS

The fate of this species in Singapore is somewhat dire, with the only male and only female plants in the Republic, being separated by a large distance. It is not known if this species was initially scarce in the Republic or decimated because of habitat loss with the destruction of beach vegetation and mangrove forests because of land reclamation and urban development. It is, however, possible to reintroduce propagated plants to offshore islands such as Pulau Ubin, Pulau Tekong, Pulau Semakau, Lazarus Island, and the military live-firing islands of Pulau Senang, Pulau Sudong, and Pulau Pawai, as well as to the landward edges of mangrove forest fragments of the Sungei Buloh Wetland Reserve, and Lim Chu Kang areas where relatively little disturbance occurs. Possible methods of propagating this species for reintroduction are planting of seeds collected from the Pulau Semakau plant and vegetative propagation via stem cuttings of both plants from Pulau Semakau and Lazarus Island. It is, however, advisable to collect seeds from Johore, Malaysia, or the Riau Archipelago (Indonesia) as well to increase the genetic diversity of the species here in Singapore.

ACKNOWLEDGEMENTS

We would like to express our gratitude to the Director, Tropical Marine Science Institute (TMSI) for allowing us access via the TMSI St John's Island ferry, and Goh Soon Huat of Sentosa Development Corporation for allowing us access to Lazarus Island. We are also grateful to Richard A. Howard (Smithsonian Institute), and Forest and Kim Starr (Hawaii

Ecosystems at Risk) for allowing us use of their images of *Caesalpinia bonduc*, and to Joseph Lai, and Ron K. H. Yeo for kindly sharing their observations of this species with us.

LITERATURE CITED

- Costin, A. B., 1965. Long-distance seed dispersal to Macquarie Island. *Nature* **206**(3): 317.
- Daehler, C., 2005. *Caesalpinia bonduc* risk assessment, Pacific Islands at Risk (PIER). http://www.hear.org/Pier/wra/pacific/caesalpinia_bonduc_htmlwra.htm. (Accessed 16 Nov.2009)
- Francis, J. K., 2000. *Caesalpinia bonduc* (L.) Roxb. Gray nicker bean. Fabaceae. <http://www.fs.fed.us/global/iitf/pdf/shrubs/Caesalpinia%20bonduc.pdf>. (Accessed 15 Nov.2009)
- Hou, D., K. Larsen & S. S. Larsen, 1996. Caesalpinaceae. *Flora Malesiana*, Series 1, **12**(2): 409–730.
- Keng, H., 1990. *The Concise Flora of Singapore: Gymnosperms and Dicotyletons*. Singapore University Press, Singapore. 222 pp.
- Markland, J., 2002. Drift seeds. In: *West Word, Community paper for Glenfinnan, Lochailort, Glenuig, Arisaig, Morar, Mallaig, Knoydart, and the Small Isles*. <http://road-to-theisles.org.uk/westword/march2002.html>. (Accessed 17 Nov.2009).
- Tan, H. T. W., K.-x. Tan, Ali bin Ibrahim, P. T. Chew, K. S. Chua, H. Duistermaat, S. K. Ganesan, M. W. K. Goh, A. T. Gwee, R. Kiew, S. M. L. Lee, P. Leong, J. Lim, A. F. S. L. Lok, A. H. B. Loo, S. K. Y. Lum, T. Morgany, Saifuddin Suran, S. Sim, Haji Samsuri bin Haji Ahmad, Y. C. Wee, K. F. Yap, C. K. Yeo & J. W. H. Yong, 2008. Checklists of Threatened Species — Seed Plants. In: Davison, G. W. H., P. K. L. Ng & H. C. Ho (eds.), *The Singapore Red Data Book, 2nd Edition*. The Nature Society (Singapore), Singapore. Pp. 213–244.
- Tomlinson, P. B., 1986. *The Botany of Mangroves*. Cambridge University Press, Cambridge. 413 pp.