

Further observations on a natural *Rhizophora* hybrid population in Malaysia

Introduction

In Malaysia, the first encounter of a *Rhizophora* hybrid was reported by Chan (1996). *Rhizophora* × *lamarckii* Montr. was growing alongside its putative parents, *Rhizophora apiculata* Bl. and *Rhizophora stylosa* Griff., on Pulau Burung (Fig. 1), an islet off the coast of Port Dickson in Negeri Sembilan. The morphological features of *R.* × *lamarckii* have been described by several authors (Chan, 1996; Duke, 2006, 2010). Here are further descriptions of the *Rhizophora* hybrid population on Pulau Burung (2°32'N, 101°47'E) observed during a field survey conducted in March 2012. All trees of *R. apiculata*, *R. stylosa*, hybrid(s) including *Rhizophora mucronata* Lamk. were in flower.



Fig. 1. Aerial view of Pulau Burung (Google Earth)

Flowers of hybrid(s)

Inflorescences of the *Rhizophora* hybrid(s) usually had a pair (occasionally two pairs) of buds borne on a stout peduncle, similar to those of *R. apiculata*. This suggests that one of the putative parents may be *R. apiculata*. Despite having flowers, no fruits or propagules were found, unlike the other *Rhizophora* species. Taking a closer look at the hybrids, we found that most of the flowers had abnormal development (Fig. 2). One or two pairs of the calyx lobes were incompletely separated and reproductive parts were non-functional at anthesis. These observations are consistent with other studies that deemed *Rhizophora* hybrids to be sterile and/or limited to the F_1 stage (Lo, 2010; Parani *et al.*, 1997).



Fig. 2. Abnormal development of flowers of *Rhizophora* hybrid(s)

Leaves of hybrid(s)

Three leaves per tree were sampled from two *R. apiculata*, three *R. mucronata*, nine *R. stylosa* and 12 *Rhizophora* hybrid(s), and their blade length, blade width and petiole length measured (Table 1). From our measurements, there were significant differences in leaf dimensions among the hybrid(s). Hybrids are thought to express phenotypes that are intermediate to their parents. Some hybrid individuals showed intermediary characteristics between *R. apiculata* and *R. stylosa*, while the others between *R. apiculata* and *R. mucronata*. Besides having large, broad leaves (Fig. 3), some of the hybrid(s) showed discernable venation patterns on their leaves (Fig. 4). There was great variation in this trait, as some hybrid(s) had no such leaf patterns, while others were intermediate.

Habitat and growth of hybrid(s)

Habitat types of Pulau Burung include rocky shores, and littoral mud and sand flats. Trees of *R. mucronata* and the hybrid(s) were found growing on all habitat types of the islet, while *R. apiculata* and *R. stylosa* were restricted to the mud and sand flats. Generally, the *Rhizophora* hybrid(s) showed better growth than their putative parents (Table 2). Trees displayed luxuriant growth with extensive rooting systems and multiple stems (Fig. 5). Together with their ability to grow on all habitat types on Pulau Burung, the *Rhizophora* hybrid(s) may be expressing hybrid vigour, a condition where the hybrids outperform the parental species in terms of establishment and growth.

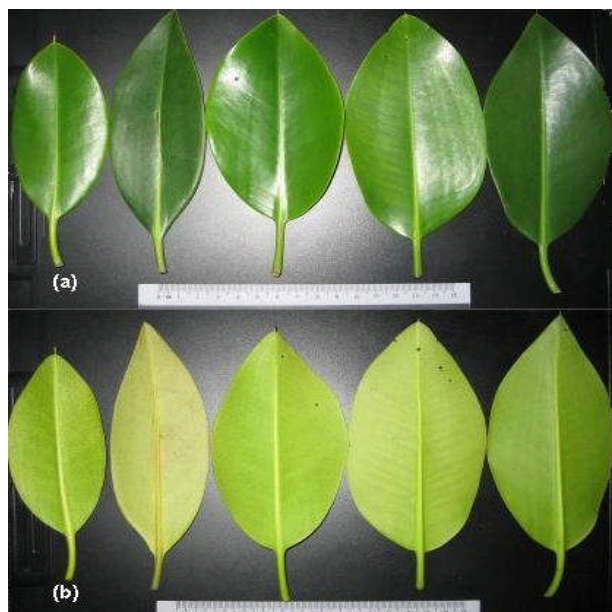


Fig. 3. Leaf morphology of *Rhizophora* spp. and hybrid(s). (a) top surface (b) under surface. *R. stylosa*, *R. apiculata*, *R. mucronata*, hybrid 1 and hybrid 2 (from left to right).



Fig. 4. Clear venation pattern on some hybrid(s)

Identity of hybrid(s)

Chan (1996) made no mention of *R. mucronata* on Pulau Burung. During our field survey, trees of *R. mucronata* were found, albeit at a lower frequency compared to *R. stylosa*. The occurrence of *R. mucronata* throws into question the identity of the hybrid individuals. A study on the chemical constituents of leaves of *R. apiculata*, *R. stylosa*, and a hybrid on Pulau Burung suggests that *R. × lamarckii* grows on the islet (Chan, 2009). However, *R. mucronata* was not included in the comparison. Given the similarities in morphology between *R. stylosa* and *R. mucronata*, the different crosses with *R. apiculata* may not be discernible morphologically. This would mean that there may be a mixture of *R. × lamarckii* and other types of interspecific crosses, e.g. *Rhizophora × annamalayana* Kathiresan (= *R. apiculata* × *R. mucronata*) among the *Rhizophora* hybrid population on Pulau Burung. Leaves of hybrid individuals and the putative parent species were collected for further molecular studies to confirm the identities of the hybrid(s).



Fig. 5. Vigorous growth of a *Rhizophora* hybrid

Although there are other coastal locations in Malaysia where *R. apiculata*, *R. mucronata* and *R. stylosa* co-exist, there is only one other report of *Rhizophora* hybrid, i.e. the occurrence of *R. × annamalayana* in Merbok Mangroves, Kedah (Ong, 2003). Therefore, further studies on the *Rhizophora* hybrid population on Pulau Burung are crucial for the understanding of such rare mangrove flora, and every effort should be made to conserve this unique habitat.

Acknowledgement

This work was supported in part by the Global COE Program, Ministry of Education, Culture, Sports, Science and Technology, Japan.

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Table 1. Leaf dimensions of *Rhizophora* spp. and hybrid(s) on Pulau Burung

Species	Individual	N	Mean BL (cm)	Mean BW (cm)	Mean PL (cm)
<i>R. apiculata</i>	-	6	13.6 ± 0.8	5.1 ± 0.4	1.4 ± 0.1
<i>R. mucronata</i>	-	9	14.6 ± 1.4	7.2 ± 0.7	2.7 ± 0.8
<i>R. stylosa</i>	-	27	10.7 ± 1.0	5.1 ± 0.5	2.5 ± 0.3
<i>R. hybrid(s)</i>	01	3	12.7 ± 1.4	7.0 ± 1.1	1.7 ± 0.2
	02	3	12.4 ± 0.3	7.0 ± 0.1	2.5 ± 0.2
	03	3	12.6 ± 1.6	6.1 ± 0.8	2.5 ± 0.2
	04	3	13.1 ± 0.9	6.1 ± 0.6	2.2 ± 0.3
	05	3	12.4 ± 0.1	6.0 ± 0.3	2.4 ± 0.4
	06	3	14.1 ± 0.4	7.1 ± 0.1	2.7 ± 0.2
	07	3	14.3 ± 0.9	6.7 ± 0.4	2.1 ± 0.3
	08	3	13.6 ± 0.5	6.7 ± 0.2	2.1 ± 0.4
	09	3	11.4 ± 1.9	5.4 ± 0.8	1.7 ± 0.4
	10	3	9.9 ± 0.5	5.7 ± 0.3	1.8 ± 0.2
	11	3	10.6 ± 0.8	5.1 ± 0.4	2.5 ± 0.1
	12	3	12.5 ± 0.7	5.8 ± 0.4	2.5 ± 0.2

Abbreviations: N = number of leaves measured, BL = blade length (measured from base of leaf blade to tip of leaf blade and excluding mucronate), BW = blade width (measured at the widest point of leaf blade), and PL = petiole length.

Table 2. Tree heights of *Rhizophora* spp. and hybrid(s) on Pulau Burung

Species	N	Height range (m)	Mean height (m)
<i>R. apiculata</i>	2	3.5 – 8.0	5.8
<i>R. mucronata</i>	3	4.8 – 7.5	6.1
<i>R. stylosa</i>	9	2.0 – 6.8	3.9
<i>Rhizophora</i> hybrid(s)	12	2.3 – 7.2	5.6

Abbreviation: N = number of trees measured.