

## THE STATUS AND DISTRIBUTION OF *BARCLAYA* (NYMPHAEACEAE) IN SINGAPORE

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### INTRODUCTION

The genus *Barclaya*, previously *Hydrostemma* (Stone, 1982), is found in Borneo, Peninsular Malaysia (Malaya), Thailand and Myanmar (Burma), and was placed in its own family, Barclayaceae, but has now been moved to the Nymphaeaceae (the waterlilies) (Williamson & Schneider, 1994). Nathaniel Wallich published the name *Hydrostemma* in June 1827, and six months later, he published the name *Barclaya* in December 1827 in honour of Robert Barclay (1757–1830), English botanist and horticulturist (see Stearn, 1996). The reason for the author's change of mind is unclear, and during the time when no formal nomenclatural rules were agreed upon, the name *Barclaya* was accepted. According to the current International Code of Botanical Nomenclature, the name *Barclaya* should yield to the generic name *Hydrostemma*, as *Hydrostemma* was coined first, in accordance to the rule of priority. However Crusio & Bogner (1984) proposed the conservation of *Barclaya* over *Hydrostemma* and it was accepted because *Barclaya* was widely used among thousands of aquarists, but also in scientific literature as well as popular hobbyist reading material on waterplants and local floras.

The genus *Barclaya* is endemic to Southeast Asia and grows in or along the edges of muddy or clear sandy-bottomed forest streams in tropical rain forests (Williamson & Schneider, 1994). Because of the rapid deforestation in Southeast Asia, many of the habitats where *Barclaya* grows, have either been extirpated or heavily sedimented owing to erosional run-off and as such have become turbid and unsuitable for the growth of these plants. *Barclaya* is the only member of the family Nymphaeaceae native to Singapore and is one of four truly native aquatic spermatophytes recorded from



Fig. 1. *Barclaya kunstleri* growing in a clear sandy forest stream in Bukit Timah Nature Reserve (Photograph by Alvin Francis Lok Siew Loon).



Fig. 2. *Barclaya longifolia* showing emergent chasmogamous flowers in a stream in Southern Thailand. (Photograph by: Nattawut Chuenban).



Fig. 3. Close up of *Barclaya longifolia* flowers. (Photograph by: Nattawut Chuenban).



Fig. 4. *Barclaya motleyi* in a ditch on Gunung Gaharu, Sarawak, Malaysia. (Photograph by: Michael Lo).



Fig. 5. *Barclaya motleyi* flowering during a dry period at Gunung Gaharu, Sarawak, Malaysia. (Photograph by: Michael Lo).



Fig. 6. *Barclaya rotundifolia* showing its typical emergent form at Kota Tinggi, Johore, Malaysia. (Photograph by: Michael Lo).



Fig. 7. *Barclaya rotundifolia* showing its emergent chasmogamous flower at Kota Tinggi, Johore, Malaysia. (Photograph by: Michael Lo).



Figure 8. Herbarium sheet of *Barclaya kunstleri* collected at Nee Soon Swamp Forest between firing Ranges 1 and 2. (Photograph courtesy of the National Parks Board).



Figure 9. Herbarium sheet of *Barclaya motleyi* collected from Sarawak, Malaysia. (Photograph courtesy of the National Parks Board).



Fig. 10. The habitat of *Barclaya kunstleri*, dominated by *Pandanus atrocarpus* and *Cyrtosperma merkusii*. (Photograph by: Alvin Francis Lok Siew Loon).

Singapore (Tan et al., 2007). The genus *Barclaya* today consists of four species, *Barclaya kunstleri* (Fig.1), *Barclaya longifolia* (Figs. 2, 3), *Barclaya motleyi* (Figs. 4, 5) and *Barclaya rotundifolia* (Figs. 6, 7) (Williamson & Schneider, 1994).

Vegetatively, three of the four species of *Barclaya*, look superficially very similar especially in their emergent and submergent growth forms. *Barclaya longiflora* is the most vegetatively-distinct species, having linear-lanceolate (Fig. 2) and basally cordate leaves as compared to the broadly orbicular blades of the other species, including many intermediate forms between them. In contrast to the very similar vegetative morphology between the three species, Williamson & Schneider (1994) reported differences in pollination among the species. *Barclaya longifolia* flowers are observed to be submerged, cleistogamous, and self-pollinating, which does not seem accurate, when most flowers observed in aquaria and in the wild are emergent and open fully, suggesting insect pollination (Fig. 3). On the other hand, *Barclaya kunstleri* (previously known as *Barclaya motleyi* var. *kunstleri*) (Fig. 1), is reported to have both submerged and emergent flowers (Williamson & Schneider, 1994), although only emergent flowers were observed in Singapore. In this species, the flowers were also reported by Williamson & Schneider (1994) as being cleistogamous, and are presumably self-pollinated, although Singapore plants have been observed with fully opened flowers, again suggesting insect pollination. *Barclaya motleyi* is observed to be chasmogamous, with flowers that are elevated above the water surface. Field observations of *Barclaya motleyi* were also made to study pollinator visitation. The study lasted three weeks, with no pollinator having been identified. Exclusion experiments carried out indicated that *Barclaya motleyi* was also capable of selfing. The last species, *Barclaya rotundifolia* is reported to have aerial and chasmogamous flowers.

According to Keng (1990), only one species of *Barclaya* occurred in Singapore, which for years was thought to be *Barclaya motleyi*. We now know that possibly two species of *Barclaya* existed in Singapore—*Barclaya motleyi* and *Barclaya kunstleri*. *Barclaya kunstleri* was previously known as *Barclaya motleyi* var. *kunstleri*, and described by British botanist, Sir George King (1840–1909) in honour of Hermann H. Kunstler (“King’s collector”) who was under King’s employment as a plant collector in Perak (Stone, 1982). This variety was later raised to species level by H. N. Ridley and is now considered to be *Barclaya kunstleri* (King) Ridley, on the basis that plants of *Barclaya kunstleri* have thinner, glabrous leaves, and globose seeds, more similar to those found in *Barclaya longifolia* than those of *Barclaya motleyi*, but the sepals found in *Barclaya kunstleri* are more similar to those of *Barclaya motleyi*.



Fig. 11. *Barclaya kunstleri* growing under dense growth of *Pandanus atroparpus*. (Photograph by: Alvin Francis Lok Siew Loon).



Fig. 12. *Cyrtosperma merkusii* growing in abundance in the *Barclaya kunstleri* locality. (Photograph by: Alvin Francis Lok Siew Loon).



Fig. 13. *Barclaya kunstleri* growing with petioles and much of the plants buried under sand or humus, exposing only their laminas. (Photograph by: Alvin Francis Lok Siew Loon).



Fig. 14. Pinkish globose fruits of *Barclaya kunstleri*. (Photograph by: Alvin Francis Lok Siew Loon).

#### PAST AND PRESENT RECORDS

*Barclaya* was previously collected at three localities in Singapore—Ang Mo Kio, Bukit Timah and Seletar (Table 1). The specimens collected by both J. Sinclair (Fig. 8) and H. N. Ridley from all three localities were previously identified as *Barclaya motleyi*, but have now been determined to be *Barclaya kunstleri*. Later in 1934, Z. Teruya collected three more specimens of *Barclaya* without localities, and one of the specimens was determined to be the typical form of *Barclaya motleyi* and not *Barclaya kunstleri*, although this could merely be the emergent form of *Barclaya kunstleri* and should even be dismissed because of the lack of locality details. The Ang Mo Kio habitat where Ridley originally collected *Barclaya kunstleri* was cleared for development and a public housing estate resides there now.

The second *Barclaya* locality mentioned from the Botanic Gardens' Herbarium (SING) records was collected by Sinclair on 17 Jul.1954 at Seletar forest, or more correctly known as the Nee Soon Swamp Forest (NSSF). Today *Barclaya kunstleri* is no longer found at this site, and only extensive patches of *Cryptocoryne griffithii* are present. *Barclaya* in the NSSF locality have probably been replaced by *Cryptocoryne griffithii*, although more field research is required to verify the true status of *Barclaya kunstleri* there.

The last known locality where *Barclaya kunstleri* was collected by Ridley in 1892 is the Bukit Timah Nature Reserve (BTNR). Today the last surviving population of *Barclaya kunstleri* in Singapore is found at the edge of the BTNR where submergent plants grow in a flowing clear-water stream which drains into a large pond (Fig. 10). *Pandanus atrocarpus* (giant pandan) (Fig. 11), *Cyrtosperma merkusii* (Fig. 12) and a *Pinanga* species are common at the confluence of two streams. The substratum is composed of clay and sand with accumulation of some leaf litter.

Table 1. Previous collections of species of *Barclaya* Wall. deposited in the Herbarium, Singapore Botanic Gardens (SING).

S/No.	Species	Bar Code No.	Collector	Collectors No.	Date	Locality
1.	<i>Barclaya kunstleri</i>	113327	J. Sinclair	40337	17 Jul.1954	Seletar forest
2.	<i>Barclaya kunstleri</i>	113328	H. N. Ridley	s.n.	1892	Bukit Timah
3.	<i>Barclaya kunstleri</i>	113329	H. N. Ridley	s.n.	1894	Ang Mo Kio
4.	<i>Barclaya kunstleri</i>	113330	Z. Teruya	2480	1934	–
5.	<i>Barclaya kunstleri</i>	113331	Z. Teruya	2480	1934	–
6.	<i>Barclaya motleyi</i>	30488	Z. Teruya	2830	–	–



The plants were found growing with only their laminae visible as most of them had their petioles buried in the sand or in the humus built up around the plant (Fig. 13). A mature plant, when viewed from the top, appeared as a rosette of leaves with the younger ones inside. The young lamina was a lighter shade of green when compared to the mature lamina. The plants were shallowly rooted (10–15 cm in the substrate) and could be easily extracted intact. The buried petioles could function as anchorage since the water was constantly flowing (specimens observed growing in stagnant or slow-flowing streams from Gunung Santubong, Sarawak, Malaysia, and Pulau Bintan, Indonesia, had exposed petioles). Specimens were consistently found with holes in the lamina and this could be attributed to herbivory by insects (D. H. Murphy, pers. comm.).

Collections of *Barclaya kunstleri* by a fish survey team led by the National Parks Board in Dec.1994, by HHT in Mar.1995 and by AFSL and WFA in Mar.2009, indicate that the fruiting period is from Dec.–Mar. The fruiting period is probably longer, but a long-term study is required to establish the actual period. *Barclaya kunstleri* is observed to carry its pinkish globose fruits (Fig. 14) erect, at just above the water surface. The fruit contains spongy tissue which makes the abscised fruit buoyant. From this observation, it can be postulated that the plant relies upon hydrochory for its dispersal. A simulation of this was carried out *ex situ*. The fruit was observed to disintegrate within 48 hours into a slimy layer with black, spiny seeds embedded in white buoyant tissue. The seeds were then observed to sink once the tissue had absorbed water, after approximately 24 hours. When the seed was placed onto peat saturated with water, it germinated in approximately 48–72 hours, but if placed into deeper water, no germination of the seed was observed. This indicates that the initial floating mass of tissue and seeds are transported to shallow, stagnant waters or stream banks, where they germinate quickly and establish themselves. Both *Barclaya kunstleri* and *Barclaya motleyi* also propagate vegetatively by runners and can cover quite extensive areas. A corm-like structure is also present at the base of mature plants and probably acts as a storage organ. New plants could probably be propagated from the corm, as is how done for *Barclaya longifolia* for the aquarium trade.

## CONCLUSIONS

At present, *Barclaya kunstleri* is only known from a stream feeding a pond along the periphery of the BTNR, and this site should be protected from trail development so as to prevent sediment deposition from erosion, which would otherwise smother these beautiful plants. What remains today of the original vegetation in Singapore are mostly in Bukit Timah and Central Catchment Nature Reserves but it is uncertain if *Barclaya kunstleri* can be found in the other forest streams of these relatively untouched areas or if it is the only species of *Barclaya* found in Singapore. Hence, more exploration is needed in the forested areas of our nature reserves to ascertain the true status of *Barclaya* here in Singapore, especially in areas like the Nee Soon Swamp Forest. It is also highly probable that *Barclaya kunstleri* is the only species in *Barclaya* in Singapore, and the record of *Barclaya motleyi* by Z. Teruya was due to erroneous collection information on the locality. The National Parks Board, should also look into collecting some of these plants for *ex situ* conservation, which can include mass propagation of these aquatic plants using tissue culture techniques, after which they can be reintroduced into other streams in Bukit Timah and Central Catchment Nature Reserves, where species and a hybrid of *Cryptocoryne* are not found to avoid competition between these taxa.

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