

NYMPHAEACEAE

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Salisb., Ann. Bot. 2, fasc. 1 (1805) 70, nom. cons.; Hooker & Thomson in Hooker, Fl. Brit. India 1, fasc. 1 (1872) 113; Ridley, Fl. Malay Penins. 1 (1922) 115; Keng, Ord. Fam. Malayan Seed Pl., ed. 3 (1983) 42; Keng, Concise Fl. Singapore, vol. 1, Gymn. Dicot. (1990) 22; Schneider & Williamson in Kubitzki et al. (ed.), Fam. Gen. Vasc. Pl. 2 (1993) 486; Heywood in Heywood et al., Fl. Pl. Fam. World (2007) 231; Kiew, Fl. Penins. Malaysia, ser. 2, 5 (2015) 207; La-ongsri, Fl. Thailand 14(4) (2020) 543. **Type:** *Nymphaea* L.

Barclayaceae H.L.Li, Amer. Midl. Naturalist 54 (1955) 40. **Type:** *Barclaya* Wall.

Aquatic perennial herbs rooted in substrate, with long horizontal rhizomes, sometimes tuberous or with a short erect stem, rarely marsh plants. Stipules present or lacking. **Leaves** spirally arranged, floating, submerged or rarely emergent; with or without thorns on the petiole and lower lamina surface; petioles long; lamina simple, peltate or attached at lamina base, ovate to orbicular or rarely ribbon-like, base cordate or sagittate, margin entire or dentate or upturned. **Flowers** often large and showy, actinomorphic, bisexual, solitary, held above the water surface on long pedicels, organs spirally arranged. **Sepals** 4–9, green or coloured. **Petals** (0–)3 to many, yellow, pink, red, blue, purple or white. **Stamens** 14 to many, free, laminar or with a distinct filament. **Ovary** inferior or semi-inferior or superior, carpels 3–40, joined or partly free; placentation lamellar. **Fruit** a spongy berry, splitting when the mucilage inside swells or indehiscent. **Seeds** many, arillate or aril lacking; perisperm copious, endosperm scanty.

Distribution. Cosmopolitan in temperate, subtropical and tropical regions, with 5 genera and c. 84 species. *Nymphaea* L. is the most speciose genus with c. 60 species and is widespread from Europe to Australia, *Victoria* R.H.Schomb. (2 species) occurs in South America, *Nuphar* Sm. (18 species) in north temperate regions, *Barclaya* Wall. (3–8 species) in West Malesia, and *Euryale* Salisb. (1 species) in East Asia. Some studies, however, suggest that *Victoria* and *Euryale* are nested in *Nymphaea* and should be synonymised within it (see Cheng et al., Front. Genet. (2022) 13:1031705). In Singapore, 1 genus and 1 native species.

Ecology. In freshwater lakes, ponds, rivers and streams, ditches, canals, etc., rooted in mud; usually in full sun, rarely in shade (*Barclaya*). The flowers are raised above the water surface and are insect pollinated, either by bees (day flowering species) or beetles (night flowering species). The fruit often ripens below the water surface. Seeds of some species have arils that enclose an air bubble and so the seeds float and are dispersed by water currents (*Nymphaea*) or the seeds are covered in spines (*Barclaya*) that suggest they could become attached to the fur of animals, such as pigs (Mabberley, Mabberley's Pl. Book, ed. 4 (2017) 637).

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Uses. The flowers of the large waterlilies are strikingly beautiful and many species and hybrids of *Nymphaea* are valued for their ornamental value (Slocum, Waterlilies & Lotuses (2005)). The Amazon waterlilies, *Victoria amazonica* (Poepp.) Klotzsch and *V. cruziana* A.D.Orb., native to South America, are grown in botanical gardens for their spectacularly large leaves that can grow to 2 m diameter with an upturned margin to 10 cm high. *Barclaya longifolia* Wall., with colourful submerged leaves, is traded as an aquarium plant. In Sri Lanka, the rhizomes of the blue water lily, *Nymphaea nouchali* Burm.f., are cultivated for starch, the flower stalks are eaten as a vegetable, and the seeds eaten as puffed grain (Slocum, Waterlilies & Lotuses (2005)).

Vernacular name. In English, known as the waterlily family.

Taxonomy. Based on similarities in aquatic habit, earlier accounts of Nymphaeaceae for Singapore (e.g., Ridley, Fl. Malay Penins. 1 (1922) 115) included the lotus, *Nelumbo* Adans., which is now recognised as a distantly related and distinct family, Nelumbonaceae (Lee, Fl. Penins. Malaysia, ser. 2, 1 (2010) 151).

Li (Amer. Midl. Naturalist 54 (1955) 40) described Barclayaceae as a distinct family because *Barclaya* differs from the other genera in a number of characters: the gynoecium is completely inferior, the petals are joined into a tube which is lobed at the apex, the stamens are epipetalous, pendent and attached over the inner surface of the corolla tube, ovules are orthotropous (anatropous in all the other genera), and the seeds do not have an aril. Based on a molecular phylogenetic analysis, Les et al. (Syst. Bot. 24 (1999) 28) recognised it as subfamily Barclayoideae of the Nymphaeaceae. Currently (Heywood et al., Fl. Pl. Fam. World (2007) 271; Mabberley, Mabberley's Pl. Book, ed. 4 (2017) 637), Nymphaeaceae is considered to have two subfamilies: Nymphaeoidae (*Barclaya*, *Euryale*, *Nymphaea*, *Victoria*) and Nupharoidae (*Nuphar*).

The fossil record shows that Nymphaeaceae is one of the most ancient groups of flowering plants and was widely distributed in the Tertiary, possibly as early as the Early Cretaceous, and indeed displayed much greater diversity in the past. While its aquatic habit is considered specialised, the waterlily flower with many, free, spirally arranged flower parts, the lack of differentiation into small green sepals and larger colourful petals and the laminar stamens place it among the basal group of flowering plant families.

BARCLAYA Wall.

(Robert Barclay, 1751–1830, London brewer, gardener
and friend of Nathaniel Wallich)

Trans. Linn. Soc. Lond. 15 (1827) 442, nom. cons.; Hooker & Thomson in Hooker, Fl. Brit. India 1, fasc. 1 (1872) 115; King, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 58(4) (1889) 390; Ridley, Fl. Malay Penins. 1 (1922) 116; Hu, Dansk Bot. Ark. 23(4) (1968) 535, fig. 1; Schneider & Williamson in Kubitzki et al. (ed.), Fam. Gen. Vasc. Pl. 2 (1993) 491, fig. 104: F; Kiew, Fl. Penins. Malaysia, ser. 2, 5 (2015) 209; La-ongsri, Fl. Thailand 14(4) (2020) 543. **Synonym:** *Hydrostemma* Wall., Philos. Mag. Ann. Chem. 1 (1827) 454, nom. rej.; Mabberley, Taxon 31 (1982) 68. **Type:** *Barclaya longifolia* Wall.

Perennial herbs; rhizome fleshy, creeping. **Leaves** in rosettes, submerged or just above the water surface; lamina lanceolate to ovate to orbicular, margin entire or undulate; venation pinnate. **Flowers** hypogynous; buds narrowly ellipsoid. **Sepals** narrowly lanceolate, opening wide, pale yellow or greenish brown, (4–)5, free, strongly keeled elongating into a long apical tip. **Petals** deep pink or purple or red, connate into a corolla tube adnate to the syncarpous ovary, lobes (8–)12(–many), in several series inserted at different levels. **Stamens** many, magenta, epipetalous within the corolla tube, pendent, staminodia 10–20, above the stamens. **Ovary** syncarpous, carpels 8–14, carpellary appendages encircling the stigmatic cup. **Berry** globose to ellipsoid, spongy, dehiscing irregularly, sepals persistent. **Seeds** many, globose or ellipsoid, c. 1 mm diam., embedded in mucilage or in spongy tissue, testa with long, soft spines, without an aril.

Distribution. A genus of between 3 (Kiew, Fl. Penins. Malaysia, ser. 2, 5 (2015) 209–215) and 8 (Jacobsen et al., Nord. J. Bot. (2022) e03392: 1–41) species from the Andaman Islands, Myanmar, Thailand, Peninsular Malaysia, Sumatra and Borneo to New Guinea. In Singapore, 1 native species.

Ecology. Throughout its range, in shaded primary lowland forest or peat swamp forest in waterlogged hollows or in clear, shallow streams on fine clay substrate or on fine gravel, sometimes persisting after disturbance. Only *Barclaya rotundifolia* M.Hotta from Peninsular Malaysia and Borneo holds its leaves above the water surface; in *B. longifolia*, from the Andaman Islands and continental Southeast Asia, and in *B. motleyi* (see below) the leaves are submerged or, when exposed by falling water levels, lie prostrate on the wet substrate. The flowers are held and open above the water surface, although Williamson & Schneider (Pl. Syst. & Evol., Suppl. 8 (1994) 159–173) reported that *Barclaya longifolia* is sometimes cleistogamous and self-pollinating with flowers remaining closed and not emerging above the water surface. Williamson & Schneider (1994) suggested flies as a possible pollinator for *Barclaya rotundifolia* based on observations of flies in the vicinity of the flowers and drowned in fluid in the stigmatic cup. Its flowers have been reported to produce a pungent fermenting odour or smell of rotten meat. *Barclaya motleyi* produces a strong stink at night (Abdullah Piee, pers. comm.) suggesting beetle pollination. After pollination, the sepals and corolla tube persist, while the stalk bends so that the fruit ripens at or below the water surface. The pericarp disintegrates or ruptures irregularly as the mucilage inside swells and the spongy pericarp tissue enables the fruit to float so it may be dispersed by water currents. The spiny seeds may be further dispersed on the fur or feathers of mammals or birds. *Barclaya* species also propagate vegetatively by runners or by small tubers.

Uses. In Continental Europe and North America, *Barclaya longifolia* is traded as ‘Orchid Lily’ and is valued as an aquarium plant for its reddish submerged leaves.

Taxonomy. Jacobsen et al. (Nord. J. Bot. (2022) e03392: 1–41) recognise eight species in *Barclaya*, several of which they newly describe. The only species of relevance for Singapore is their *Barclaya kunstleri* which is included here in synonymy of *Barclaya motleyi* Hook.f.

Notes. Li (Amer. Midl. Naturalist 54 (1955) 40) and several other authors interpreted the sepals as bracts and the corolla as the perianth. Developmental anatomy confirms the outer organs as sepals (Williamson & Schneider, Pl. Syst. Evol., Suppl. 8 (1994) 159–173).

Barclaya motleyi Hook.f.

(James Motley, 1822–1859, English mining engineer,
surveyor and naturalist, particularly in Borneo)

Trans. Linn. Soc. London 23(1) (1860) 157, t. 21; King, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 58(4) (1889) 390, as '*mottleyi*'; Ridley, Fl. Malay Penins. 1 (1922) 116, fig. 10, p.p.; Sinclair, Gard. Bull. Singapore 15 (1956) 29; Keng, Gard. Bull. Singapore 27 (1974) 83; Corner, Gard. Bull. Singapore, Suppl. 1 (1978) 79, as '*motleyana*'; Turner, Gard. Bull. Singapore 47 (1997 ['1995']) 390; Turner et al., Gard. Bull. Singapore 48 (1998 ['1996']) 151; Chew et al., Gard. Bull. Singapore 49(2) (1999 ['1997']) 202; Chong et al., Checkl. Vasc. Pl. Fl. Singapore (2009) 18, 157, 201; Turner & Chua, Checkl. Vasc. Pl. Sp. Bukit Timah Nat. Res. (2011) 56; Wong et al., Checkl. Pl. Sp. Nee Soon Swamp Forest (2013) 33, 431; Kiew, Fl. Penins. Malaysia, ser. 2, 5 (2015) 212; Wong & Ganesan, Fl. Singapore 1 (2019) 44; Yee et al., Fl. Singapore 1 (2019) 60; La-ongsri, Fl. Thailand 14(4) (2020) 544, fig. 2; Lindsay et al., Gard. Bull. Singapore 74(Suppl. 1) (2022) 513. **Synonym:** *Hydrostemma motleyi* (Hook.f.) Mabb., Taxon 31 (1982) 68; Keng, Concise Fl. Singapore, vol. 1, Gymn. Dicot. (1990) 22, fig. 17.1; Turner, Gard. Bull. Singapore 45 (1993) 157. **Type:** *Motley 956*, [Indonesia], Borneo, Bangarmassing [Banjarmasin], August 1857 (lectotype K [K000442105], designated here; isoelectotype K [K000442106]). **Fig. 1.**

Barclaya motleyi Hook.f. var. *kunstleri* King, J. Asiat. Soc. Bengal, Pt. 2, Nat. Hist. 58(4) (1889) 390, as '*mottleyi*'; Ridley, J. Straits Branch Roy. Asiat. Soc. 33 (1900) 43. **Synonyms:** *Barclaya kunstleri* (King) Ridl., Fl. Malay Penins. 1 (1922) 117; Stone, Malayan Naturalist (for Sep. 1978) (1978) 20, fig. 1; Turner, Gard. Bull. Singapore 47 (1997 ['1995']) 390; Lok et al., Nat. Singapore 2 (2009) 237–245; Ho et al., Gard. Bull. Singapore 71(Suppl. 1) (2019) 100; Jacobsen et al., Nord. J. Bot. (2022) e03392: 26. – *Hydrostemma kunstleri* (King) B.C.Stone, Gard. Bull. Singapore 35(1) (1982) 71, fig. 1; Keng, Order Fam. Malay. Seed Pl., ed. 3 (1983) 44, fig. 21. **Type:** *Kunstler 10866*, [Malaysia], Perak, Bera, August 1886 (lectotype K [K000442104], first step designated by Stone, Gard. Bull. Singapore 35(1) (1982) 69, second step designated here; isoelectotype CAL n.v.).

Submerged aquatic herbs with a long thin branching rhizome, nodes rooting and producing leaves. **Leaves:** petiole reddish, thin and flexible, 8.5–27.5 cm long, (1–)2–3(–5) mm diam. when dry, densely pubescent becoming glabrescent; lamina brownish or purplish green or dull green above, yellowish, reddish or purplish brown or deep magenta beneath, thin, broadly oval to obovate or ovate-rotund, rarely rotund, 4–10 × 3.5–8 cm, base slightly cordate, lobes 0.3–1.5 cm long and lobes far apart or truncate, sometimes unequal, margin undulate, apex rounded, sometimes obtusely acute; lateral veins 3–5 pairs, sometimes the lowermost two pairs arising together from base of the midrib, plane above, slightly prominent beneath, glabrous to densely pubescent; intercostal veins obscure. **Flowers:** pedicel (5–)10.5–19 cm long, lengthening to (9.5–)22–26.5 cm in fruit, pubescent, sparsely clothed with short white hairs or glabrous. **Calyx lobes** (sepals) 5, dull purple-brown or pink, narrowly lanceolate, 14–50 × 3–5 mm, outer surface slightly hairy, slightly keeled, sometimes apex abruptly narrowed into an apiculus 2–4 mm long. **Corolla** tube dark red, purplish or greenish yellow, to 8–9 mm long, c. 4.5 mm wide, with (5–)12–15 lobes, 7–9 × 2–5 mm, rounded and hood-like, 3



Figure 1. *Barclaya motleyi* Hook.f. **A.** Habit with fruit above the water. **B.** Closed flower and fruit. **C.** Plant showing rhizoids, leaves and fruit. (A–C from Singapore, A & B, Bukit Timah, *Lok & Ang* 2007017125; C, Bukit Timah, *Lua & Ang* SING2016-100. Photos: A & B, W.F. Ang; C, P.K.F. Leong).

outermost lobes greenish, middle four larger and pink-magenta, eight innermost lobes reduced and white. **Stamens** c. 21, anthers subsessile, white, tinged pink, oblong, to 1.5 mm long, tip slightly apiculate. **Ovary** with concave stigma ring, locules c. 9. **Berry** globose, pinkish, 1.5–2.2 cm diam. **Seeds** spiny, globose, black.

Distribution. Peninsular Thailand, Peninsular Malaysia, Borneo and New Guinea. In Singapore, there are historical collections from Bukit Timah (*Ridley s.n.*, 1892, SING [SING0113328]), Ang Mo Kio (*Ridley s.n.*, 1894, SING [SING0113329]) and Nee Soon (*Sinclair SFN 40337*, 17 Jul 1954, SING [SING0280950]). Nowadays, known only from Bukit Timah (*Lua & Ang SING2016-100*, 13 May 2016, SING [SING0219190]) and Upper Peirce (*Yeoh et al. SING2019-1339*, 14 Nov 2019, SING [SING0295604]).

Ecology. Throughout its range, found in peat swamp forest in deep shade or in lowland forest in stagnant or slow-flowing clear streams with fluctuating water levels where its leaves may be periodically submerged in water to c. 65 cm deep or in dry periods flop on the water-logged mud. It sometimes grows together with *Cryptocoryne* Fisch. ex Wydler (Araceae) species. In Peninsular Malaysia, it has been collected in flower in February and March and again in November and December suggesting it flowers seasonally. In Singapore, it is recorded to fruit in December to March. In ex situ experiments its seeds were found to germinate within 48–72 hours on wet peat but did not germinate when submerged (Lok et al., Nat. Singapore 2 (2009) 245).

Conservation assessment. Globally, Data Deficient (DD) (IUCN Red List, 2026). In Singapore, assessed as Critically Endangered (CR/D) by Middleton et al. (in Davison et al., Singapore Red Data Book, ed. 3 (2024) 495).

Notes. *Barclaya motleyi* was never a common species in Singapore. It was previously believed to have become nationally extinct (Keng, Concise Fl. Singapore, vol. 1, Gymn. Dicot. (1990) 22) but was rediscovered at Bukit Timah in 1994 (Lok et al., Nat. Singapore 2 (2009) 245) and, subsequently, also collected from Upper Peirce.

Jacobsen et al. (Nord. J. Bot. (2022) e03392: 26) acknowledged that Stone (Gard. Bull. Singapore 35(1) (1982) 69) effectively referred to the collection *Kunstler 10866* as the type but they chose a different collection from amongst the original material as lectotype because they stated that *Kunstler 10866* is *Barclaya motleyi* rather than their concept of *B. kunstleri*. Nevertheless, as Stone designated *Kunstler 10866* in a first step, only a specimen of this collection can be designated as lectotype in a second step. Even with the narrower species concept of Jacobsen et al., therefore, *Barclaya kunstleri* is a synonym of *B. motleyi*.