Chapter 4

A Selection of Water Plants for Waterways and Waterbodies.

The plants selected in this book are categorised largely by their growth habits. In addition to the botanical description of the plants, horticultural information and landscaping uses of these plants are provided through the use of symbols. All these plants are able to remove varying quantities of nitrogen and phosphorus from the aquatic and semi-aquatic environment.

Plant Type

Floating Plants float on the surface of the water. Some are rooted in the sediment and have leaves that float on the water surface. They may also have underwater leaves. They sometimes form extensive green mats on the water surface. Floating leaf plants may also be categorised using this symbol.

Submerged Plants are usually found entirely underwater, but the flowers and fruits may rise above the water surface. Submerged species are rooted in the sediment and have underwater leaves. They can grow from shallow water to depths greater than ten meters in very clear water.

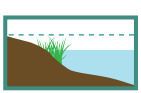
Shoreline Plants grow along edges of lakes, rivers, streams, and ponds, or on wet ground away from open water. They have at least part of their stems, leaves, and flowers emerging above the water surface and are generally rooted in the sediments. This symbol will also be used for rheophytes.

For every plant, there is a preferred range of growth conditions in terms of light and water requirements. While these are indicated for every species in this book, they serve only as a rough guide to the cultivation needs of the plant. The actual requirements will vary from site to site. Plants are in fact fairly resilient organisms and will adapt to small variations in the growth environment.

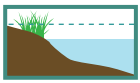
Planting Information

Zonation

Permanent Water Zone is constantly wet and flooded. All floaters, floating-leaf and submerged plants are found here.



Littoral Zone consists of plants that grow at the margins, and can tolerate flooding. The dotted lines represent the flood lines that could happen during heavy downpours.



Upland Zone is usually higher on terrestrial land, but the plants here can withstand the occasional flooding. They however cannot tolerate constant or prolong flooding. The dotted lines represent the flood lines that can happen during heavy downpours.

Cultivation

Full shade Plants are plants that require less than three hours of direct sunlight daily, with filtered sunlight during the rest of the day. However, full shade does not mean no sunlight.

Semi-shade Plants are plants that require three to six hours of sun each day, preferably in the morning and early afternoon.

Full sun Plants are plants that require six full hours of direct sunlight daily.

Horticultural Value

Indoor Plants are plants that grow well indoors in the home and office where they provide numerous benefits in addition to being beautiful.

Native plant species of Singapore. These plants are native to the country.

Ornamental Flower indicates plants that are usually grown for their flowers.

Ornamental Foliage indicates plants that are noteworthy for their foliage, which could be colour, texture, size or shape.

“Medicinal Plants”. These are plants which are (or have been in the past) used to cure disease and to promote health and healing.

Dipteris lobbiana

Rheophytes

Cuphea hyssopifolia

Phyllanthus myrtifolius

Cuphea hyssopifolia Kunth

False Heather

Family Lythraceae

The natural habitat of *Cuphea hyssopifolia* is almost wholly confined to large rocks along the edges of swift streams. These rocks project above the mean level of the stream, but during times of heavy rain the plants are often covered by rushing water. They have tough stems that are able to withstand the debris carried by the rapid currents of water.

Features
A small shrub of 25-50 cm in height. It is densely branched and foliaged with ascending branches.

Leaves
The leaves are small and are arranged alternately. Leaves are lanceolate to oblanceolate with a narrow cuneate at the base. It does not have a distinct petiole.

Root system
It consists of a taproot and many lateral roots of equal thickness.

Flowers
The flowers are of many colours, from the typical purple to lavender, white and pink.

Fruits
The fruits are not showy. The seeds are brown in colour.

Distribution
Native to Central America, Mexico, Guatemala and Honduras.

Propagation: By vegetative propagation (division or cuttings) or by seeds.

Uses: This plant is widely grown for commercial ornamental use as it blends well with other plants.

Note: It is a perfect choice for permanent evergreen groundcover, as it requires minimal pruning.

(Top left) The shoot of Cuphea hyssopifolia*. (Top right) The purple and white flowers of* Cuphea hyssopifolia*. (Middle left)* Cuphea hyssopifolia *is usually planted as a road side groundcover plant. (Bottom left)* Cuphea hyssopifolia *(purplish patch on the left) is planted as part of a bioretention swale along Sengkang West Way (Singapore) to treat rainwater runoff from the road. (Bottom right)* Cuphea hyssopifolia *planted beside a pond as part of water landscaping.*

Dipteris lobbiana (Hook.) T. Moore

Janggut Ali

Family Dipteridaceae

Dipteris lobbiana is a hardy species that thrives on rocky ground and is found primarily along the small gorges and waterfalls of many Malaysian and Indonesian rainforests. Its narrow fronds are the typical distinctive feature of the rheophytic species.

Features
Rheophytic fern with fronds that are small with narrow lobes.

Leaves
Fronds can grow up to 100 cm long and petiole 30-70 cm long. The lamina is fan-shaped. The fronds are dichotomously divided, and end in long linear lobes with a central midrib and a row of naked circular sori.

Root system
The rhizomes are underground, long-creeping, woody, but scale-like when dry.

Flowers
Not applicable.

Fruits
Not applicable.

Distribution
Native to Malaysia, Indonesia, the Philippines, Celebes, and New Guinea.

Propagation: By spores.

Uses: This plant is well-adapted against fast-flowing waters, although frequent prolonged floods would damage the plant eventually.

Note: The most distinctive feature for this species is its frond shape: it tends to have narrow, willow-like fronds that appear to offer little resistance to water flowing over them, and can thus survive flash-flooding with little foliage damage.

Young Dipteris *sporophytes.*

The beautiful frond of Dipteris lobbiana.

The spore bags found on the underside of the frond.

Ficus celebensis Corner

Willow Fig

Family Moraceae

The genus *Ficus* has a number of species which are only found naturally in a rheophytic environment. Unlike most of their terrestrial relatives, they have narrow slender leaves which are adapted to riparian environment.

Features
A willow-like tree that can grow up to 25 m.

Leaves
Leaves are lanceolate, 5-19 cm in length, attenuate to both ends.

Root system
It has wide clinging root systems.

Flowers
Insignificant.

Fruits
It bears club-shaped green fruits.

Distribution
Originated from Sulawesi, Indonesia.

Propagation: By seeds.

Uses: It is planted as a wayside tree in an urban setting.

Note: Its slender leaves and drooping branches are similar to the Weeping Willow, *Salix babylonica* and therefore it is a frequent plant choice for horticultural design of water gardens.

The branches of Ficus celebensis.

The fruits of Ficus celebensis.

The tree trunk of Ficus celebensis.

The slender shoots and leaves of Ficus celebensis *resemble that of the Weeping Willow* (Salix babylonica).

Ixora lobbii King & Gamble var. *stenophylla*

Pecah Periuk

Family Rubiaceae

(Copyright: Ivan Polunin)

Ixora, named after an Indian deity, is a genus with about 400 species. *Ixora lobbii* var. *stenophylla* is a shrub with long narrow shiny leaves that grows on riverbanks in Johor, Pahang and Borneo. This species is able to survive when submerged by torrential floodwaters.

Features
A shrub up to 2 m tall.

Leaves
The shiny leaves are lanceolate and gradually tapering to the long acuminate apex.

Root system
It has a deep-branching root system.

Flowers
The unopened buds look like needles. As the flowers open, they resemble a broken clay pot. The flowers are much larger than those of other *Ixoras*.

Fruits
The unripe fruits are reddish and turn black when ripe.

Distribution
Native to Southeast Asia.

Propagation: By stem cuttings.

Uses: The *Ixora* plant is cultivated as an ornamental plant.

Note: *Ixora lobbii* is sometimes used as a medicinal plant. The roots of the plants are used to relieve swelling and as a remedy for eye disease.

(Top left) The beautiful flowers of Ixora lobbii *(Copyright: Malaysian Nature Society). (Top right) The flowers of the different forest* Ixora *species. (Middle) The waterlogged tolerance of the other common ornamental* Ixora *species and hybrids is being evaluated by plant scientists. (Bottom) The common* Ixora *species is also found in lowland tropical forest.*

Nerium sp.

Oleander

Family Apocynaceae

The Oleander is a hardy shrub that is inexpensive and easy to grow in most landscapes. It is an evergreen shrub with long narrow leaves, which produces showy flowers at the tips of the branches when it blooms.

Phytoremediation potential: In particular, *Nerium oleander* is able to accumulate cadmium and lead.

Propagation: By stem cuttings or by seeds.

Uses: This species is used in many horticultural applications, such as screens, informal hedges, beach plantings, and other urban green spaces. Oleanders are very attractive small trees which are suitable for small gardens.

Note: Oleander is poisonous if ingested, and skin contact to its sap may cause adverse reaction(s). This plant should not be used in playgrounds or other areas frequented by young children and pets.

Features

This fast growing evergreen shrub can reach up to 6 m tall but is usually seen trimmed at 1-3 m. It forms a rounded mound of about 3 m wide.

Leaves

The leaves are in whorls of threes or fours. The leaf is linear-lanceolate, having a dimension of 8-20 cm by 1-3 cm. It cuneates at both ends where the apex is acute and leathery. The petiole is strong and thick.

Root system

It has a large, vigorous and branched root system.

Flowers

Showy summertime fragrant flowers in white, red, pink, salmon and light yellow. The flowers (3-5 cm in diameter) grow in clusters at the end of each branch.

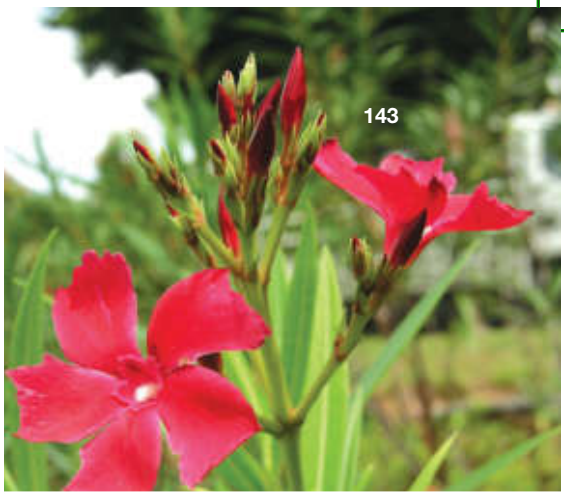
Fruits

The fruit is a long narrow capsule or follicle of 5-23 cm long, which splits open at maturity to release numerous downy seeds.

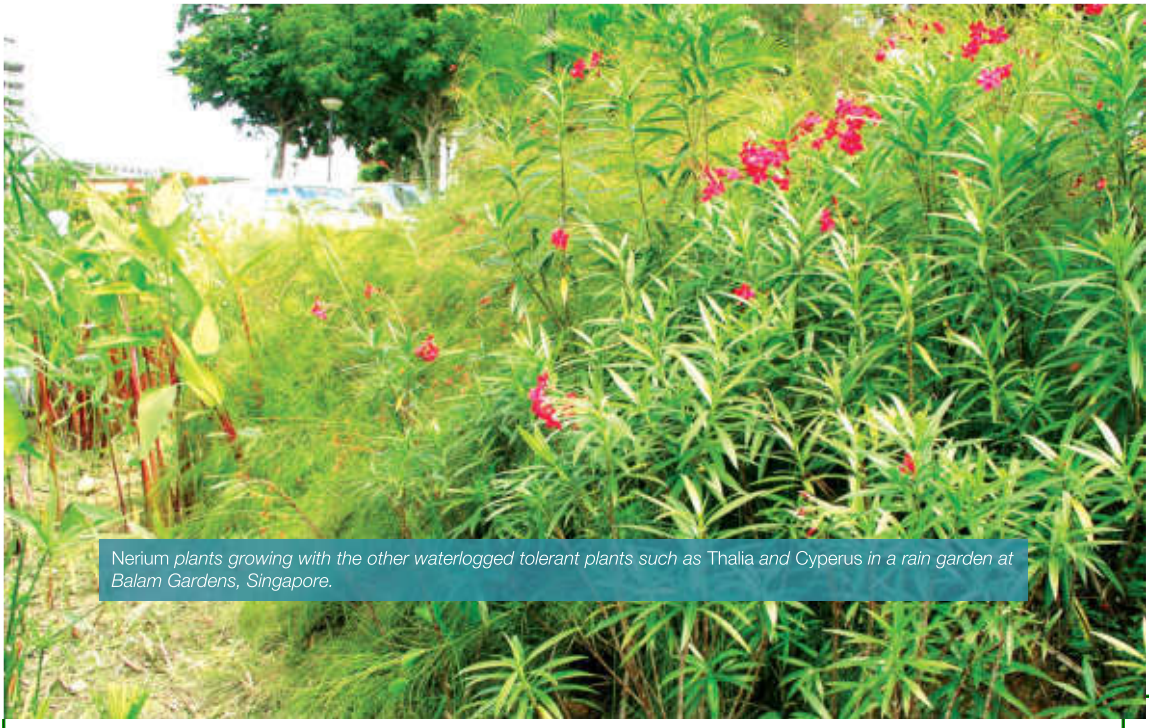
Distribution

Native to the South Europe, the Mediterranean, Southeast Asia and South Asia.

The natural habitat of Nerium *sp.*



The flowers of Nerium *sp.*



Nerium *plants growing with the other waterlogged tolerant plants such as* Thalia *and* Cyperus *in a rain garden at Balam Gardens, Singapore.*

Osmoxylon lineare (Merr.) Philipson

Miagos Bush

Family Araliaceae

This is a tropical ornamental shrub valuable for its fine-cut leaves. It is commonly used for Japanese-styled garden designs.

Features
It is a glabrous and erect shrub which can grow up to 3 m.

Leaves
The leaves are crowded near the branch-tips. Each leaf has four to seven accuminate leaflets.

Root system
Strong root system to anchor the plant onto substrate.

Flowers
Flowers are in flat-topped terminal clusters (umbels).

Fruits
The fruits are whitish and have narrow deep grooves.

Distribution
Native to Southeast Asia.

Propagation: By stem cuttings or by seeds.

Uses: This species is used in many horticultural applications and is also a popular indoor decorative plant.

Note: Due to its versatility in adapting to many urban and natural environmental conditions, i.e. varying light and soil moisture conditions, this is one of the most popular horticultural plant species for landscaping, and it is therefore widely available in local nurseries.

Osmoxylon lineare *plants.*

The flowering and fruiting shoots of Osmoxylon lineare.

Osmoxylon lineare *planted in a rain garden at Balam Gardens, Singapore.*

Phyllanthus myrtifolius (Wight) Mull. Arg.

Mousetail Plant

Family Euphorbiaceae

Phyllanthus myrtifolius is widely cultivated as ornamental shrubs due to its small leaves, arching branches and attractive pink flowers.

Features
A small or large rigid shrub up to 3 m, with numerous irregular stems and many slender, much-branched elongated twigs.

Leaves
The leaves are linear-lanceolate to oblong. Small leaves line the long arching stems and are arranged on the stem in a flat plane.

Root system
The root system is extensive.

Flowers
The flowers are small and pink to red in colour.

Fruits
The fruits are small and capsule-like.

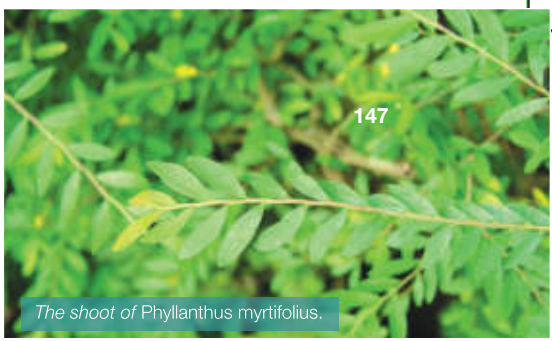
Distribution
Originating from Sri Lanka (Ceylon), Southeast Asia, Australia, and the tropical Americas.

Propagation: By stem cuttings.

Uses: This plant is usually cultivated as a bonsai and used as a border plant.

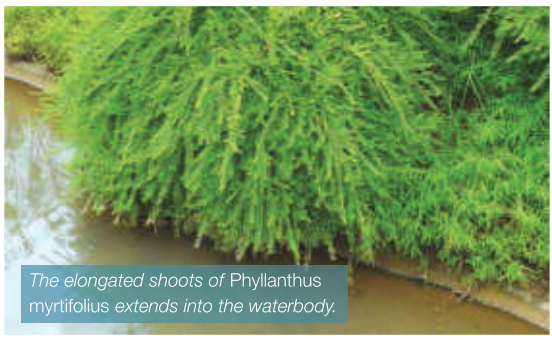
Note: Tannins extracted from this plant have been reported to have anti-bacterial properties.

Phyllanthus myrtifolius *can be planted as ornamental bonsai plants.*



The shoot of Phyllanthus myrtifolius.

The flowers and fruit of Phyllanthus myrtifolius.



The elongated shoots of Phyllanthus myrtifolius *extends into the waterbody.*

The dense growth of Phyllanthus cochinchinensis *and* Phyllanthus myrtifolius *transforms the wall into a beautiful naturalised green hedge.*

Phyllanthus watsonii A. Shaw

Phyllanthus

Family Euphorbiaceae

Phyllanthus watsonii grows only along Sungai Endau (Malaysia) and its tributaries, and nowhere else in the world. It has good root establishment and can grow well along the edge of the river, under flowing water conditions.

Features
A shrub or small tree which grows to about 1 m tall.

Leaves
The leaves are sessile and compound in rosettes. They are obliquely rhomboid-oblong, 7-15 mm by 3-4 mm. The leaves are glabrous, rigid, with recurved margins, and attenuated at both ends.

Root system
The root system is extensive and clings tenaciously onto the rocky substrate.

Flowers
Not known.

Fruits
Not known.

Distribution
Found only in Peninsular Malaysia.

Propagation: By division.

Uses: No known uses.

Note: *Phyllanthus watsonii* species produces bioactive compounds which may have medicinal properties.

A colony of Phyllanthus watsonii *growing in a riparian environment* (Copyright: Chew Keng Lin).

Phyllanthus watsonii *can be found beside fast-flowing streams of pristine tropical rainforest.*

Pinanga rivularis Becc.

River Pinanga

Family Arecaceae

(Copyright: John Dransfield)

The rheophytic taxon of *Pinanga* is highly characteristic of the stable rocks in the larger rivers of Borneo and are capable of regular submergence below the flood line.

Propagation: By vegetative propagation or by seeds.

Uses: No known uses.

Note: The dense branching of this plant allows it to survive burial by sand and also contributes to the stabilisation of sand banks.

Features

They can grow up to 1.5 m with branching that occurs along the stem. They grow densely and the stems may be lying on the ground with rising tips in the direction of stream flow.

Leaves

The leaves are pinnate with 14-18 narrow leaflets of 10-20 cm long and 2-5 mm broad.

Root system

Extensive root systems which appear at the base of the intermodal branches.

Flowers

The female flower possesses a calyx consisting of fused sepals and the triads of flowers are arranged distichously on the axis of the spikelet in a plane radial to the stem.

Fruits

The fruits are green throughout the period of maturation. They do not have fleshy mesocarp. The fruits are globular and depressed at the tip.

Distribution

Native to Borneo.

The mature fruits of Pinanga rivularis. *The hook-like fibers suggest that a possible way of dispersion is through animal or water current, where the fruits then hook on to protruding objects in their next destination* *(Copyright: John Dransfield).*

The dense branching of Pinanga rivularis *(Copyright: John Dransfield).*

Pinanga tenella (Wendl.) Scheff. var. *tenella*

Pinanga

Family Arecaceae

Pinanga tenella var. *tenella* and *P. rivularis* are very similar, they both form bushes of narrow willow-like foliage along river banks. However, they differ in terms of inflorescence and fruit characteristics.

Propagation: By vegetative propagation or by seeds.

Uses: No known uses.

Note: The plant occurs on stable pebbly or silty river banks, and more rarely in crevices between rocks. The profuse branching may be an adaptation to easy recovery after possible damage due to flash floods.

Features

A small palm of 0.5-1.5 m tall. The stems are in tufts or clumps. Dense branching occurs at the base of clumps which may consist of 60 stems or more.

Leaves

The leaves are about 50 cm long and they are linear-lanceolate, acuminate and attenuate to the base, with two folds.

Root system

Extensive root systems which appear at the base of the intermodal branches.

Flowers

The female flower possesses a calyx consisting of separate sepals and the triads are arranged distichously on the axis of the spikelet in a plane perpendicular (at a right angle) to the stem.

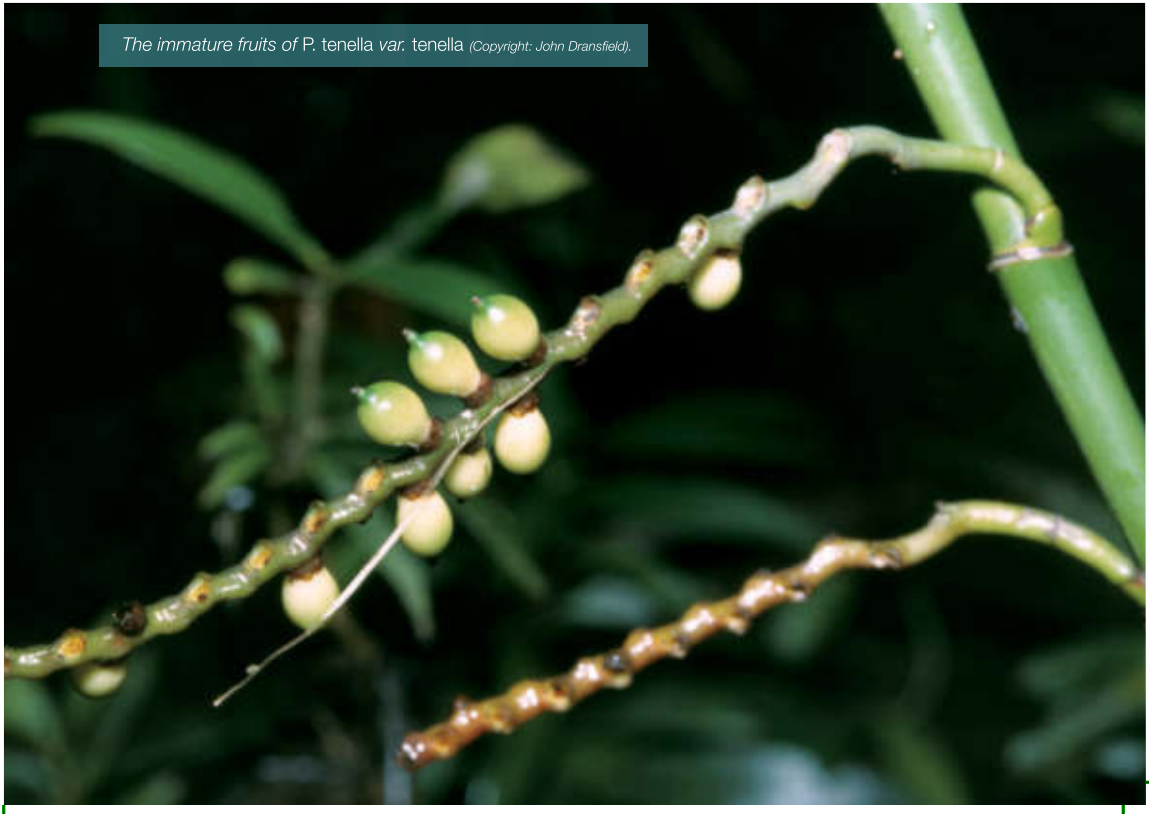
Fruits

The fruits are spindle shaped and pointed at the tip.

Distribution

Native to Borneo.

The basal clump of Pinanga tenella *var.* tenella *showing a high degree of branching* *(Copyright: John Dransfield).*



The immature fruits of P. tenella *var.* tenella *(Copyright: John Dransfield).*

Pteris semipinnata L.

Paku Pelanduk

Family Pteridaceae

This fern species was first listed by van Steenis (1981) in association with *Dipteris lobbiana* and *Dryopteris padangensis*. It is an uncommon and slope-loving fern which seems to be confined only to habitats such as coastal hills and islands in Malaysia and Singapore.

Features
A medium-sized fern with clustered fronds.

Leaves
The fronds are monomorphic, clustered or closely spaced. They are green in colour.

Root system
Extensive rhizome system.

Flowers
Not applicable.

Fruits
Not applicable.

Distribution
Native to tropical Asia.

Propagation: By spores.

Uses: *Pteris semipinnata* is used in traditional Chinese medicine. The fronds are pounded into a paste with water and applied locally to reduce pain.

Note: Greater effort is needed to increase its population through conservation measures such as *in-vitro* propagation.

Natural habitats of many fern species (waterfall in Lambir Hills, Sarawak)

Salix babylonica L.

Weeping Willow

Family Salicaceae

Salix babylonica is a medium to large sized, fast-growing deciduous tree. It is cultivated for millennia in Asia and it was being traded along the silk road to Southwest Asia and Europe. It prefers moist environments and occurs commonly along water courses. It is great as a botanical focal point in areas that are constantly moist.

Features
A large tree with drooping, reddish branches. The branches are divided into many stems, hanging as pendulous curtains to the ground.

Leaves
The narrow leaves are olive green on top and silver on the underside, and they are spirally arranged. The leaves are glabrous, linear-lanceolate, with finely serrated margins.

Root system
Extensive root system.

Flowers
Insignificant staminate flowers and green pistillate flower clusters without petals.

Fruits
The fruits are in the form of capsules.

Distribution
Native to Northern China. It is cultivated worldwide.

Phytoremediation potential: It is able to accumulate ethanol and benzene.

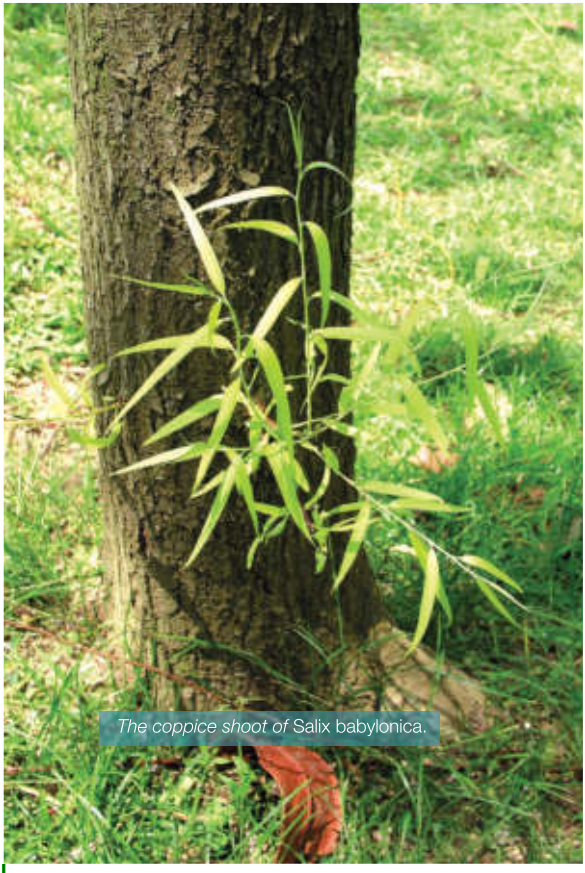
Propagation: By stem cuttings.

Uses: This plant is a popular ornamental tree. It is also used for wood production. In China, the bark is used traditionally as a medicine to treat rheumatoid arthritis and fever.

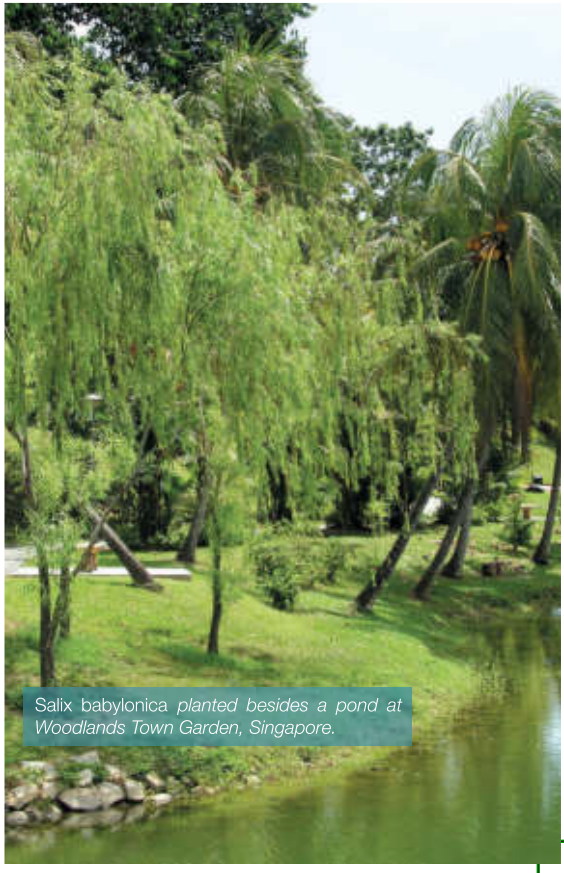
Note: *Salix babylonica* helps to protect agricultural land from erosion induced by desert storms. It also produces salicylic acid, which is used in the production of aspirin.

Salix babylonica*; (Inset) The leaf of* Salix babylonica.

The drooping branches of Salix babylonica *hanging over the water in a lake garden, enhancing the oriental theme of the garden.*



The coppice shoot of Salix babylonica.



Salix babylonica *planted besides a pond at Woodlands Town Garden, Singapore.*

Thevetia peruviana (Pers.) K. Schum.

Yellow Oleander

Family Apocynaceae

The genus name *Thevetia* honours a 16th century French Franciscan monk Andre Thevet who accompanied a French expedition to Brazil in the 1550s. The yellow flowers of this attractive plant bloom in the morning and close in the afternoon.

Features
A shrub or a tree that is densely foliaged and branched. It can grow up to 10 m.

Leaves
Leaves are linear, 7-15 cm by 0.5-1 cm, long-attenuated to both ends. The leaves grow in whorls of three. The leaf tips are pointed with a dark green colour.

Root system
It has a large, vigorous and branched root system.

Flowers
The flowers are generally yellow, but there are varieties with white and orange flowers too.

Fruits
The fruit is small, containing two to four flat seeds.

Distribution
Native to Central and South America. It is cultivated worldwide.

Propagation: By stem cuttings.

Uses: These plants are used in a variety of landscape applications including hedges, screens, foundation plantings and borders.

Note: The milky sap of *Thevetia peruviana* contains a compound called Thevetin which is used as a heart stimulant. All parts of the plant, especially the seeds and the sap, are poisonous when ingested.

(Top left) The yellow flower of Thevetia peruviana*. (Top right) The* Thevetia *variety with orange flowers,* Thevetia peruviana *var.* aurantica*. The flower buds (Middle left) and fruit (Middle right) of* Thevetia peruviana*. (Bottom) The* Thevetia peruviana *planted along Kallang River near the Kolam Ayer ABC Waterfront, Singapore.*

There are other rheophytes which have potential for use in Singapore. Many of these plants are however, not readily available in the horticulture trade. A list of such plants is provided below to raise the awareness of the potential of this group of plants.

Name	Family	Common Name	Habit
Aglaia yzermannii Boerl. & Koord.	Meliaceae	Aglaia	Shrub
Antidesma salicifolium C. Presl	Euphorbiaceae	Antidesma	Shrub
Antidesma salicinum Ridl.	Euphorbiaceae	Asian Antidesma	Shrub
Aspidium semibipinnatum Hook.	Dryopteridaceae	Aspidium	Fern
Asplenium subaquatile Ces.	Aspleniaceae	Asplenium Fern	Fern
Buddleja asiatica Lour.	Loganiaceae	Butterfly Bush	Shrub
Calophyllum rupicola Ridl.	Clusiaceae	Callophyllum	Shrub
Casuarina junghuhniana Miq.	Casuarinaceae	Jemara	Tree
Cladopus nymani H. Moll.	Podostemaceae	Cladopus	Herb
Crataeva nurvala Buch. Ham.	Capparaceae	Three-leaved Caper	Shrub
Croton viminalis Griseb.	Euphorbiaceae	Croton	Shrub
Didymocarpus salicinus Ridl.	Gesneriaceae	Didymocarpus	Shrub
Dipterocarpus oblongifolius Blume	Dipterocarpaceae	Neram	Tree
Dryopteris padangensis (Bedd.) C. Chr.	Dryopteridaceae	Dryopteris	Fern
Dysoxylum angustifolium King	Meliaceae	Dysoxylum	Shrub
Elaeocarpus grandiflorus Sm.	Elaeocarpaceae	Elaeocarpus	Shrub/Tree
Enaulophyton lanceolatum Steenis	Melastomataceae	Enaulophyton	Shrub
Equisetum debile Roxb.	Equisetaceae	Horsetail	Herb
Erigeron sumatrensis Retz.	Asteraceae	Sumatran Fleabane	Shrub
Erycibe longifolia Becc.	Convolvulaceae	Ericybe	Shrub
Eugenia subglauca Koord. & Valeton	Myrtaceae	Eugenia	Shrub

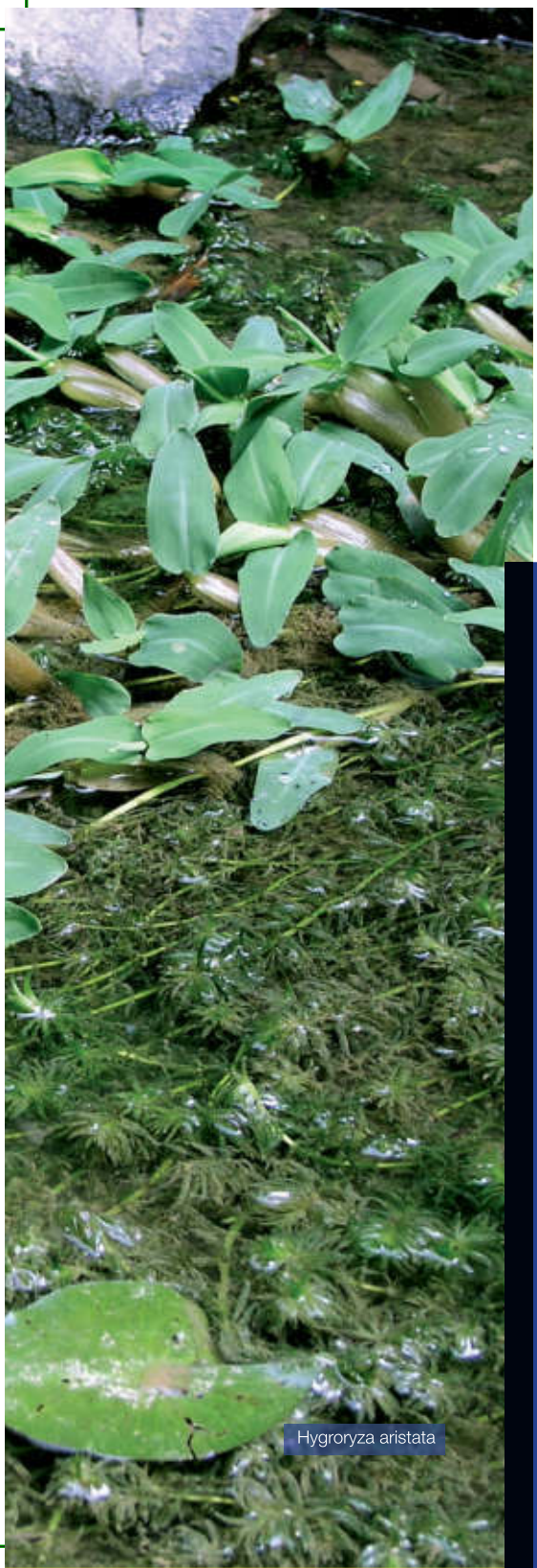
Eugenia vrieseana Koord. & Valeton	Myrtaceae	Eugenia	Shrub
Fagraea stenophylla Becc. ex Merr.	Loganiaceae	Fagraea	Shrub
Ficus pyriformis Hook. & Arn.	Moraceae	Fig	Shrub
Ficus racemosa L.	Moraceae	Cluster Fig	Tree
Ficus riparia Hochst. ex Miq.	Moraceae	Fig	Shrub
Garcinia linearis Pierre	Guttiferae	Garciana	Shrub
Garnotia acutigluma (Steud.) Ohwi	Poaceae	Garnotia	Grass
Glycosmis perakensis V. Naray	Rutaceae	Glycosmis	Shrub
Gomphocarpus fruticosus (L.) W. T. Aiton	Asclepiadaceae	Milkweed	Shrub
Homonoia riparia Lour.	Euphorbiaceae	Homonoia	Shrub
Hygrophila pusilla Bl.	Acanthaceae	Hygrophila	Herb
Jasminum crassifolium Blume	Oleaceae	Jasminum	Shrub
Lactuca laevigata (Bl.) DC.	Asteraceae	Lactuca	Herb
Microcasia pygmaea Becc.	Araceae	Microcasia	Herb
Myrmeconauclea rheophila (Steen.) Ridsdale	Rubiaceae	Myrmeconauclea	Shrub
Myrmeconauclea strigosa (Korth.) Merr.	Rubiaceae	Bornean Myrmeconauclea	Shrub
Nauclea rivularis Becc.	Rubiaceae	Nauclea	Shrub
Nauclea subdita (Korth.) Steud.	Rubiaceae	Lempedu Tanah	Shrub
Nectandra angustifolia (Schrad.) Nees	Lauraceae	Nectandra	Shrub
Neonauclea pallida (Reinw. ex Havil.) Bakh. f.	Rubiaceae	Neonauclea	Shrub
Nerium indicum Mill.	Apocynaceae	Indian Oleander	Shrub
Osmoxylon borneense Seem.	Araliaceae	Osmoxylon	Shrub
Pandanus dorystigma Martelli	Pandanaceae	Pandanus	Shrub
Pentasacme caudatum Wall. ex Wight	Asclepiadaceae	Pentasacme	Fern
Podochilus maingayi	Orchidaceae	Podochilus	Herb

Pogonatherum paniceum (Lam.) Hack.	Poaceae	Miniature Bamboo Grass	Grass
Polygonum chinense L.	Polygonaceae	Chinese Knotweed	Herb
Psychotria acuminata Becc.	Rubiaceae	Psychotria	Shrub
Rotula aquatica Lour.	Boraginaceae	Aquatic Rotula	Shrub
Saraca indica L.	Leguminosae	Asoka Tree	Tree
Saurauia angustifolia Turcz.	Actinidiaceae	Saurauia	Shrub
Syzygium neriifolium Becc.	Myrtaceae	Syzygium	Tree
Tetranthera salicifolia Roxburgh ex Nees.	Lauraceae	Tetanthera	Shrub
Thelypteris salicifolia (Wallich ex Hook.) C. F. Reed	Thelypteridaceae	Thelypteris	Fern

Islands of riparian vegetation along a fast flowing river (Sichuan, China).

Plants growing beside a waterfall (Sichuan, China).

A riparian environment has both fast and slow-moving water channels (Sichuan, China).



Hygroryza aristata

Floaters

Neptunia oleracea

Eichhornia crassipes

Eichhornia crassipes (Mart.) Solms

Water Hyacinth

Family Pontederiaceae

One of the most beautiful and fastest growing water plants, the Water Hyacinth was introduced to Singapore from Hong Kong in 1893.

Features
A free-floating aquatic macrophyte which can reach a size of 0.5 m across.

Leaves
The plant consists of a rosette of leaves which possess swollen, air-filled leaf stalks to aid in floatation.

Root system
The roots are long, fibrous and feather-like.

Flowers
The flowers are lavender blue with a yellow centre and are produced on single spikes up to 60 cm in length.

Fruits
The fruit is a three-celled capsule containing numerous minute, ribbed seeds.

Distribution
Worldwide but originated from Amazonia, Brazil.

Phytoremediation potential: It is able to absorb nitrogen and phosphorus rapidly. In addition it is able to absorb a wide range of pollutants like arsenic, chromium, mercury, nickel, lead and zinc from the aqueous solution.

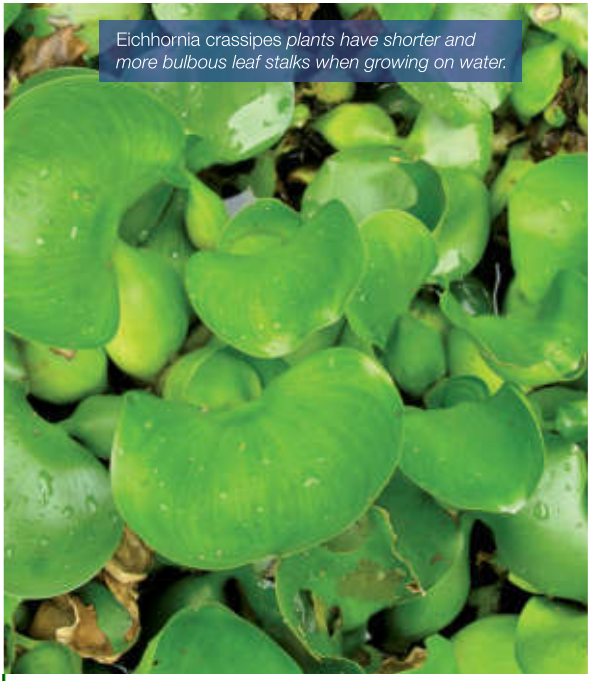
Propagation: By stolons or by seeds.

Uses: *Eichhornia crassipes* is sold in many nurseries for its unusual appearance and attractive flowers. They are also used as pig fodder in some rural areas.

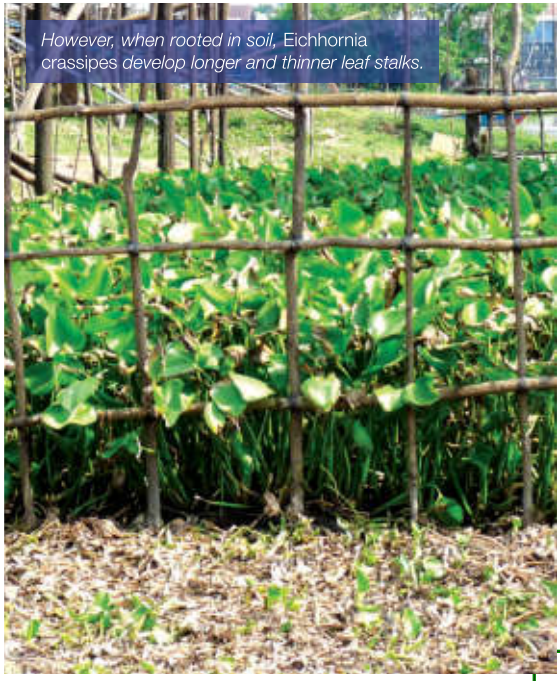
Note: There are studies on the use of *Eichhornia crassipes* to detoxify sewage and sludge because of its ability to accumulate a wide range of pollutants. Care needs to be taken to prevent the uncontrolled spread of floaters especially under high nutrient conditions in the waterways/ waterbodies, In addition, there must be regular harvesting and proper disposal of floaters in order to remove the nutrients from the waterways/ waterbodies.

A population of Eichhornia crassipes *growing with* Polygonum *sp.*

Eichhornia crassipes *plant and its flowers.*



Eichhornia crassipes *plants have shorter and more bulbous leaf stalks when growing on water.*



However, when rooted in soil, Eichhornia crassipes *develop longer and thinner leaf stalks.*

(Top left) Eichhornia crassipes *growing in muddy water. (Top right)* Eichhornia crassipes *is often used in combination with the other aquatic plants, such as the* Echinodorus palaefolius*, for landscaping purposes. (Bottom left) In Cambodia,* Eichhornia crassipes *leaf stalks are used as raw materials for weaving. (Bottom right) A selection of baskets, table tops and water-bottle holders made from dried leaf stalks of* Eichhornia crassipes.

Eichhornia crassipes *plants were temporarily introduced into Bishan Park lake (Singapore) as an interim measure to reduce the nutrient levels of the water.*

The performance of Eichhornia crassipes *under different nutrient levels was monitored carefully using a portable gas exchange system.*

Hygroryza aristata (Retz.) Nees

Asian Watergrass

Family Poaceae

The genus name *Hygroryza* came from the Greek words *hygros* (wet, moist) and *Oryza* (a related genus which consist of rice). *Hygroryza aristata* is a popular aquarium plant. It forms long, decorative roots providing good hiding-places for fishes.

Features
A floating aquatic perennial in which the floating stalks can grow up to 1.5 m long. It is diffusely branched and rooted in dense masses at the nodes.

Leaves
The leaf sheaths are inflated, bladderlike, with transverse veinlets. The blades are 2-8 cm long, 5-20 mm wide, and they are flat with rounded to cordate bases and blunt to rounded apices.

Root system
It has a feathery adventitious root system.

Flowers
The inflorescences are triangular in shape and the spikelets are greenish.

Fruits
The grains are narrowly oblong.

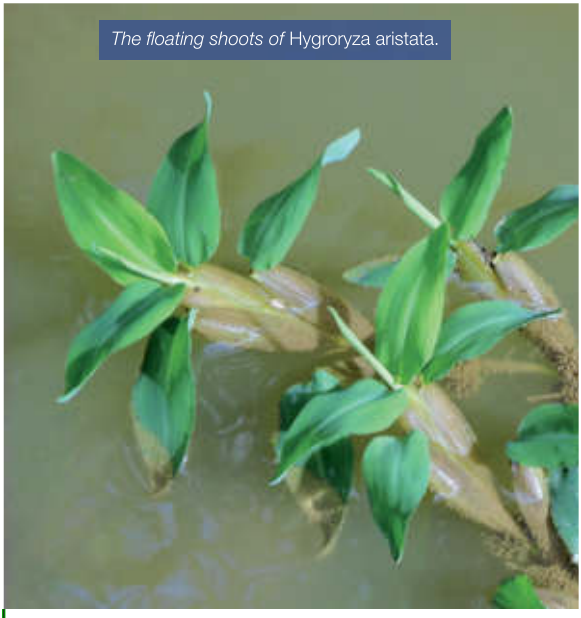
Distribution
Native to tropical Asia.

Propagation: By rhizomes.

Uses: This plant is cultivated as an aquarium plant. It is also suitable to be planted at the edge of the pond or as floating cover beneath taller plants.

Note: The roots and seeds can be used to treat diarrhoea, burning sensation and fatigue.

Hygroryza aristata *colonies.*



The floating shoots of Hygroryza aristata.

Hygroryza aristata *is used in water landscaping with Water Lily.*

Lemna minor L.

Lesser Duckweed

Family Lemnaceae

Lemna is the genus with the smallest flowering plants in the world. They are light green and less than 1 cm in diameter. Duckweed is made up of metabolically active cells with very little structural fiber. The cells absorb organic molecules such as simple carbohydrates and various amino acids directly from the water.

Features
Small aquatic herbs, floating on or below the surface of quiet streams and ponds. It often forms dense, homogeneous clonal populations.

Leaves
The leaves and stems are merged in a common structure typically called a frond or thallus.

Root system
Rootless.

Flowers
Uncommon.

Fruits
Uncommon.

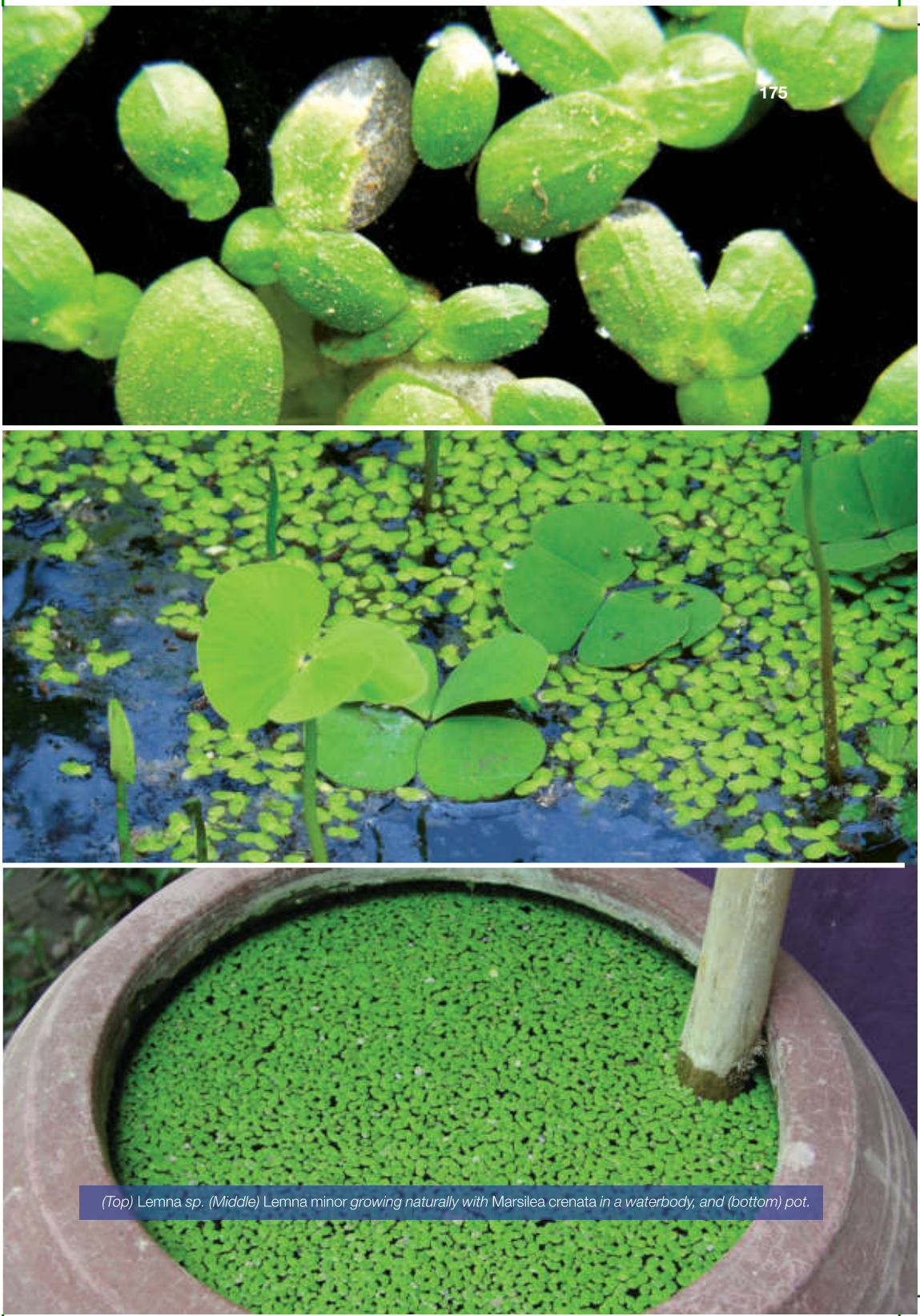
Distribution
Widespread globally.

Phytoremediation potential: It is able to absorb nitrogen and phosphorus rapidly. In addition it is able to accumulate iron and copper.

Propagation: By division.

Uses: *Lemna minor* is used for wastewater treatment in treating sewage.

Note: With the entire body of *Lemna minor* composed of non-structural, metabolically active tissue, most photosynthesis is devoted to the production of proteins and nucleic acids, making them very high in nutritional value.



(Top) Lemna *sp. (Middle)* Lemna minor *growing naturally with* Marsilea crenata *in a waterbody, and (bottom) pot.*

Ludwigia adscendens (L.) H. Hara

White Primrose

Family Onagraceae

This plant has long hollow stems on the water's surface, and is further buoyed by spindle-shaped floats derived from modified roots. The shape of these roots gives the plant another common name, the Water Banana. These roots only develop when the plant is growing in water; when growing in mud it has shorter stems without floating roots and flowers.

Propagation: By stem cuttings.

Uses: This plant is traditionally used as an antibacterial and diuretic agent. External application of poultices made of pounded fresh plant matter is used to treat snake bites and burns.

Note: *Ludwigia adscendens* can grow as free floating plants or as emergents with horizontal extensions of stems "running" over the water surface.

Features
A floating aquatic perennial in which the floating stalks can grow up to 1.5 m long. It is diffusely branched and rooted in dense masses at the nodes.

Leaves
It has shiny, deep green leaves with pale veins. They are arranged in an alternate manner, and are oblong shaped with round or obtuse apex.

Root system
It has two types of root systems: one is adventitious roots which anchor it in soil, and the other contains air sac to keep the plant afloat and assist respiration.

Flowers
The flowers have five white petals which are yellow at the bases.

Fruits
The fruits are capsular, linear and narrow at the base with longitudinal ridges.

Distribution
Native to South Asia, East China, Malaysia and Australia.

Ludwigia adscendens.

The white flower of Ludwigia adscendens.

The "water bananas"- the air-filled roots of Ludwigia adscendens *which offer buoyancy. The brown strands in the middle are the anchoring roots.*

Ludwigia sedoides (Humb. & Bonpl.) H. Hara.

Mosaic Plant

Family Onagraceae

Features
A floating leaf marginal aquatic perennial.

Leaves
Red and green diamond-shaped leaves in rounded clusters.

Root system
Adventitious roots.

Flowers
The yellow flowers have four petals and measure up to 5 cm in diameter.

Fruits
Not available.

Distribution
Native to Central and South America.

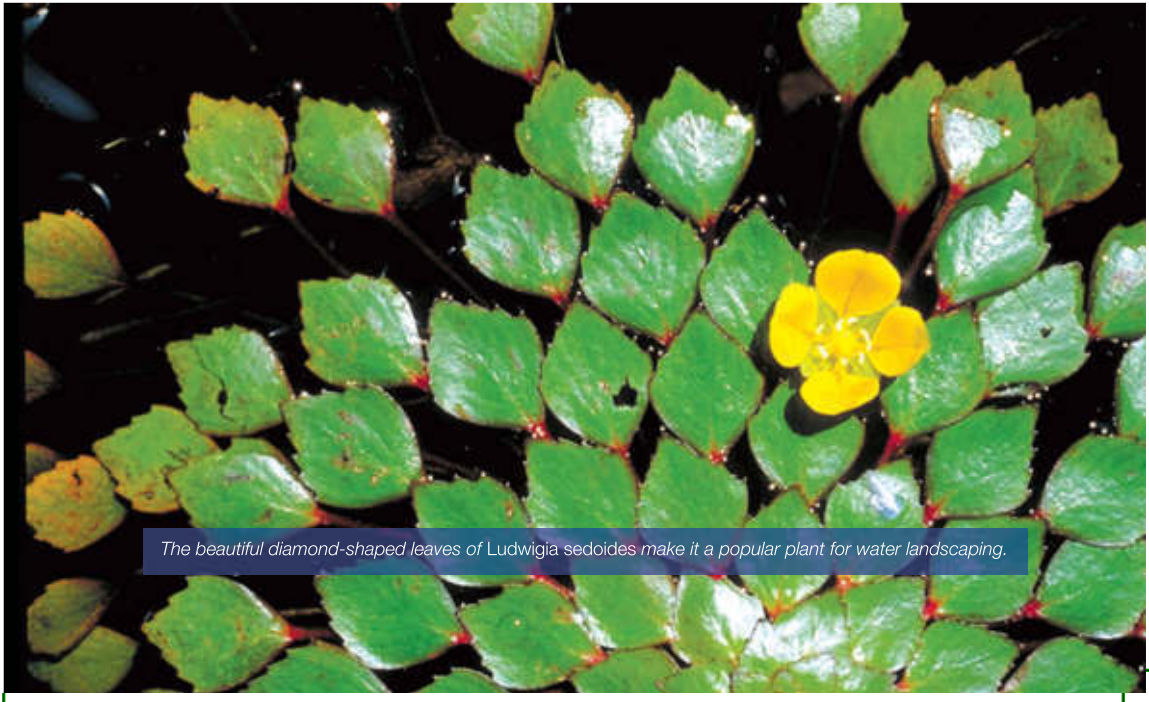
The diamond-shaped leaves of this plant form a beautiful rosette pattern. During the day, the mosaic fully opens with gaps between the leaves; at night, it contracts until the leaves shingle over each other.

Propagation: By stem cuttings.

Uses: *Ludwigia sedoides* gives a unique texture to outdoor plants, due to its beautiful circles of reddish foliage.

Note: It requires high light intensity to achieve satisfactory growth. Flowers would be formed if the plant is growing well.

Ludwigia sedoides.



The beautiful diamond-shaped leaves of Ludwigia sedoides *make it a popular plant for water landscaping.*

Neptunia oleracea Lour.

Aquatic Sensitive Plant

Family Leguminosae

As the common name suggests, the leaves, like the terrestrial "Sensitive Plant", close when they are touched. The floating mature stems of this tropical plant are covered in spongy tissue and are full of "air cells".

Features
A perennial herb with floating stems buoyed up by white spongy tissue. It can grow up to 2 m long.

Leaves
The leaves lack glands with 20 leaflets per pinna. The leaves grow in an alternate and bipinnate manner. Stipules are present but are not apparent on floating stems.

Root system
The roots are found at the nodes, and these trail into the water.

Flowers
The inflorescence grows in an erect spike from the axils of the leaves. The spikes are ovoid in bud. The yellow flowers contain 30–50 petals, each subtended by a single bract.

Fruits
Legume-like pods.

Distribution
Native to tropical Asia, Africa and South America.

Phytoremediation potential: It is able to accumulate selenium.

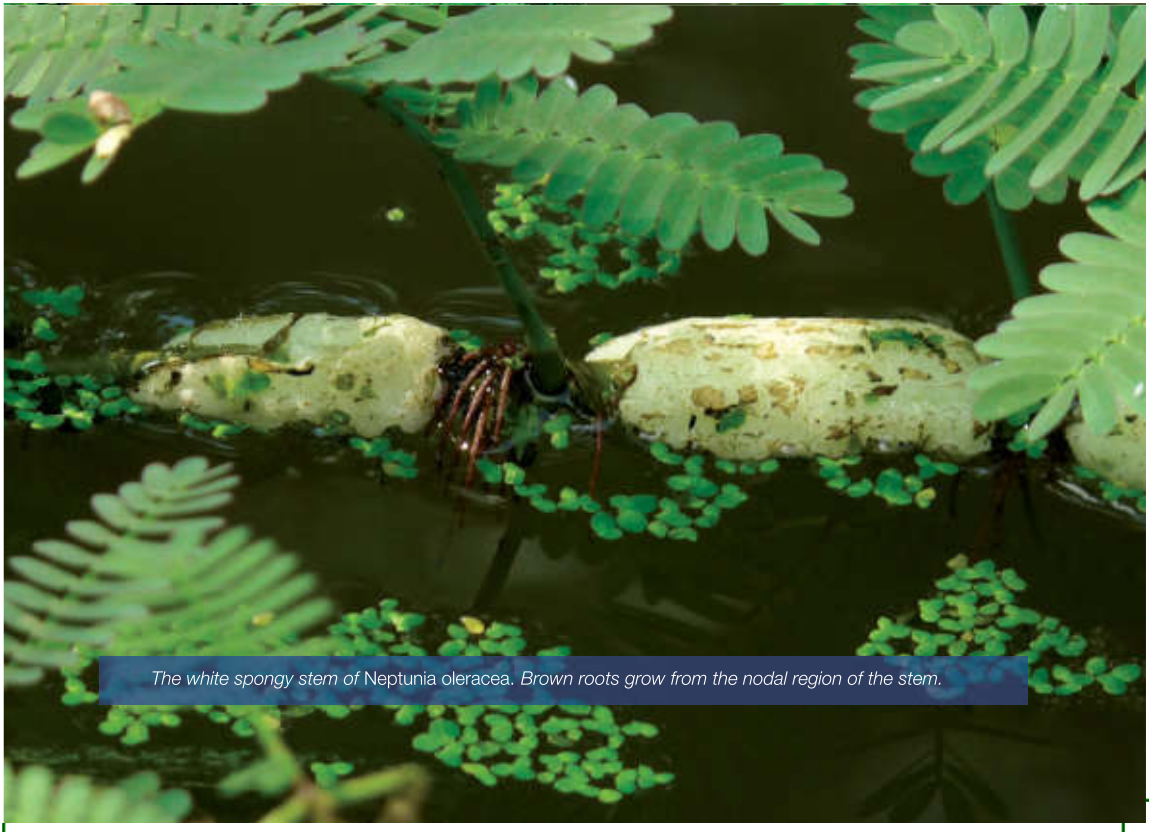
Propagation: By stem cuttings or by seeds.

Uses: It is widely used in the aquarium and aquatic ornamental plant trade.

Note: The young shoot tips and young pods are commonly eaten raw or stir-fried in Thailand and the roots are used medicinally.

The Neptunia oleracea *plants spread across the water surface using their air-filled floating stems.*

The delicate arrangement of the foliage makes it a potential ornamental plant which provides aesthetic value.



The white spongy stem of Neptunia oleracea. *Brown roots grow from the nodal region of the stem.*

Pistia stratiotes L.

Water Lettuce

Family Araceae

Water Lettuce is the only free-floating aroid of the family Araceae. It is also the one and only species in its genus and subfamily, the Pistioideae. The Water Lettuce is a common plant in the horticulture and aquarium trade.

Features
A free-floating monocot perennial, which grows up to 30 cm across.

Leaves
The thick, soft and waxy leaves are formed in rosettes with no leaf stems. The leaves are fleshy, pale green with velvety hairs.

Root system
It has a long and extensive root system.

Flowers
The small flowers are enclosed in a leaf-like spathe that makes them hidden amongst the leaves.

Fruits
The fruits are light green berries. They contain light brown seeds.

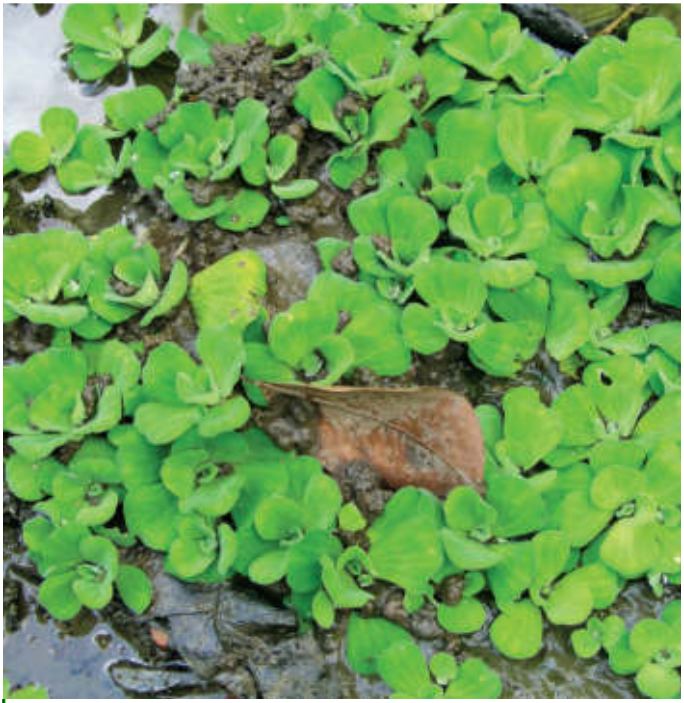
Distribution
Native to the tropics and subtropics in both the Old and New Worlds.

Phytoremediation potential: It is able to absorb nitrogen and phosphorus rapidly.

Propagation: By stolons.

Uses: *Pistia stratiotes* is sold in the aquarium and water garden trade.This species was previously cultivated as pig fodder.

Note: The leaves of *Pistia stratiotes* will get bleached when exposed to direct sunlight. Care needs to be taken to prevent the uncontrolled spread of floaters especially under high nutrient conditions in the waterways/ waterbodies, In addition, there must be regular harvesting and proper disposal of floaters in order to remove the nutrients from the waterways/ waterbodies.



(Top left) Pistia stratiotes. *(Top right) A clump of* Pistia stratiotes *showing reproduction by stolon. (Middle left)* Pistia stratiotes *featured in a water landscape design. (Middle right) The application of* Pistia stratiotes *in phytoremediation. (Bottom) A rare scene of* Pistia stratiotes *growing in wet soil.*

Salvinia molesta D. S. Mitch.

Giant Salvinia

Family Salviniaceae

This plant was introduced to Singapore from Sri Lanka in the 1950s as a teaching material for university courses. In the 1970s, reservoirs in Singapore were almost entirely covered by this species.

Features
A floating, rootless aquatic fern.

Leaves
The plants have three fronds, two float on the surface and one dangles underwater. The upper surfaces of the floating fronds are covered with rows of white, bristly hairs. The brown submersed fronds are feather-like in appearance and are commonly mistaken as roots.

Root system
Rootless.

Flowers
Not available as it is a fern.

Fruits
Not available as it is a fern.

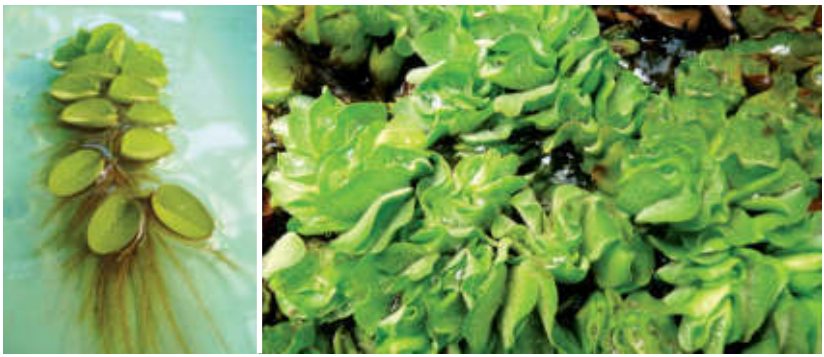
Distribution
Native to Brazil, it has spread to other parts of the world.

Phytoremediation potential: It is able to absorb nitrogen and phosphorus rapidly. In addition it is also able to accumulate chromium.

Propagation: By division or by spores.

Uses: *Salvinia molesta* is used as mulch, compost, fodder and for paper making, handcrafts and bio-gas generation.

Note: The rapid growth rate and tolerance to environmental stress makes *Salvinia molesta* a suitable candidate in treating eutrophic water conditions. Nevertheless, care needs to be taken to prevent the uncontrolled spread of floaters especially under high nutrient conditions in the waterways/ waterbodies, In addition, there must be regular harvesting and proper disposal of floaters in order to remove the nutrients from the waterways/ waterbodies.



(Left) Salvinia molesta*; note that the root-like structures are actually another form of frond. (Right) In a crowded population,* Salvinia molesta *develops bigger and more crumpled fronds.*

(Top left) A population of Salvinia molesta *growing in muddy freshwater. (Top right)* Salvinia molesta *used in a water landscape with* Pistia stratiotes*. (Bottom left)* Salvinia cucullata*, a relative of* Salvinia molesta*. (Bottom right)* Salvinia cucullata *plants have deep indented frond apices, which are different from that of* Salvinia molesta*.*

Spirodela polyrhiza (L.) Schleid.

Giant Duckweed

Family Lemnaceae

Spirodela polyrhiza plants are useful as a water crop as they can acclimatise themselves to almost all growing conditions, with some thriving in manure-rich or eutrophic waters. They reproduce quickly, extending over large surface areas, and are easily harvested.

Features
A diminutive floating aquatic perennial.

Leaves
Leaves and stems are merged in a common structure typically called a frond or thallus. The underside of the fronds is purple in colour.

Root system
There are about 6-12 roots per frond.

Flowers
Uncommon.

Fruits
Uncommon.

Distribution
Widespread in North and Central America, Europe, Africa, Asia, and northern Australia; in South America.

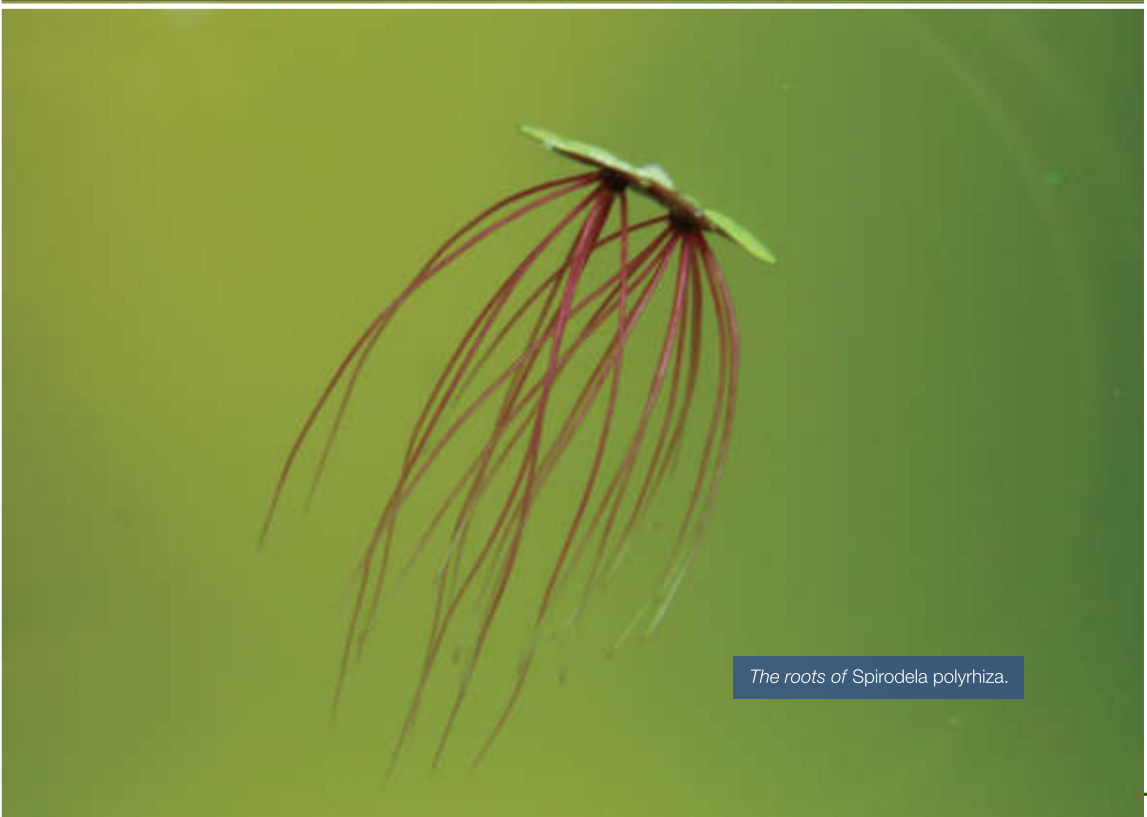
Phytoremediation potential: It is able to absorb nitrogen and phosphorus rapidly. In addition it is also able to accumulate iron and copper.

Propagation: By division.

Uses: *Spirodela polyrhiza* plants are used as a source of food for animals and poultry, due to their high fat and protein content.

Note: This species has the potential for wastewater treatment: to absorb excess nutrients from surface waters and to reduce suspended solids and biochemical oxygen demand of the water.

The leaves of Spirodela polyrhiza.

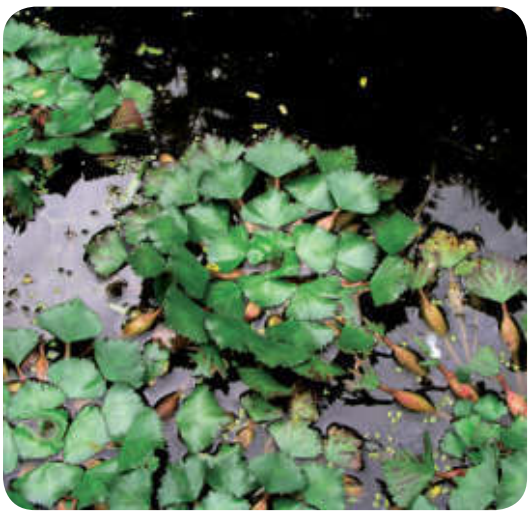


The roots of Spirodela polyrhiza.

Trapa natans L.

Water Chestnut

Family Trapaceae



Trapa natans belongs to the family Trapaceae. This species are noted for their clusters of triangular leaves which float on the water surface. It is not to be confused with another aquatic plant of a similar name, Chinese Water Chestnut *(Eleocharis dulcis)* of the family Cyperaceae, which is a popular ingredient in Southeast Asian and Chinese dishes.

Features
A rooted, floating plant that forms dense, floating mats which are often three layers deep.

Leaves
The spongy inflated leaf petioles allow the rosette to float. New leaves are produced from a central terminal meristem in the rosette near the surface of the water.

Root system
Very fine lateral roots.

Flowers
Inconspicuous flowers are formed in the lead axils of younger leaves above the water. The flowers are hermaphrodite.

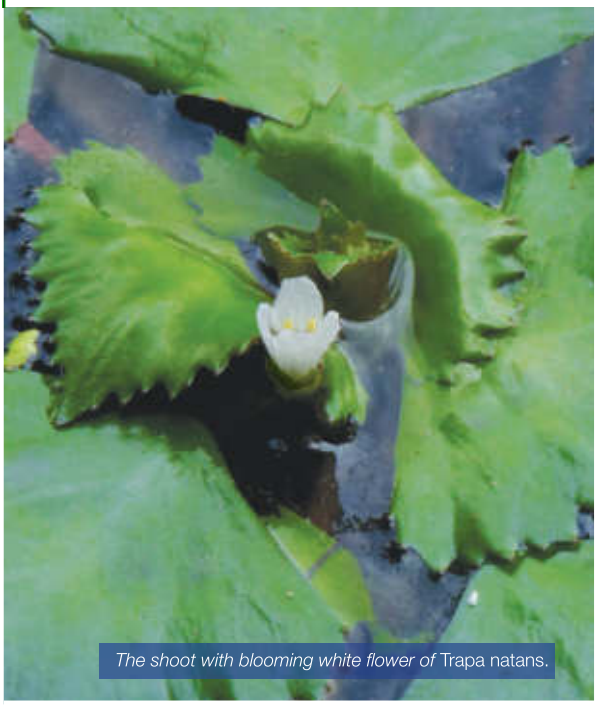
Fruits
The fruit is single-seeded and woody. It bears four sharply pointed horns, which act as anchors. When mature, it falls from the plant and sinks to the bottom of the water.

Distribution
Native to North America.

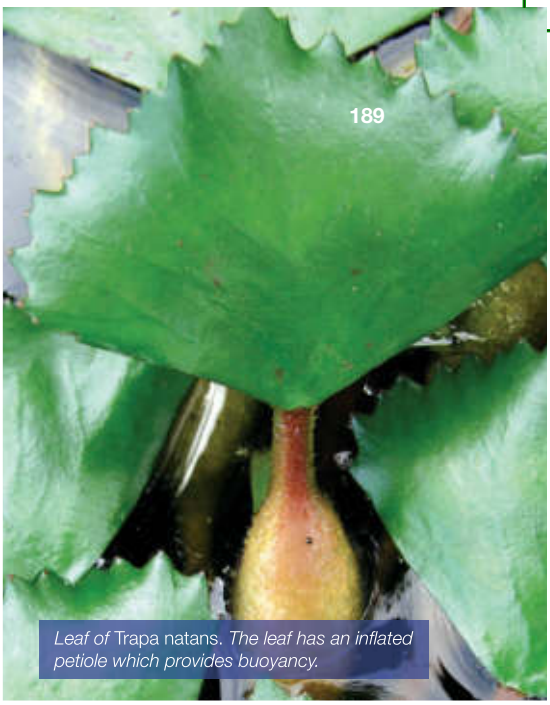
Propagation: By fragmentation or by seeds.

Uses: The seed is edible and can be consumed raw, cooked, dried or ground into powder. It has a sweet and floury flavor similar to sweet chestnuts.

Note: It dislikes calcium-rich waters and growth will be affected.



The shoot with blooming white flower of Trapa natans.



Leaf of Trapa natans. *The leaf has an inflated petiole which provides buoyancy.*

The small diamond-shape leaves of Trapa natans *complement the giant leaves of* Victoria amazonica *in water landscaping.*

Other floaters which can be grown:

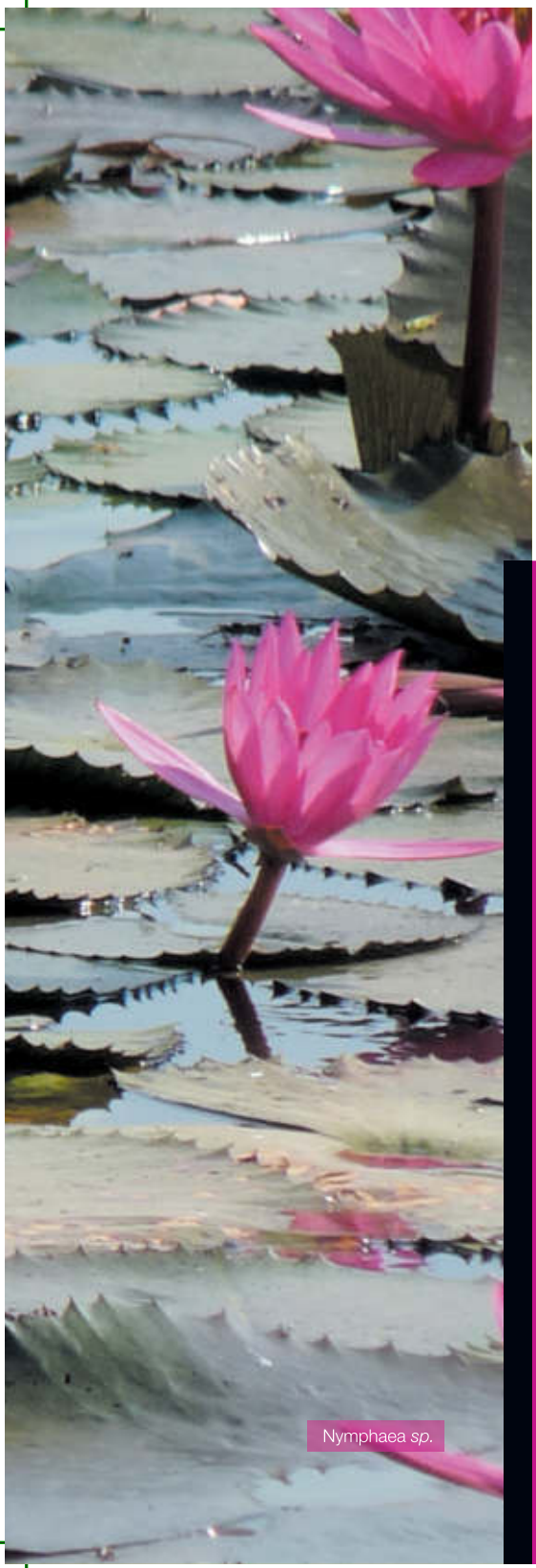
Name	Family	Common Name	Habit
Eichhornia azurea (Sw.) Kunth	Pontederiaceae	Peacock Water Hyacinth	Herb
Hydrocleys nymphoides (Humb. & Bonpl. ex Willd.) Buchenau	Limnocharitaceae	Water Poppy	Herb
Salvinia minima Baker	Salviniaceae	Water Spangle	Herb
Salvinia natans (L.) All.	Salviniaceae	Floating Watermoss	Herb
Utricularia aurea Lour.	Lentibulariaceae	Bladderwort	Herb

Ludwigia adscendens *growing on the surface of a pond (MacRitchie Reservoir, Singapore).*

Growth pattern of Azolla *sp. The leaves contain a blue-green alga which fixes nitrogen for this floating plant.*

Planting Azolla *sp. is not advisable as this species is able to fix nitrogen and enriches the water.*

Getting young children excited about water plants



Nymphaea *sp.*

Floating-Leaf Plants

Victoria amazonica

Marsilea crenata Presl

Water Shamrock

Family Marsileaceae

Marsilea crenata is an aquatic fern although it can be grown as a potted plant if the soil is kept wet. It is a fern of the rice field and its life cycle follows the water levels of the rice growing season. It only develops reproductive organs during rice harvesting season where the field is dry. It was introduced into Singapore from Penang for teaching purposes.

Features
It is an aquatic fern reaching 15-20 cm in height.

Leaves
It bears long-stalked fronds with four clover-like lobes.

Root system
Long slender rhizomes which rooted in mud.

Flowers
Not applicable.

Fruits
Not applicable.

Distribution
Native to central and southern Europe, Caucasia, western Siberia, Afghanistan, India, China, Cambodia, Japan and North America.

Propagation: By rhizomes or by spores.

Uses: The juice made from the leaves of this plant has medicinal properties, and is used as a traditional medicine to treat snake bite.

Note: During the day, the leaflets lie in a plane, orientated to receive maximum light; at night or during a storm, the leaflets will fold together.

(Top left) The natural habitat of Marsilea crenata *at the bank of a waterbody. (Top right) The clover-like fronds of* Marsilea crenata*. (Bottom left) When the water level is low,* Marsilea crenata *will produce emerging fronds with shorter stalks. Photo showing* Marsilea crenata *growing naturally with* Ipomoea aquatica *and* Lemna *sp. in a waterbody. (Bottom right) In other waterbodies,* Marsilea crenata *is associated with* Utricularia *sp. They produce floating fronds when the water level is high.*

Nelumbo nucifera Gaertn.

Water Lotus

Family Nelumbonaceae

Lotus plants have been cultivated in Asia for more than 3,000 years. They are featured in many religions. To the Buddhists, the flower represents the perpetual cycles of reincarnation, while the Hindus associate the flower with the creation of the world. In Japan, it is also held as a symbol of purity and beauty. Many hybrids have been developed in the Asian Lotus and more than 600 varieties are recorded.

Features
The plants are rooted firmly in the mud, and they send out long stems to which their leaves are attached.

Leaves
There are two types of leaves: floating or erect. The large floating leaves are about 60 cm across, without serrated edges. The erect leaves are held above water.

Root system
Thick rhizomes with fibrous roots.

Flowers
Flowers are usually found on thick stems rising several centimeters above the water. The attractive flowers are up to 25 cm wide; they are fragrant with pink petals.

Fruits
The fruit is a conical structure with sockets. Each socket contains one seed.

Distribution
Native to the Asian subcontinent from Persia to China and Japan.

Phytoremediation potential: It is able to accumulate cadmium and copper.

Propagation: By rhizomes or by seeds.

Uses: *Nelumbo nucifera* is cultivated as an ornamental plant or for the edible seeds and starchy rhizomes. The leaves are also used as a wrap for food.

Note: The plant parts of the Lotus such as flowers and seeds have medicinal value and are often used in traditional Chinese medicine.

(Top) Nelumbo nucifera *colonies. (Bottom left) The blooming* Nelumbo nucifera *flower. (Bottom right) The fruit or seed pod of* Nelumbo nucifera*; each socket contains one seed.*

Nelumbo nucifera *is commonly grown in lake gardens throughout China.*

Nelumbo nucifera *is available in many commercial nurseries.*

Nymphaea hybrids

Water Lily

Family Nymphaeaceae

It is easy to understand why Water Lilies are such a popular choice for ponds. For all their beauty and splendor, Water Lilies are relatively easy to grow. There is also a range of varieties to select from. The cultivation of Water Lilies has a long history which can be traced back to the ancient Egypt. They have also played a part in the history of many different cultures and are important in religious ceremonies. The consistent hybridization of Water Lilies carried out by horticulturists resulted in the production of more than 500 cultivars today.

Features
A perennial plant which has floating leaf blades with a toothed margin.

Leaves
The mature leaves are often spherical, cleft at the base with most of the leaves floating.

Root system
Rhizomes are erect, producing slender stolons.

Flowers
The showy flowers rise on long solitary stalks and are borne at the surface of the water or elevated slightly above it. The white (or sometimes pink) fragrant flowers have yellow centres surrounded by 25 or more petals.

Fruits
The fruit is ovoid to subglobose.

Distribution
Native to India, Southeast Asia and New Guinea.

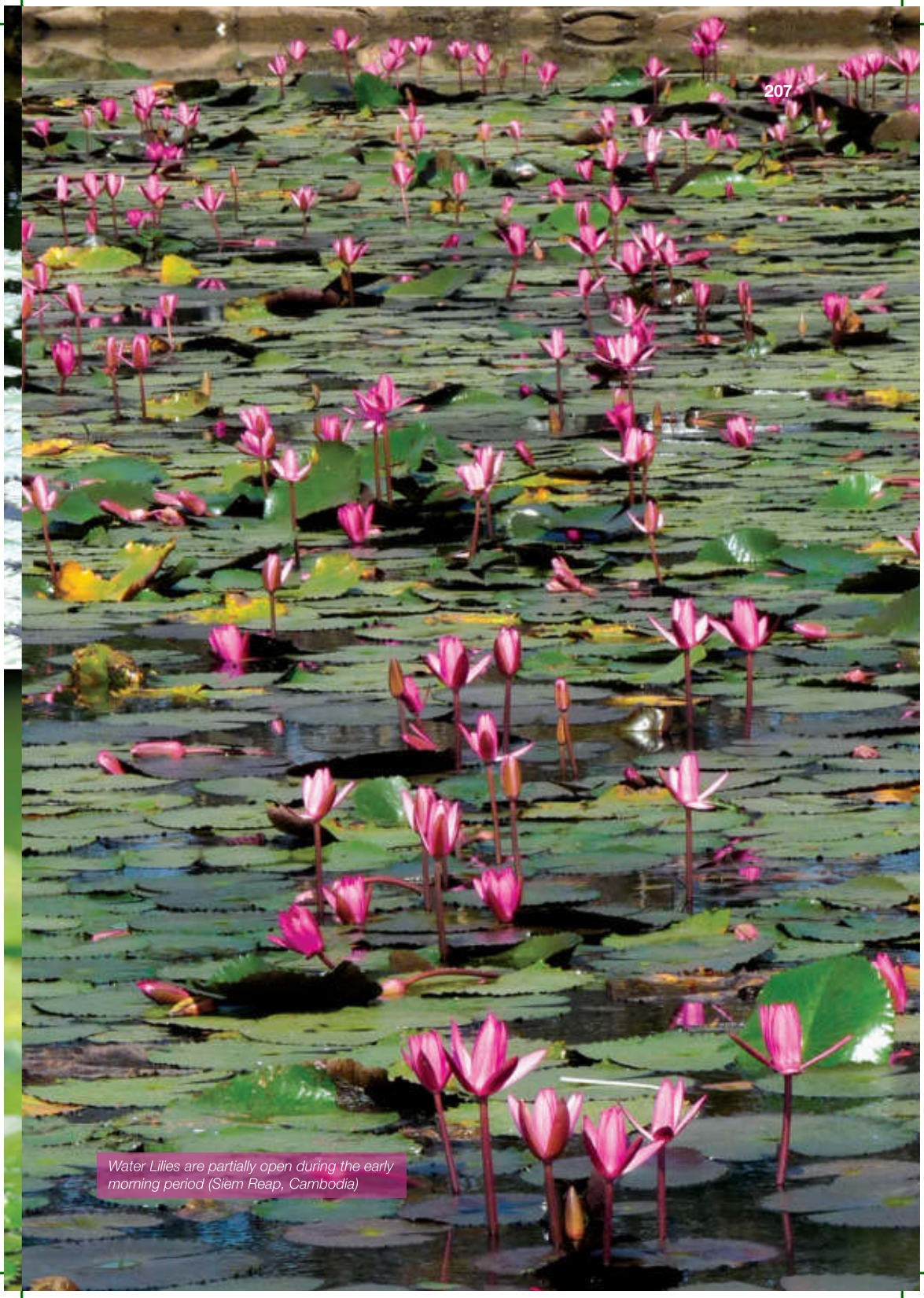
Propagation: By vegetative propagation (corms or tubers).

Uses: The Water Lilies is cultivated for water gardens or ponds for its pretty flowers.

Note: Most of the Water Lilies are night blooming and the flowers have a sweet fragrance.

The different varieties of Water Lily with a wide range of flower forms and colours.

The lovely flowers of the Water Lily make them the all time favourites for pond or lake water landscaping.



Water Lilies are partially open during the early morning period (Siem Reap, Cambodia)

Nymphaea leibergii Morong

Dwarf Water Lily

Family Nymphaeaceae

This species is named after Swedish-American botanist, John Bernhard Leiberg, who discovered the plant in the late 1800s. *Nymphaea leibergii* is closely related to *Nymphaea tetragona* and they were once thought to be the same species. *Nymphaea leibergii* is normally found in shallow and slow-moving streams.

Features
An aquatic perennial with floating leaves and flowers arising from erect, unbranched rhizomes.

Leaves
The leaves are ovate to elliptic and hairless with smooth margins. The upper surface of the leaf is green while the lower surface is green to deep purple. The leaf vein radiates centrally without a web-like pattern.

Root system
Erect and unbranched rhizomes.

Flowers
The white flowers open in the afternoon and close in the evening. They have four green sepals.

Fruits
The fruits are berry-like and leathery. The fruit capsules rupture when ripe and release a jelly-like seed mass.

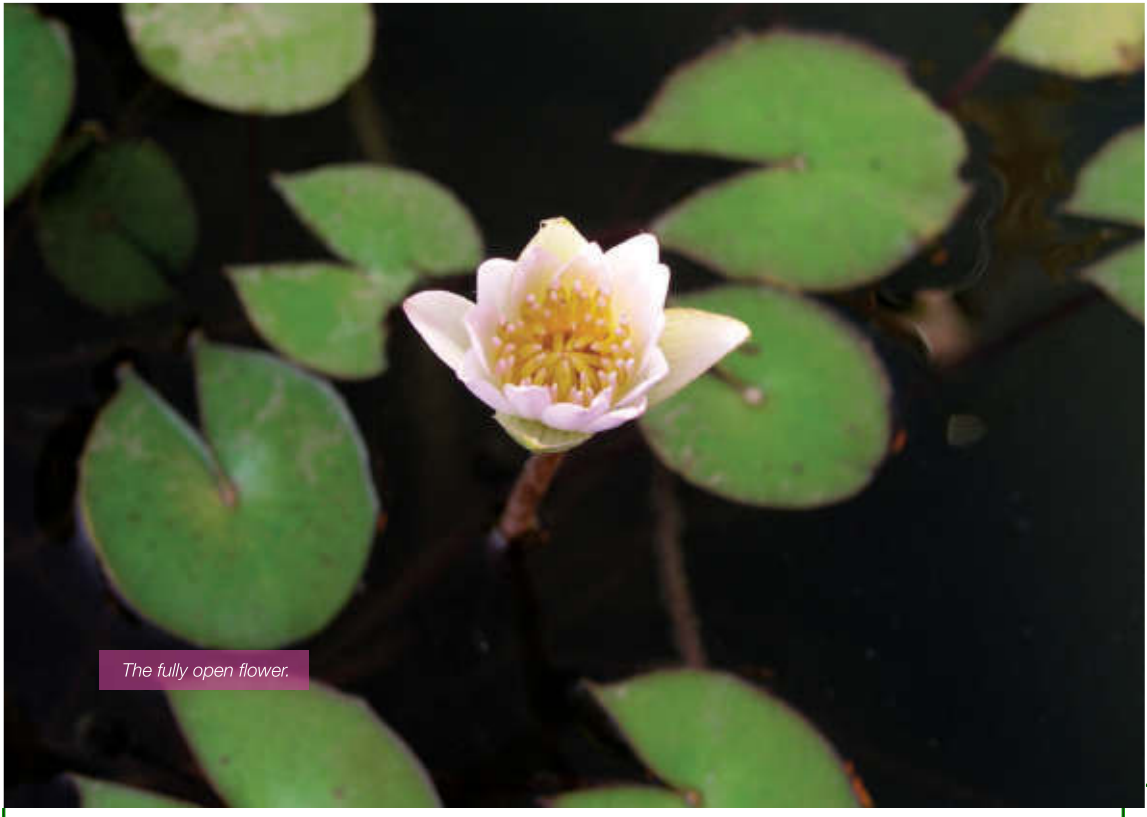
Distribution
Native to Europe and North America.

Propagation: By vegetative propagation (corms or tubers).

Uses: This species is useful for water garden or pond landscaping design.

Note: Unlike their night blooming lily relatives, *Nymphaea leibergii* bloom in the afternoon. Another distinctive feature of this species is that it has upright rhizomes, while all other Water Lilies have horizontal and prostrate rhizomes.

The half-open white flower of Dwarf Water Lily.



The fully open flower.

Nymphaea nouchali Burm. f.

Water Lily

Family Nymphaeaceae

Nymphaea nouchali is the national flower of Sri Lanka. Since ancient times, it was known to be a symbol of virtue, discipline and purity.

Propagation: By rhizomes or by seeds.

Uses: *Nymphaea nouchali* can be successfully grown in a variety of water-filled pottery containers, wooden barrels and other water features, like a water garden or pond.

Note: The rhizome of the Water Lily can be used as an astringent and antiseptic. Water Lily has also been used to treat bronchial congestion and kidney pain, and taken as a gargle for sore throats.

Features
A floating-leaf aquatic perennial herb that is rooted in mucky or silty sediments.

Leaves
The floating leaf blade varies in shape from roundly elongated to round. The leaf stalk is submerged. The leaf blade is hairless.

Root system
Thick fleshy rhizomes. The horizontal creeping and branching rhizomes are attached by adventitious roots arising in groups below the leaf bases.

Flowers
The showy flowers rise on long solitary stalks and are borne at the surface of the water or elevated slightly above it. The flowers are up to 12 cm wide, with purplish blue petals and yellow stamens which have purple tips.

Fruits
Hard green berry-like ovate to pear-shaped fruit.

Distribution
Native to Southeast Asia and western New Guinea.

The habit of Nymphaea nouchali. *(Inset) The purple flower of* Nymphaea nouchali.

Nymphaea nouchali *used in urban water landscaping.*

Nymphoides cordata (Elliot) Fernald

Little Floating Heart

Family Menyanthaceae

Surprisingly perhaps, these plants are not related to Water Lilies, as one might infer from their general appearance and from the name *Nymphoides*. The name *Nymphoides* means similar to, or in the form of, a *Nymphaea* (Water Lily), but it has no direct relationship to that genus.

Features
It is an aquatic plant with floating leaves and aerial flowers.

Leaves
Heart shaped leaves with purple underside which float on the water surface. The leaves can be solid green or with purple blotches.

Root system
The rhizomes are buried in the mud. Tuberous roots are also present below the inflorescences.

Flowers
The flowers are white with five petals, and emerge from the submersed stem to the water surface on slender stalks.

Fruits
The fruits are in capsule form with subglobose smooth seeds.

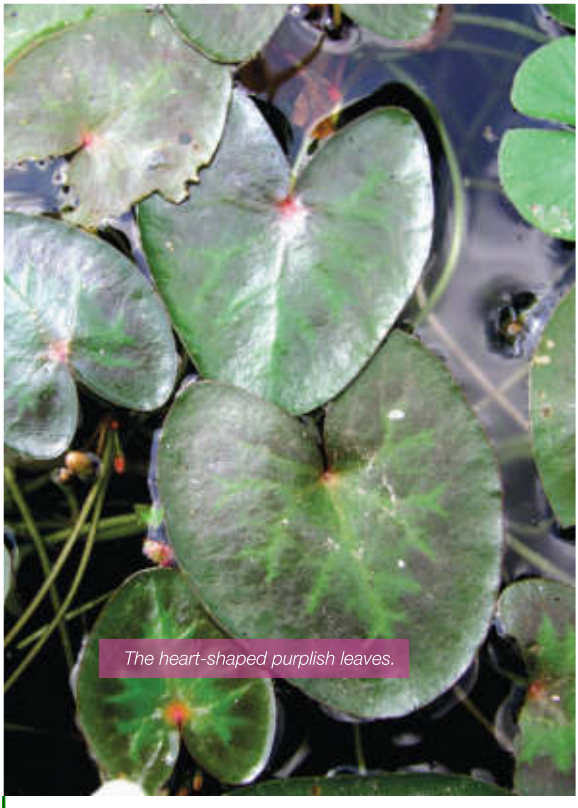
Distribution
Native to North America.

Propagation: By rhizomes or by seeds.

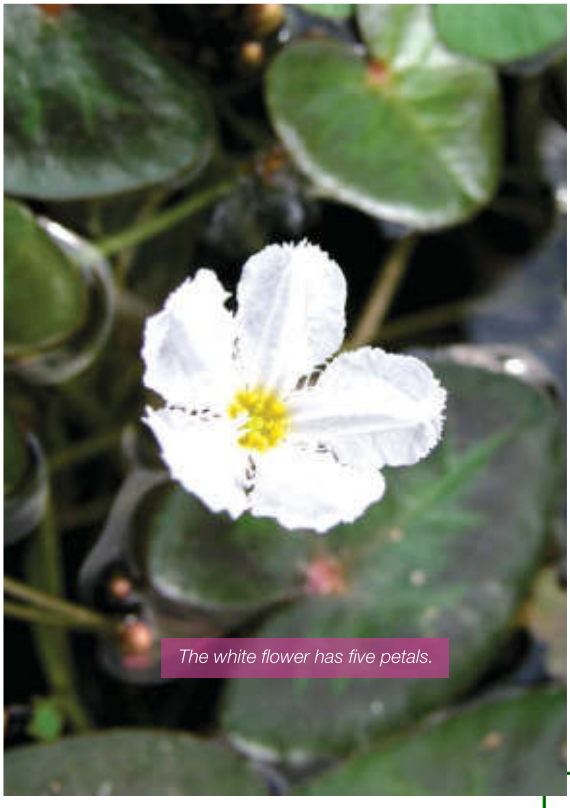
Uses: It is used as an ornamental plant both in garden ponds and aquarium.

Note: This plant prefers shallow and still water and it provides food and shelter for fishes.

A population of Nymphoides cordata *growing in a lake at Siem Reap, Cambodia.*



The heart-shaped purplish leaves.



The white flower has five petals.

Nymphoides indica (L.) Kuntze

Water Gentian

Family Menyanthaceae

This *Nymphoides* species is a worthy substitute of the exotic Water Lily as their leaves are very similar. This species, however, has a more delicate and beautiful flower.

Features
Almost circular floating leaf blades which have a leaf stalk up to 5 m and a slender stem.

Leaves
Heart-shaped leaves of green to reddish-brown colour. The floating leaves have purple undersides and red stems of about 10 cm long.

Root system
"Banana-like" bunches of root tubercles.

Flowers
The small flowers are white with a deep yellow centre, and they have feathery petals.

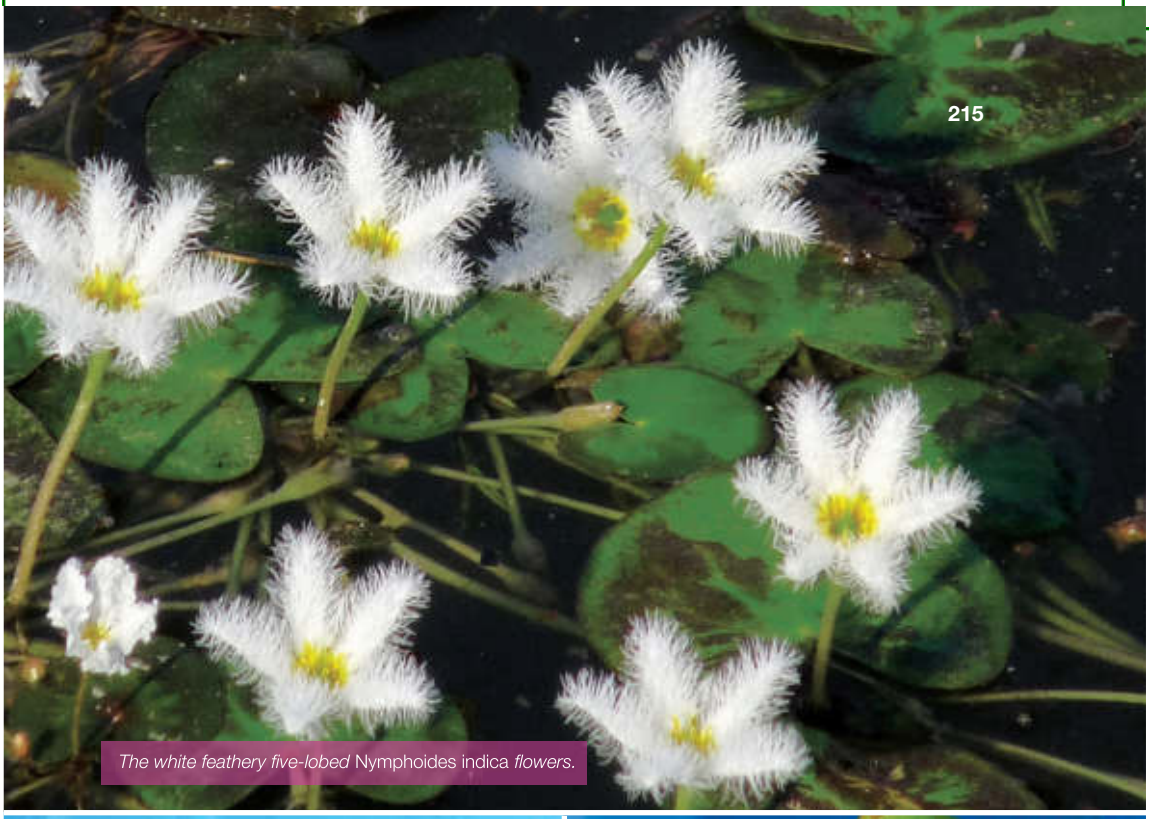
Fruits
Not available.

Distribution
World Tropics.

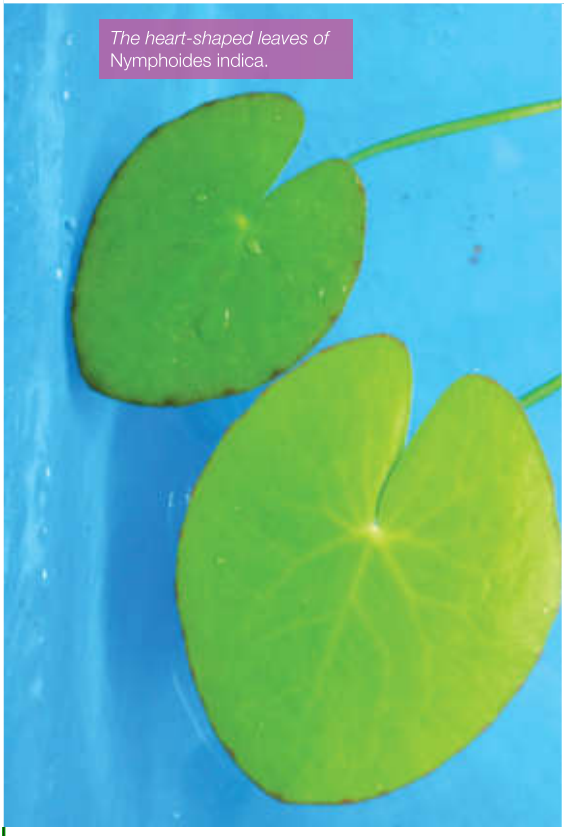
Propagation: By vegetative propagation (stolons or stem cuttings).

Uses: *Nymphoides indica* is grown as an ornamental plant locally and abroad.

Note: The stems of *Nymphoides indica* break easily and the plantlets, each with a single leaf and multiple flowers, can float away to take root elsewhere.

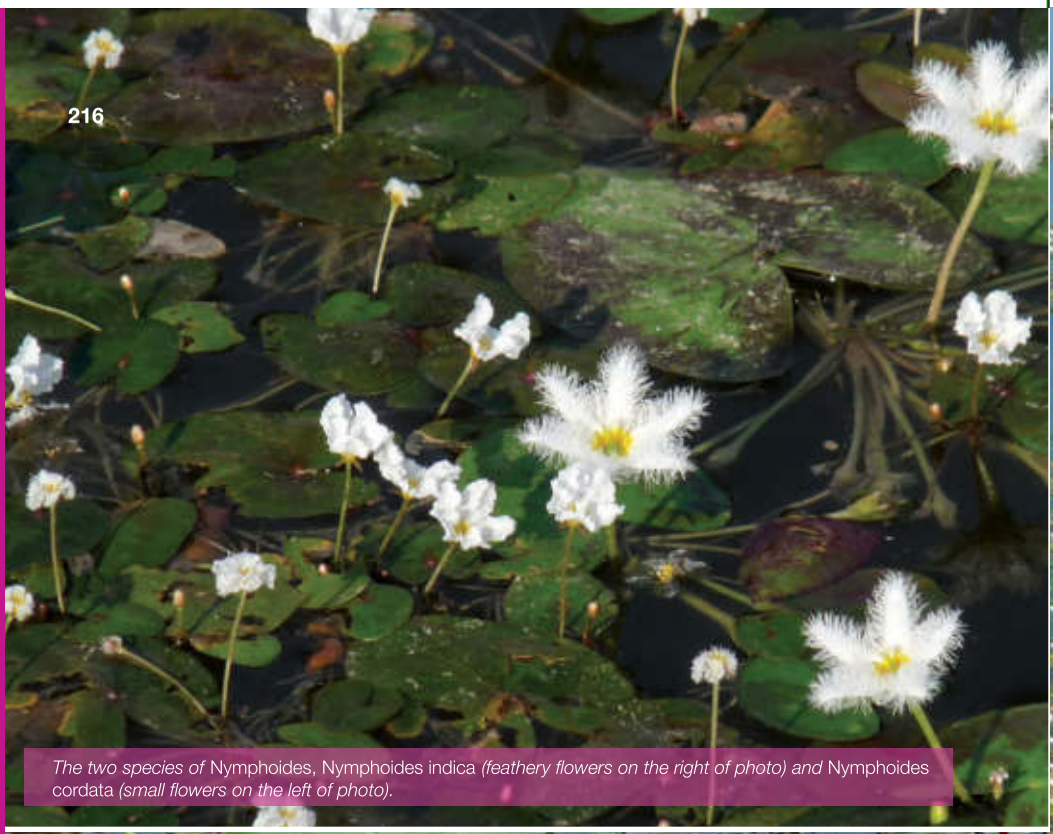


The white feathery five-lobed Nymphoides indica *flowers.*

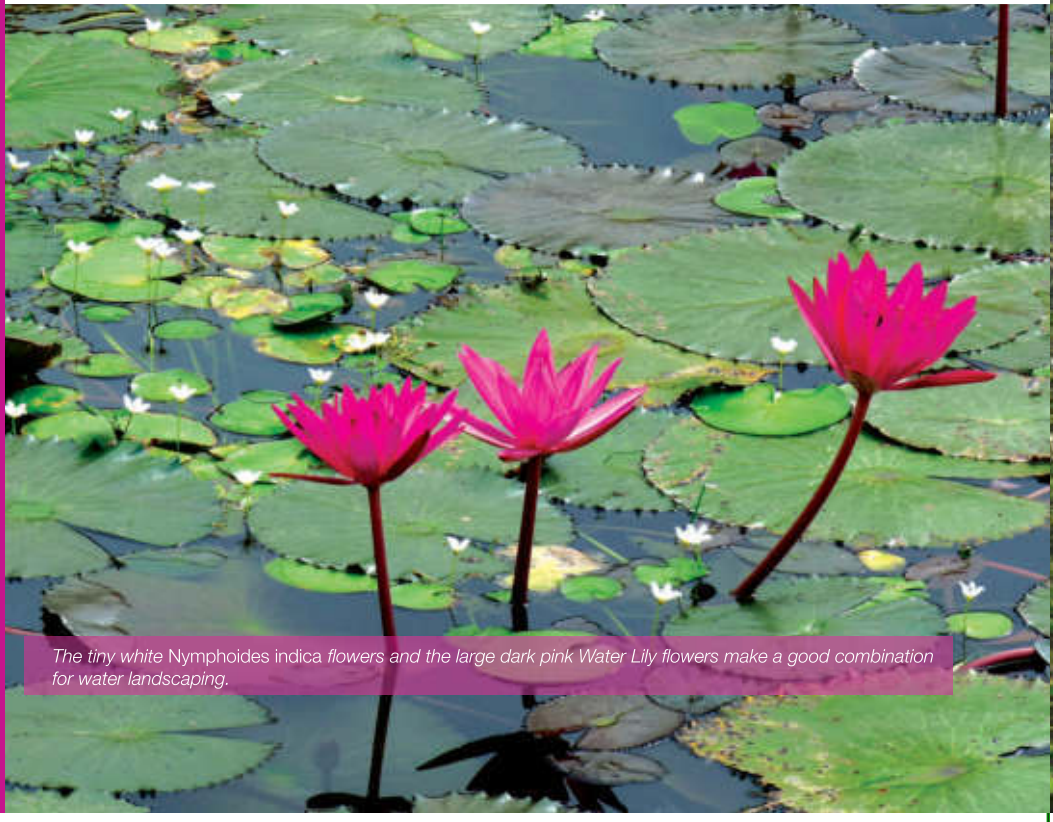


The heart-shaped leaves of Nymphoides indica.

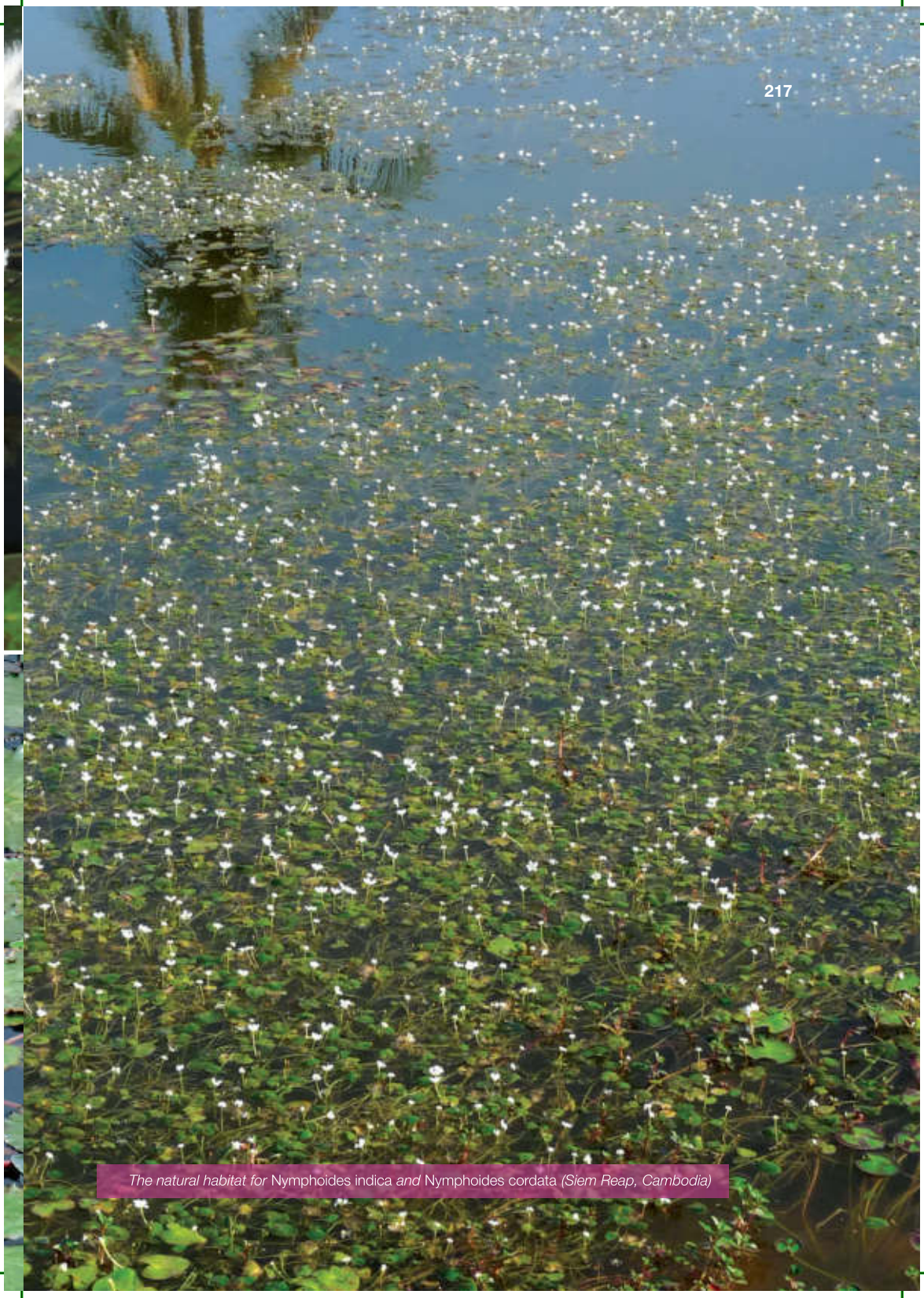
The "Banana like" roots of Nymphoides indica.



The two species of Nymphoides, Nymphoides indica *(feathery flowers on the right of photo) and* Nymphoides cordata *(small flowers on the left of photo).*



The tiny white Nymphoides indica *flowers and the large dark pink Water Lily flowers make a good combination for water landscaping.*



The natural habitat for Nymphoides indica *and* Nymphoides cordata *(Siem Reap, Cambodia)*

Victoria amazonica (Poepp.) J. C. Sowerby

Giant Water Lily

Family Nymphaeaceae

Victoria amazonica is the largest of the Nymphaeaceae family of Water Lilies. It originates in the murky, shallow waters and swamps of the Amazon. The genus name was given in honor of Queen Victoria of the United Kingdom.

Features
The species has very large leaves which can reach up to 3 m in diameter. It floats on the water surface on a submerged stalk which is 7-8 m in length.

Leaves
Sharp spines are present on the stems and undersides of leaves. The leaf edges turn up to form a rim and the underside of the leaf is coppery red.

Root system
The horizontal creeping and branching rhizomes are attached by adventitious roots arising in groups below the leaf bases.

Flowers
The flowers can reach up to 40 cm in diameter and are night blooming. The flowers are white on the outside and pink on the inside.

Fruits
A capsule of 1-2 cm in diameter and contains many seeds.

Distribution
Native to the shallow waters of the Amazon River basin in South America.

Propagation: By rhizomes or by seeds.

Uses: *Victoria amazonica* is a favorite aquatic plant for horticulturists as it fits well into large water gardens, pools or ponds.

Note: The leaf size of *Victoria amazonica* is determined by the depth of the water in which the plant is growing: the deeper the water, the bigger the leaves. It has night-blooming flowers which emit a fragrance reminiscent of pineapple.

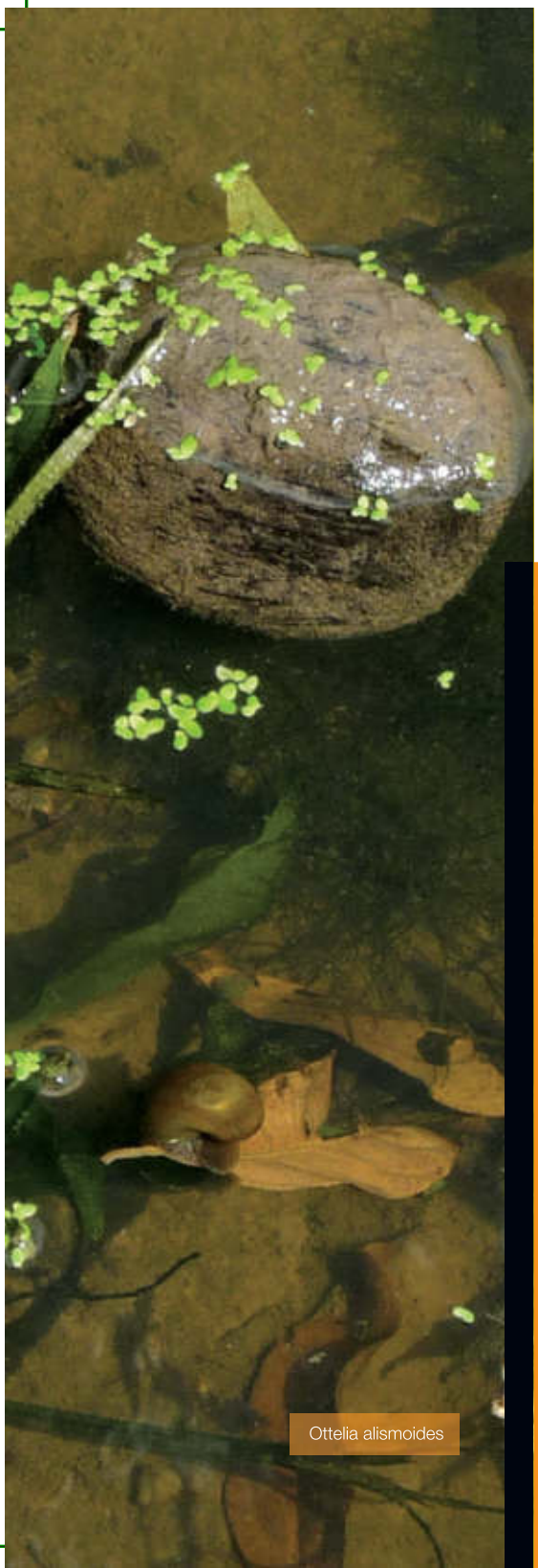
(Top left) The underside of a Victoria amazonica *leaf; note the sharp spines on the leaf vines. The flower (Top right) and flower bud (Inset) of* Victoria amazonica*.* Victoria amazonica *is often featured in water landscaping. (Bottom left) A water landscape feature at the Singapore Zoo; (Bottom right) A water garden in Leiden, Netherlands.*

Other floating-leaf plants which can be grown:

Name	Family	Common Name	Habit
Aponogeton distachyos L. f.	Aponogetonaceae	Water Hawthorn	Herb
Brasenia schreberi J. F. Gmel.	Cabombaceae	Water Shield	Herb
Hydrocleys nymphoides (Willd.) Buchenau	Limnocharitaceae	Water Poppy	Herb
Limnobium spongia (Bosc) Steudel	Hydrocharitaceae	Frogbit	Herb
Nuphar lutea (L.) Sm.	Nymphaeaceae	Yellow Pond Lily	Herb
Nymphoides peltata (S. G. Gmel.) Kuntze	Menyanthaceae	Yellow Floatingheart	Herb
Nymphaea tetragona Georgi	Nymphaeaceae	Pygmy Water Lily	Herb
Victoria cruziana A.D. Orb.	Nymphaeaceae	Santa Cruz Water Plant	Herb

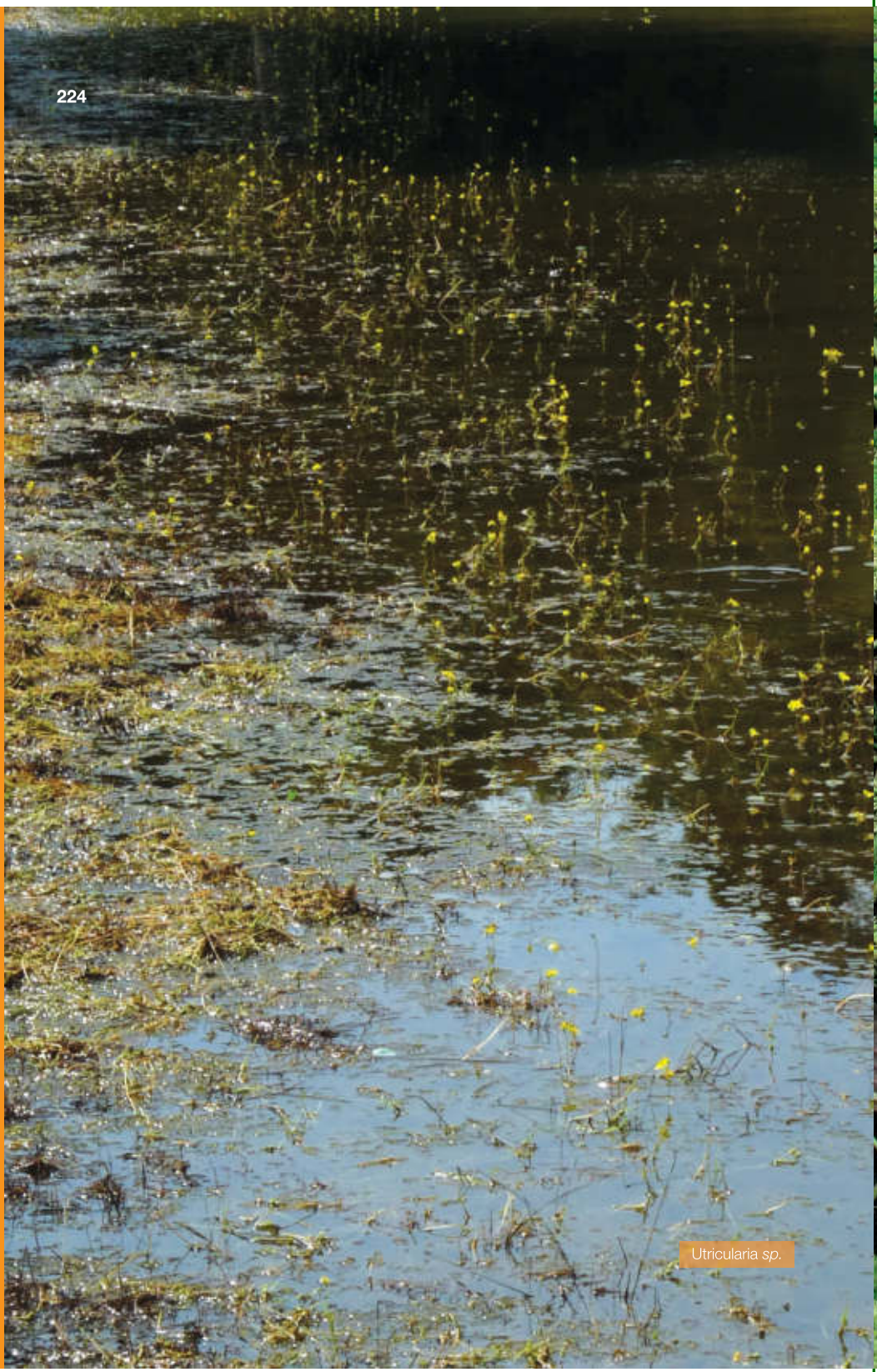
Nymphoides peltata *(yellow flowers) plants growing together with the larger Lotus plants (Beijing, China).*

Water Lilies in a water landscape (Hangzhou, China)



Ottelia alismoides

Submerged Plants



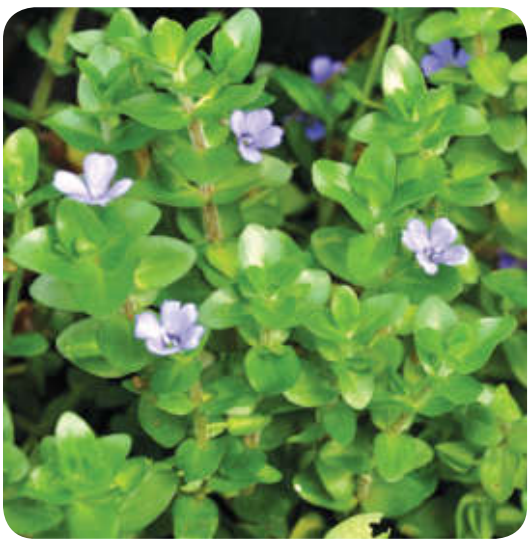
Utricularia *sp.*

Limnophila sessiliflora

Bacopa caroliniana (Walter) B. L. Rob.

Lemon Bacopa

Family Scrophulariaceae



This slow growing plant has long, cascading stems and tiny, perfect, five-petalled flowers. The leaves of *Bacopa caroliniana* give out a smell of lemon when crushed, as indicated from its common name. The level of lighting will affect the colouration of the leaves; when given bright light, the leaves will have a reddish appearance.

Features
A small, creeping, succulent herb, which only grows up to 30 cm tall.

Leaves
The leaves are oblong-lanceolate, lack stalks and are oppositely arranged on the stem. The leaves of this plant are succulent and relatively thick.

Root system
The root systems are thin, wiry, small and branched.

Flowers
The blue flowers are small and occur singly. They have four or five petals.

Fruits
The fruit is ovoid and glabrous.

Distribution
Native to North America.

Propagation: By stem cuttings.

Uses: This species is a popular aquarium plant.

Note: This species can grow as a submerged or emergent plant; therefore, it is suitable for planting in storm water detention area, where there will be periods of flood and drought.

The small purple flower (Top left) and the shoots (Top right) of Bacopa caroliniana*. (Middle left) The shoots of* Bacopa caroliniana *emerging from the water. (Middle right)* Bacopa *sp. growing at the base of a canal. (Bottom left)* Bacopa caroliniana *growing with* Hydrocotyle verticillata*. (Bottom right) A water landscaping design feature using aquatic plants such as* Bacopa *sp.*, Colocasia *sp. and* Hydrocotyle verticillata*.*

Cabomba aquatica Aubl.

Cabomba

Family Cabombaceae

Cabomba is an aquatic plant that can be readily obtained from tropical fish suppliers. This is an exotic species, commonly grown in an aquarium by hobbyists as oxygenators.

Features
A submerged herbaceous perennial freshwater plant.

Leaves
The plant produces two types of leaves: submerged and floating. The submerged leaves are finely dissected, but the floating leaves are entire and elliptic in shape. The submerged leaves are feathery and made up of 150-200 segments, 0.4 mm wide, with no veins or other markings.

Root system
Rootless.

Flowers
The flowers are white and yellow. These flowers are pushed up into the air from the stems with the floating leaves to allow pollination by insects.

Fruits
Not available.

Distribution
Native to Brazil, Paraguay, Uruguay and Northeast Argentina.

Propagation: By stem fragments or by rhizomes.

Uses: *Cabomba aquatica* is commonly used as an aquarium plant because of its delicate appearance.

Note: This plant is eaten by waterfowl and fishes in its native habitat.

Colonies of Cabomba aquatica.

The shoot of Cabomba aquatica.

The flower of Cabomba aquatica. *The round floating leaf is another leaf type besides the submerged leaf, where it often appears with the flowers.*

Ceratopteris thalictroides (L.) Brongn.

Water Sprite

Family Pteridaceae

Ceratopteris is a very adaptable plant. It can be grown rooted in the gravel, anchored to driftwood, floating on the surface or growing out of the water.

Features
A half-submerged water fern.

Leaves
The fronds are soft and of an emerald green shade. It produces two types of fronds: sterile fronds have broader lobes and more leaf-like; fertile fronds have narrow lobes and are horn-like.

Root system
Dense rhizome system.

Flowers
Not applicable.

Fruits
Not applicable.

Distribution
Native to Old World tropics.

Propagation: By vegetative propagation (rhizomes) or by spores.

Uses: *Ceratopteris thalictroides* is a good starter plant in small aquariums.

Note: This species is an excellent oxygenating plant and contributes to the biological filtration in an aquarium tank.

(Top left) The fronds of Ceratopteris thalictroides*; (Inset) The emerging young frond. (Top right) The two different types of fronds: the broader sterile frond (emerged from water) and the horn-like fertile fronds (submerged in water). (Bottom left) The fern* Ceratopteris thalictroides *in its natural habitat. (Bottom right)* Ceratopteris thalictroides *growing beside a small stream at the Singapore Botanic Gardens.*

Cryptocoryne griffithii Schott

Griffith's Cryptocoryne

Family Araceae

This plant originates from the Malay Peninsula and Indonesia. It was named after Dr. William Griffith, a British botanist who first collected the plant in 1863. Griffith's Cryptocoryne is endangered in Singapore due to the destruction of its natural habitat; the slow-flowing streams in the forests.

Features
A herbaceous plant with a short stem bearing a rosette of leaves.

Leaves
The leaves have long, white stalks and blades which are dark green mottle purple above and tinged pink below. The leaf blades are ovate, 4-5 cm long; on a petiole that is 10-12 cm long.

Root system
Extensive root system.

Flowers
The inflorescence is axillary, with the spadix enclosed by a white, cylindrical spathe.

Fruits
The fruits are rare.

Distribution
Native to Singapore and also found in the south of Peninsular Malaysia (Johor and Malacca).

Propagation: By vegetative propagation (runners or stolon).

Uses: The dark green and purple mottled leaves are very attractive and this species has been exploited as an aquarium plant.

Note: In Singapore, *Cryptocoryne griffithii* is restricted to one stream in the Bukit Timah Nature Reserve and some streams in MacRitchie Reservoir area and Nee Soon swamp forest.

(Top left) The habit of the Cryptocoryne griffithii*; (Inset) The baby plantlet of* Cryptocoryne griffithii*; note that the plantlet is connected to its mother plant by a stolon. (Top right)* Cryptocoryne longicauda*, a relative of* Cryptocoryne griffithii*, has a purplish spathe with a long tail* (Copyright: Lo Shiang Huei). *(Bottom left)* Cryptocoryne longicauda *in its natural habitat* (Copyright: Lo Shiang Huei).

Hydrilla verticillata (L. f.) Royle

Hydrilla

Family Hydrocharitaceae

This perennial species is the most common fresh water submerged macrophyte in Singapore. It can grow easily from any piece of foliage, stem or root.

Phytoremediation potential: It is able to absorb nitrogen and phosphorus rapidly. In addition, it is able to accumulate selenium.

Propagation: By root fragments or by stem fragments.

Uses: *Hydrilla verticillata* is widely traded in the aquarium industry.

Note: This plant is highly polymorphic. Its appearance can vary considerably depending on the conditions under which it is growing.

Features

It grows submerged in water and is generally rooted to the bottom. The fragments which break loose will survive in a free-floating state in the water.

Leaves

The generally green leaves are 6-40 mm long, and in whorls of three to eight at each node. The leaf margins are distinctly saw-toothed with sharp teeth along the underside midrib.

Root system

Adventitious roots form on leaves, but they are poorly developed.

Flowers

The white female flowers are solitary, tiny and float on the surface. The male flowers are also tiny, greenish and are closely attached to leaf axils toward stem tips.

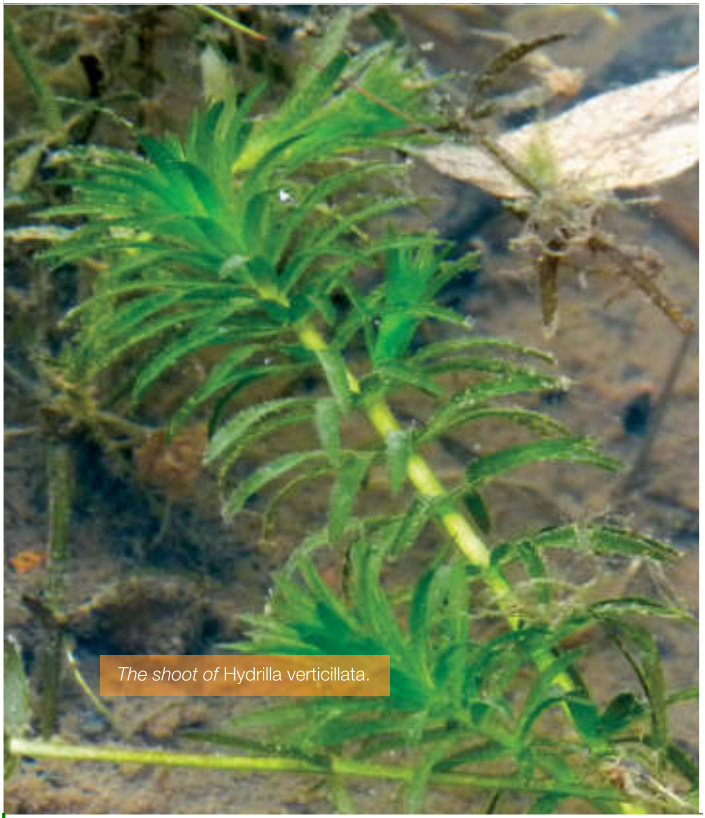
Fruits

Not available.

Distribution

Native to Asia, Eastern Europe, Africa, and Australia.

A colony of Hydrilla verticillata *in the water.*



The shoot of Hydrilla verticillata.

The white female flower of Hydrilla verticillata.

Ottelia alismoides (L.) Pers.

Turtle Grass

Family Hydrocharitaceae

Unlike most other aquatic plants, *Ottelia alismoides* is special in that its flowers are surrounded by winged or ribbed spathe. The flowers may still open fully even when completely submerged.

Phytoremediation potential: It is able to accumulate copper.

Propagation: By seeds.

Uses: It is eaten by the locals in Peninsular Thailand and the Philippines.

Note: This plant requires constant water and cannot tolerate drought.

Features

A floating aquatic perennial in which the floating stalks can grow up to 1.5 m long. It is diffusely branched and rooted in dense masses at the nodes.

Leaves

The leaves are in turf, and the blades are broad oval with a round or heart-shaped base.

Root system

It has two types of root systems: one is adventitious roots which anchor it in soil, and the other contains air sacs to keep the plant afloat and assist respiration.

Flowers

The flowers can be white, pink, blue or purple, and are often tinged with yellow at the base. They are bisexual. They are carried singly at the end of a stalk longer than the leaves and surrounded by a broad, winged spathe.

Fruits

The fruits are narrowly oblong with six grooves. They have crispate wings, persistent sepals and styles. The ripe fruits will split open and release a floating mass of seeds.

Distribution

Native to East Asia, Southeast Asia, Australia and Northeast Africa.

The submerged Ottelia alismoides *plants usually have their flowers emerging out of the water surface, which is covered with* Lemna *sp.; (Inset) The white* Ottelia alismoides *flower.*

The delicate appearance of the Ottelia alismoides *makes it a suitable candidate for water landscaping and as an ornamental plant for aquariums.*

Rotala macrandra Koehne

Giant Red Rotala

Family Lythraceae

Rotala macrandra is a plant which has long been considered by aquatic plant enthusiasts to be the most beautiful red plant that one can add to an aquatic landscape. It has few equals in its intense colouration and is sometimes known as "king of the reds".

Features
A creeping herb, with ascending branches and reddish stems. It can grow up to 25-55 cm.

Leaves
The oppositely arranged leaves are stalkless, ovate with blunt tips. The base is nearly heart-shaped.

Root system
Rooting at lower nodes.

Flowers
The small pinkish flowers occur in spike-like racemes, either at the end of branches or from the leaf axil. Each flower has four sepals, each 2 mm long and four petals. The stigma is thickened.

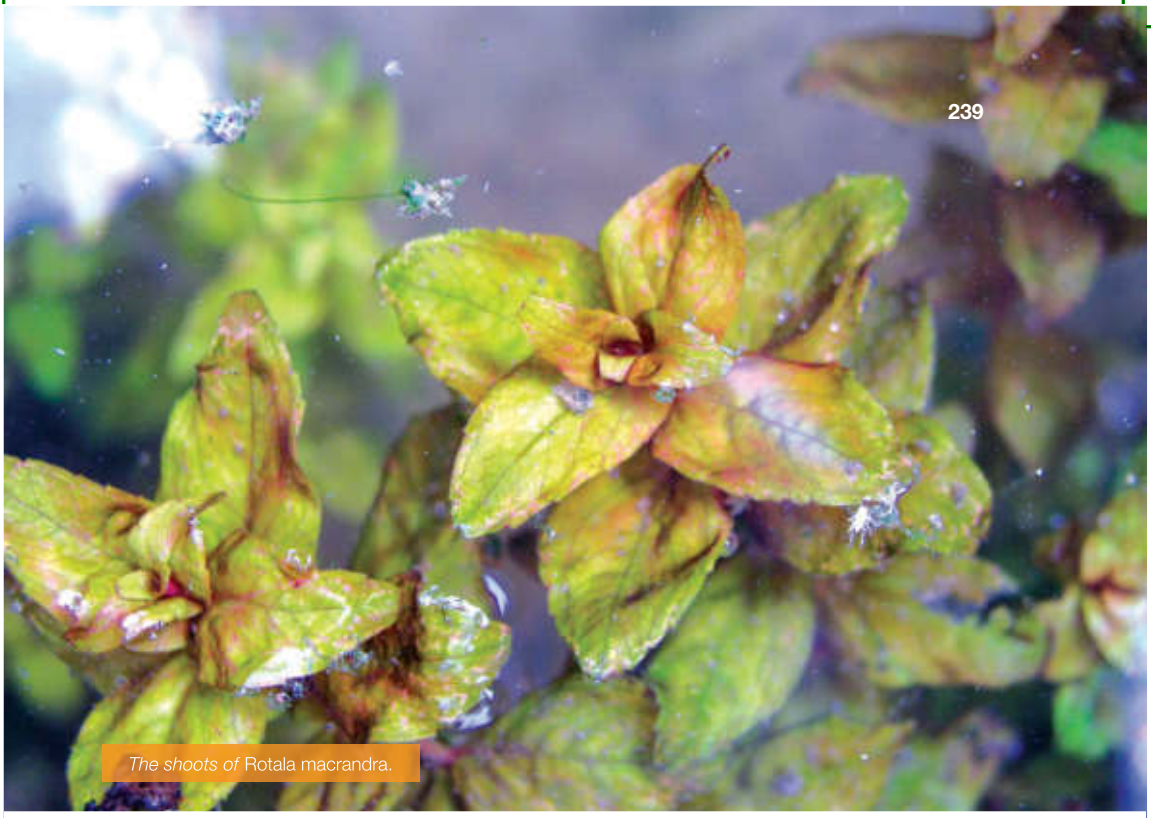
Fruits
Not available.

Distribution
Native to Sri Lanka and India.

Propagation: By stem cuttings.

Uses: It is used as an aquarium plant.

Note: An intense deep-red colouration of the leaves is often observed when the phosphate levels are relatively high (1.5-2.0 ppm); thus this plant can be used as a bioindicator for phosphate levels in the water.



The shoots of Rotala macrandra.

The reddish leaves of Rotala macrandra *add a tinge of colour to the waterbody.*

Utricularia bifida L.

Common Bladderwort

Family Lentibulariaceae

Bladderwort species are carnivorous as they trap and digest small invertebrates to supplement their nutrient requirements. A peculiarity of all the species in this genus is that they do not have roots, but instead form long, branching stems or stolons.

Features
The carnivorous bladders are attached at regular intervals along the linear stem segments. Underwater, the leaf branches or petioles are fleshy and inflated with air which allow them to float.

Leaves
The leaves are whorled with four to ten lateral leaves which fork often, giving them a very delicate capillary appearance.

Root system
All Bladderworts are rootless.

Flowers
The flowers are usually bright yellow. However some species have lavender flowers. The three-lobed flowers emerge above the water surface.

Fruits
Not available.

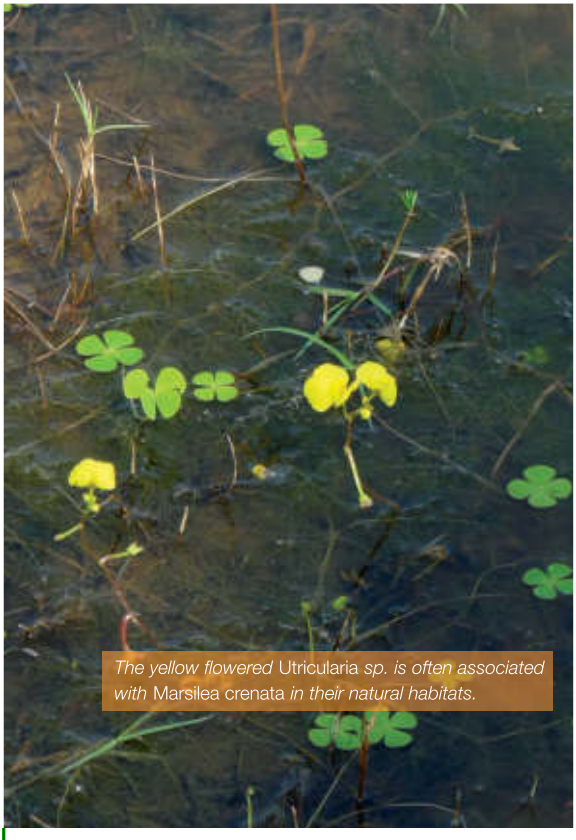
Distribution
Native to India, China, Japan, Southeast Asia and northern Australia.

Propagation: By division of clumps.

Uses: No known uses.

Note: *Utricularia bifida* grows only in nutrient-poor water, making it a good bioindicator of water quality.

The Utricularia *sp. are submerged plants with their flower stalks emerging out of the water.*

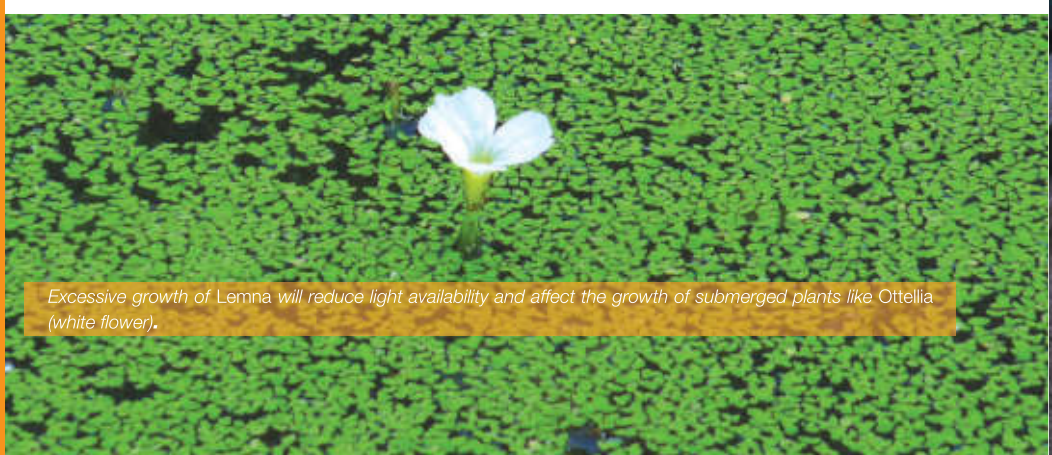


The yellow flowered Utricularia *sp. is often associated with* Marsilea crenata *in their natural habitats.*

The flower stalk of Utricularia *sp.; (Inset) The bright yellow flower.*

Other submerged plants which can be grown:

Name	Family	Common Name	Habit
Alternanthera sessilis (L.) R. Br. Ex DC.	Amaranthaceae	Sessile Joyweed	Herb
Anubias barteri Schott *var. glabra* N. E. Br.	Araceae	Water Aspidistra	Herb
Anubias sp	Araceae	Anubias	Herb
Bacopa monnieri (L.) Pennell	Scrophulariaceae	Water Hyssop	Herb
Blyxa alternifolia (Miq.) Hartog	Hydrocharitaceae	Blyxa	Herb
Blyxa aubertii Rich.	Hydrocharitaceae	Bamboo Plant	Herb
Cryptocoryne lingua Becc. ex Engl.	Araceae	Thin-leafed Cryptocoryne	Herb
Cryptocoryne longicauda Becc. ex Engl.	Araceae	Long-tailed Cryptocoryne	Herb
Cryptocoryne pallidinervia Engler	Araceae	Palli Cryptocoryne	Herb
Cryptocoryne uenoi Y. Sasaki	Araceae	Sarawak Cryptocoryne	Herb
Limnophila sessiliflora (Vahl) Blume	Scrophulariaceae	Asian Ambulia	Herb
Myriophyllum aquaticum (Vell.) Verdc.	Haloragaceae	Parrotfeather	Herb
Nasturtium officinalis R. Br.	Brassicaceae	Watercress	Herb
Nuphar japonicum DC.	Nymphaeaceae	Japanese Spatterdock	Herb
Rotala sp.	Lythraceae	Rotala	Herb



Excessive growth of Lemna *will reduce light availability and affect the growth of submerged plants like* Ottellia *(white flower).*

Stream with submerged water plants in Yunnan, China.

Lepironia articulata

Emergents

Cyperus haspan *var.* vivipurus

Lobelia chinensis

Ferns used in water landscaping

Diospyros cambodiana

Acorus gramineus Sol.

Japanese Rush

Family Acoraceae

The waterlogged tolerant genus Acorus contains only two species. They resemble members of the arum family, but lack the large bract that characteristically encloses the fleshy spike of minute flowers. Their grass-like, evergreen foliage makes them excellent additions in a mixed border.

Features
It is an aquatic or wetland perennial with grass-like foliage.

Leaves
It has narrow, 15-35 cm glossy leaves that look like thick, lush grass. The leaves are carried in two ranks, like opposing fans. They are flat, about 1.3 cm wide and tend to flop over.

Root system
Extensive root system.

Flowers
The insignificant flowers, shaped like little horns, are produced on the erect hollow stems.

Fruits
Not available.

Distribution
It is native to eastern Asia.

Phytoremediation potential: It is able to absorb Metalaxyl, a fungicide active ingredient.

Propagation: By dividing the rhizomes.

Uses: *Acorus gramineus* is used along pond margins and at the edges of water gardens.

Note: It is used as a foliage plant for shallow water and marshy areas because of its aesthetic value. When the leaves are crushed, they release a fragrance reminiscent of cinnamon.

Acorus gramineus *is often grown together with* Cyperus papyrus *in many landscaping sites associated with wet soils.*

The emerging leaf of Acorus gramineus.

Acorus gramineus *is a waterlogged tolerant species and thus it is often planted at the margin or shallow zones of a waterbody.*

Arundina graminifolia (Don) Hochr.

Bamboo Orchid

Family Orchidaceae

Although it is a native plant, this species is close to extinction in Singapore. This is largely caused by the destruction of its natural habitat, which are disturbed and open areas adjacent to the rainforests and mangroves.

Features
A terrestrial perennial orchid with reedy stems, forming into large clumps growing to a height between 70 cm and 2 m.

Leaves
Narrowly oblong to linear-lanceolate, the leaves are 8-20 cm long and 0.5-2 cm broad.

Root system
Aerial roots.

Flowers
The flowers are large and striking with white petals and sepals and a contrasting purple lip. A patch of yellow is present in the throat.

Fruits
The seed pods contain minute powdery seeds.

Distribution
Native to Asia. From Nepal, Sri Lanka, Thailand, Laos, Cambodia, Vietnam, southern China, Japan, Taiwan and south to Malaysia and Java.

Propagation: By vegetative propagation, i.e. division of rhizomes or bulbs.

Uses: These terrestrial orchids are grown in urban parks and home gardens around Singapore, and attract bees, butterflies and birds.

Note: This orchid is commonly seen in disturbed environment with poor soils.

Arundina graminifolia *growing naturally in open grassland in Yishun, Singapore.*

Arundina graminifolia *planted in a water garden; (Inset) The beautiful flower of* Arundina graminifolia.

Arundo donax L.

Giant Cane

Family Poaceae

Arundo donax is a tall perennial growing in damp soils. It has large and attractive foliages, which form dense and homogenous stands along the edges of rivers or ponds, wetlands and riparian habitats. It has been widely cultivated in many regions for thousands of years, including the ancient Egypt. This plant has the potential to be used as a renewable biofuel source due to its fast growth rate and high adaptability to the environment.

Features
A large statured clump-forming grass, 3-10 m tall with many stems from a shallow, horizontal rhizome.

Leaves
The clasping leaves are as long as 70 cm, alternately arranged in a single plane. The ligule is fringed with longish hairs.

Root system
The relatively shallow root system is fleshy, made up of a compact mass of rhizomes.

Flowers
The plant may form plume-like terminal inflorescence, but is often non-flowering in higher latitudes.

Fruits
Uncommon.

Distribution
Distributed globally from Southern Africa, subtropical United States through Mexico, the Caribbean islands and South America, Pacific Islands, Australia, and Southeast Asia.

Propagation: By vegetative propagation (rhizomes, division, stem cuttings) or by seeds.

Uses: The stems of the plant are used for roofing and basketry. Moreover, the fibre from the stems is also used to make good quality paper.

Note: The roots and leaves of this species are edible.

Arundo donax.

Arundo donax *growing beside a lake with the Sealing Wax Palm (*Cyrtostachys renda*) at the Singapore Botanic Gardens.*

The variegated form of Arundo donax.

Colonies of the variegated Arundo donax.

Blechnum orientale L.

Centipede Fern

Family Blechnaceae

This waterlogged tolerant fern produces colourful reddish bronze new emerging fronds. It is an attractive species for use in uban landscapes.

Features
A rhizomatous, perennial, herb fern, 0.3-2 m high.

Leaves
The fronds are narrow, pointed at the tip, and are leathery.

Root system
A wide creeping rhizome with extensive root systems.

Flowers
Not applicable.

Fruits
Not applicable.

Distribution
Native to Asia, Australia, Pacific and Philippines.

Phytoremediation potential: It is able to accumulate arsenic, calcium, copper, iron, magnesium, manganese, potassium, sodium and zinc.

Propagation: By spores.

Uses: These ferns are valued as an ornamental plant as the new fronds are colourful with a reddish-bronze tint.

Note: *Blechnum orientale* prefers sunny and slightly shady places and it will not grow in deep forest shade, unlike most of the ground fern species.

(Top) Blechnum orientale *fern. (Middle) The underside of the frond of* Blechnum orientale *and the sporangia (Bottom).*

Calla palustris L.

Calla Lily

Family Araceae

Calla Lilies require moist growing conditions. Hence they are commonly found along shallow waters and muddy shores. It is distinguished from other aquatic plants by its characteristic glossy, heart-shaped leaves.

Features
Calla palustris is a moisture-loving deciduous perennial with large heart-shaped leaves.

Leaves
The leaves are glossy and heart-shaped, rising on stems from long underwater rhizomes. The lateral veins are curved and parallel.

Root system
The roots are adventitious, arising from the nodes.

Flowers
The flowers are clustered upon a thick, fleshy spadix, about which a milk-white spathe is wrapped. Sepals and petals are absent.

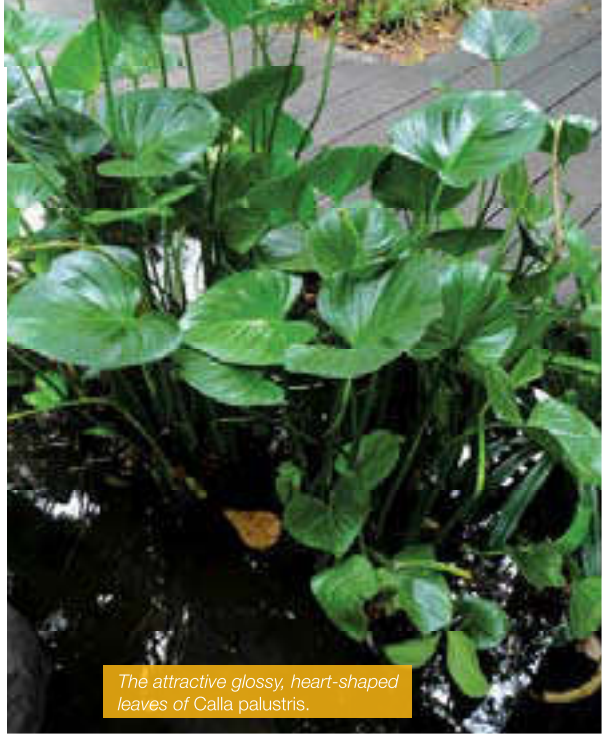
Fruits
Bright red, pear-shaped berries.

Distribution
Native to North America and Eurasia.

Propagation: By seeds or by rhizomes.

Uses: Plants are sometimes sold in aquatic garden catalogs for ornamental plantings in bog gardens.

Note: The plant contains calcium oxalate crystals. These crystals cause an extremely unpleasant sensation similar to needles being stuck into the mouth and tongue if they are eaten.



The attractive glossy, heart-shaped leaves of Calla palustris.

The root system of Calla palustris.

Calla palustris *plants are planted in pots along the edge of a lake.*

Canna generalis L. H. Bailey

Canna Lily or Canna

Family Cannaceae

Although not a true lily, the Canna Lily comes in a rainbow of colours and can add dramatic emphasis to any garden. Cannas are related to gingers and consist of a single genus with about 20 species.

Features
Tropical and subtropical flowering plants with large, banana-like leaves.

Leaves
The large, paddle-like leaves resemble banana leaves and come in greens, blue-greens, variegations and stripes.

Root system
Tuberous root.

Flowers
There are many cultivars but most have yellow, orange or red flowers, and are borne on tall stalks coming out of the foliage.

Fruits
Not available.

Distribution
Native to Central and South America.

Propagation: By seeds or by rhizomes.

Uses: The Canna Lily is a mid-sized plant for decorating garden beds, and is best when planted in a mass display. Canna rhizomes are edible and rich in starch.

Note: Most Cannas sold today are the result of multiple cross-breeding.

The different horticultural varieties of the Canna Lily.

(Left) Canna Lily planted along with Water Lilies in a lake at the Singapore Botanic Gardens. (Right) Canna Lily used as a water hedge along the bank of Eco-lake, Singapore Botanic Gardens.

Chrysopogon zizanioides (L.) Roberty

Vertiver Grass

Family Poaceae

Features
It is a densely tufted perennial grass, with aromatic roots and rhizomes.

Leaves
The leaves are narrow, linear, 25-50 cm long and 1 cm wide; erect with compressed sheaths.

Root system
It has a long fibrous root system which is knitted strongly together like a net in the soil.

Flowers
The flowers are either grey or purplish, formed in slender racemes 10-30 cm in length.

Fruits
The fruits are oblong grains.

Distribution
Native to India.

Vetiver Grass is a tropical plant which grows naturally from the highlands to lowlands in various soil conditions. The roots have many medicinal values and are used as traditional medicine in South Asia.

Phytoremediation potential: It is able to accumulate lead, arsenic, zinc, copper and petroleum hydrocarbons.

Propagation: By division of the vegetative clumps.

Uses: The plant has both deep and extensive roots that make it a valuable plant for controlling soil erosion in cultivated fields. It is often planted along the contour lines for this purpose.

Note: Vetiver oil has many therapeutic properties and can be used as an antiseptic, an aphrodisiac or as a sedative.

Vertiver Grass planted in an urban setting.

Vertiver Grass is widely used in many greening projects as its extensive roots help to stabilise slopes and prevent soil erosion.

(Top left) Vertiver Grass was tested for its waterlogging tolerance and ability to remove nutrients in an experimental setup. (Top right) The performance of Vertiver Grass under different nutrient levels was monitored carefully using a portable gas exchange system. (Bottom) The growth of Vertiver Grass (growing on a floating device) was evaluated in a waterbody.

The variegated form of the Vertiver Grass.

The inflorescences of the Vertiver Grass (variegated form).

Colocasia esculenta (L.) Schott

Cocoyam

Family Araceae

Colocasia esculenta, or Cocoyam, is widely grown in the tropics for food and as an ornamental planting. Locally it is called "yam" which, strictly speaking, refers to *Dioscorea* sp. which belongs to a different family. Many different cultivated varieties are found locally.

Features
It is a 1 m tall evergreen herb with tuberous rhizome.

Leaves
The heart-shaped leaves with long petioles. The leaves have prominent veins and the petioles are thick, succulent and often purplish.

Root system
An upright tuberous rootstock, which is a corm.

Flowers
The flower is a spathe that grows up to 35 cm long. The flowers produced are unisexual and they are not particularly showy.

Fruits
Not available.

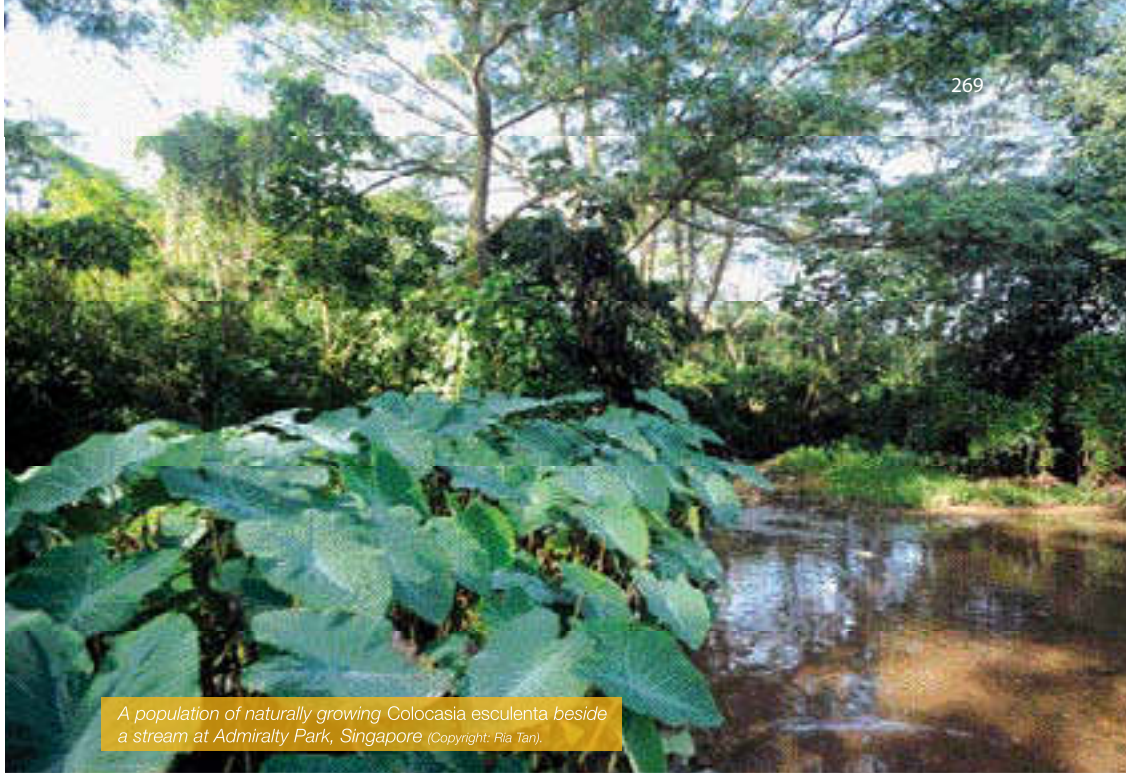
Distribution
Native to tropical Southeastern Asia, China, Japan and the West Indies.

Phytoremediation potential: It is able to accumulate mercury.

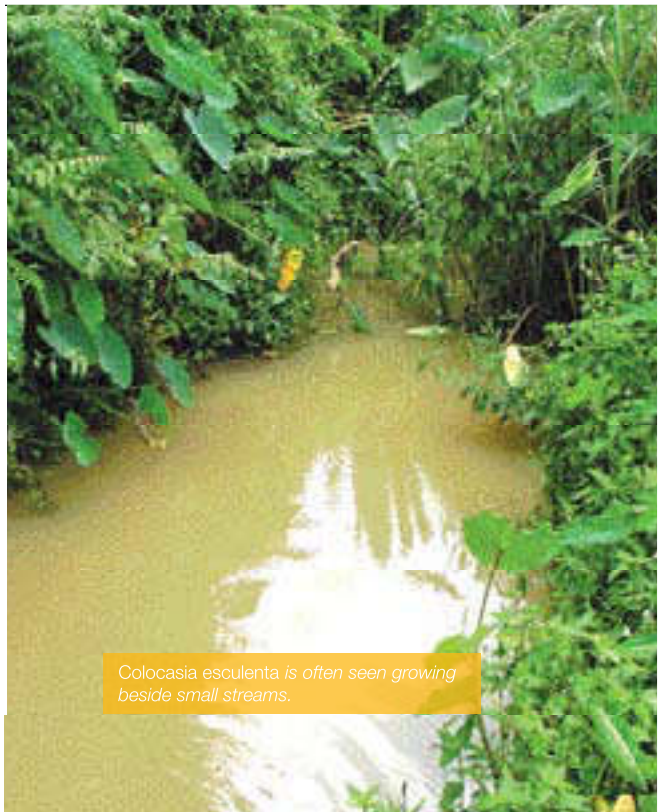
Propagation: By division of the vegetative clumps.

Uses: It has been cultivated for more than 6000 years as an ornamental foliage plant and also as an important food crop. It is a showy and waterlogged tolerant species for planting in and around water features.

Note: When grown near aquatic settings, they can be planted in deep water (up to 40 cm) and will spread quickly.



A population of naturally growing Colocasia esculenta *beside a stream at Admiralty Park, Singapore* (Copyright: Ria Tan).



Colocasia esculenta *is often seen growing beside small streams.*

Colocasia esculenta *can grow as tall as an adult.*

A colony of Colocasia esculenta *forming a green hedge along the bank of the Eco-lake at the Singapore Botanic Gardens.*

The dark purple leaves of Colocasia esculenta *var.* Black Magic *help to add colour and variety to a water landscape.*

Colocasia esculenta *can be planted together with* Thalia *sp.*

Colocasia *plants are widely available in commercial nurseries.*

Costus speciosus (Koenig) Smith

Crepe Ginger

Family Costaceae

Features
A tall plant with large dark green leaves arranged on the stalk in a spiral. It can grow up to 3 m tall.

Leaves
The leaves are spirally arranged, oblong (15-30 cm long) in shape, with a pointed tip and a short stalk. The lower surface of the leaf is covered with soft hairs.

Root system
Hardy rootstock.

Flowers
The flowers are white in colour, and look like crepe paper.

Fruits
The capsules are ovoid to round, 1.5-2 cm long, and red in colour.

Distribution
Native to Southeast Asia.

The Crepe Ginger is beautiful for its bold tropical foliage, and the white flowers are an added attraction. The ginger-like leaves are arranged in an ascending spiral around the stem and terminate with pine cone-like flowerheads.

Propagation: By vegetative propagation, i.e. rhizome or stem cuttings.

Uses: Crepe Ginger is best used for dramatic effect in a tropical landscape, but this species also combines well with other tall perennials as a “green backdrop”.

Note: As with most gingers, this plant has culinary or medicinal uses. Although this species is not commonly used in Western cultures, the rhizome has been used in India and Southeast Asia to treat a wide range of ailments. The flowers contain flavonoids.

A colony of Costus speciosus.

Costus *flower.*

Bee pollinating Costus *flower; the central lobe of* Costus *flower is enlarged to form a landing platform for visiting bees.*

Cyperus alternifolius L.

Umbrella Plant

Family Cyperaceae

The genus comes from the Greek word “kupeiros”, meaning sedge. *Cyperus alternifolius* or Umbrella Plant is a rush-like aquatic species with foliage arranged on the stems like the ribs of an umbrella. It is a large plant with slim stems, giving it a delicate look in the landscape.

Features
A half-submerged rhizomatous perennial. It can reach up to about 1-2 m tall, depending on the growing conditions.

Leaves
It has evergreen foliage, composed of long stems with involucral bracts at the top. These bracts look like narrow leaves; and these palm-like leaves atop bare stems are green to reddish-brown.

Root system
Strong underground roots.

Flowers
The inflorescence is composed of 10-20 small clusters of green-white tiny flowers.

Fruits
Not available.

Distribution
Native to Madagascar, Mauritius and the Réunion Island.

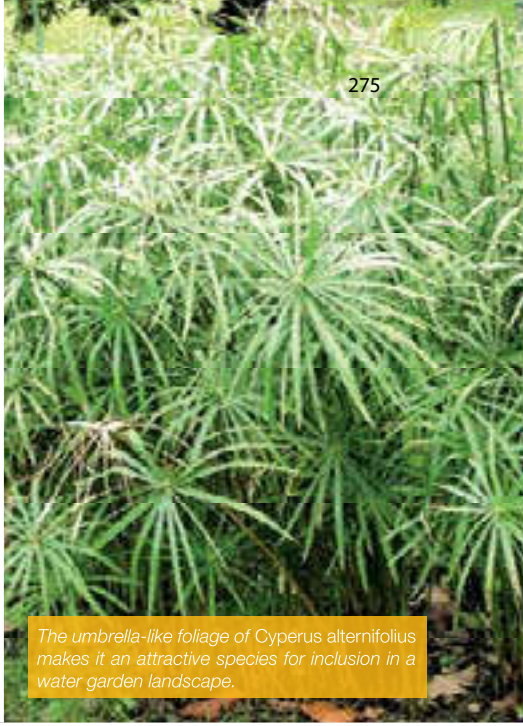
Phytoremediation potential: It is able to absorb nitrogen and phosphorus rapidly. It is also able to accumulate copper and manganese.

Propagation: By vegetative propagation, i.e. division or cuttings.

Uses: *Cyperus alternifolius* is the most commonly cultivated *Cyperus* used in horticultural applications.

Note: This plant can be grown indoors all year round in a pot if kept well watered. The wetter the roots are, the more it thrives.

The foliage of Cyperus alternifolius.



The umbrella-like foliage of Cyperus alternifolius *makes it an attractive species for inclusion in a water garden landscape.*

Cyperus alternifolius *used in water landscaping.*

Cyperus haspan L. var. *vivipurus*

Dwarf Papyrus

Family Cyperaceae

Dwarf Papyrus is a sedge which grows relatively slower than other *Cyperus* species. Its stems are small, soft and weak. It is usually found in marshes, lakes and pond margins, along moist roadside ditches and in other disturbed and natural areas with shallow water.

Features
The foliage has round brush-like balls on the end of each stalk. It grows in clumps. The stems are tuft-forming, about 10-90 cm tall.

Leaves
No leaf blades; just sheaths. The sheaths are few, purplish, and loose at the base.

Root system
Red-purple fibrous roots with slender, horizontal and short rhizomes.

Flowers
The inflorescence are branched, having few narrow leaf-like bracts.

Fruits
The fruits are achenes.

Distribution
Native to subtropical and tropical regions worldwide.

Phytoremediation potential: It is able to absorb nitrogen and phosphorus rapidly.

Propagation: By seeds or by stem cuttings.

Uses: This species makes an excellent deck or balcony plant when cultivated in tubs, kettles or other containers. It gives a nice accent to the water garden.

Note: They can be invasive if planted directly at the pond edge, but they are controllable by placing them in containers before putting them in the water.

(Top left) Cyperus haspan *var.* vivipurus *planted with* Typha *sp. in a constructed wetland in Sengkang Riverside Park, Singapore. (Bottom left)* Cyperus haspan *var.* vivipurus *colonies; (Inset) The spikelets of* Cyperus haspan *var.* vivipurus. *(Top right)* Cyperus haspan *var.* vivipurus *growing beside a lake. (Middle right) The flowering* Cyperus haspan *var.* vivipurus *gives a different accent to the water landscape. (Bottom right) The inflorescence of* Cyperus haspan *var.* vivipurus.

Cyperus papyrus L.

Papyrus

Family Cyperaceae

The species name is derived from the use of the plant for paper-making in ancient Egypt. The plant was introduced into Singapore from Thailand in 1932.

Features
Bright green, smooth, rounded culms (flowering stems) which are up to 40 mm thick at the base.

Leaves
The leaves of Papyrus are essentially short sheaths that wrap around only the lowest portion of each stem.

Root system
A network of thick woody rhizomes.

Flowers
A small flower is held at the tip of each spikelet.

Fruits
A nut-like fruit.

Distribution
Native to central tropical Africa.

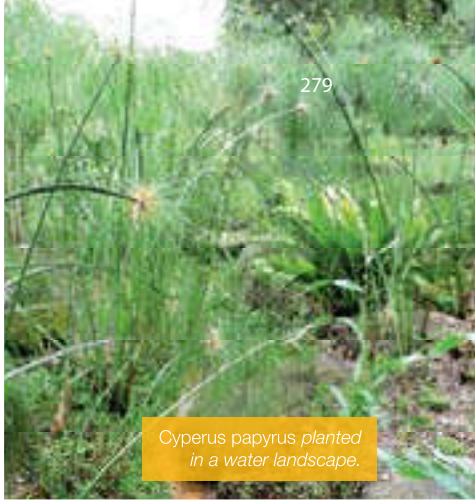
Phytoremediation potential: It is able to absorb nitrogen and phosphorus rapidly. In addition, it is able to accumulate copper, zinc and lead.

Propagation: By division of the clumps.

Uses: When used in landscaping, a single clump can serve as a focal point, or they are used in pairs to frame a decorative theme/scene. When used in smaller pools and fishponds, it is possible to grow this species in containers placed underwater.

Note: This perennial plant was used for making paper in early times by the Egyptians. In southern Africa the starchy rhizomes and culms are eaten, raw or cooked, by humans. The culms are also used for building materials.

The Cyperus papyrus *flowers.*



Cyperus papyrus *planted in a water landscape.*

Cyperus papyrus *and Water Lily planted in a water garden. The slender foliage of* Cyperus papyrus *creates a special aesthetic appearance for any pond or lake.*

Cyperus papyrus *is widely available in the nurseries.*

Cyrtostachys renda Blume

Sealing Wax Palm or Lipstick Palm

Family Arecaceae

Popularly known as the Sealing Wax Palm or Lipstick Palm, this is one of the most colourful palms in the tropics. It is best known for its brightly-coloured trunk and fronds – the only such palm in the world.

Features
The palm is medium-sized, slow-growing and slender.

Leaves
The leaves are pinnate, with up to ten stiff leaves. The leaves are widely spaced, narrow and grow up to 1-1.2 m long.

Root system
The roots are adventitious and thick.

Flowers
The flowers are small and greenish white or greenish yellow.

Fruits
The fruits are round and half an inch in diameter. They will turn black when ripe.

Distribution
Native to the swampy areas of Singapore, Peninsular Malaysia and parts of Indonesia.

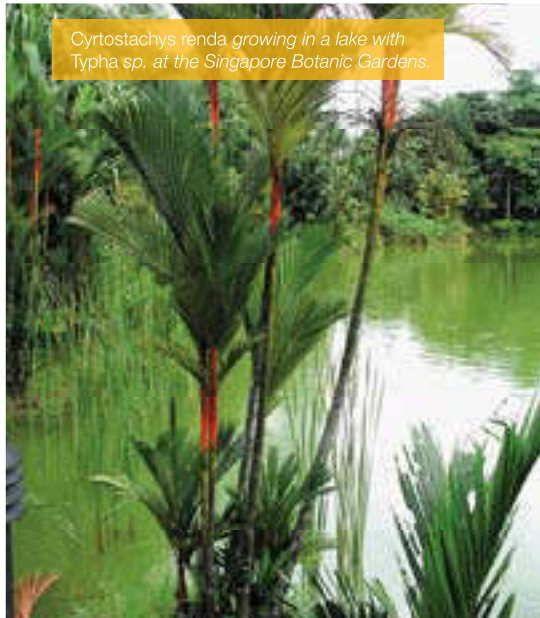
Propagation: By seeds.

Uses: It is a very popular species used in home gardens, urban parks and general landscapes.

Note: It is extremely cold-sensitive, and exposure to temperatures below 15°C is fatal to the plant.

Cyrtostachys renda *bearing fruits; (Inset) The immature fruits.*

Cyrtostachys renda *can be planted in a waterbody.*



Cyrtostachys renda *growing in a lake with* Typha *sp. at the Singapore Botanic Gardens.*

Dillenia suffruticosa (Griff. Ex Hook. F. & Thomson) Martelli

Simpoh Air

Family Dilleniaceae

The Malay word “Simpoh” means the hiss of air escaping the wood when the plant is chopped. “Air”, pronounced as “Ar yea”, is the Malay word for water, which accurately describes the characteristic habitat of this plant, next to streams or at the edge of lakes and ponds.

Features
A large shrub or small tree which can grow up to 5 m.

Leaves
The leaves are very large, thick, and waxy, from 15-35 cm long, and are elliptic to oblong with a rounded tip, almost spoon shaped. The young leaves are quite soft and yellowish to pale green. The veins are thick and prominent.

Root system
It sends out long tap root into the ground to obtain water.

Flowers
The bright yellow flowers of about 10 cm across have five petals. Each flower only lasts for a day.

Fruits
The pink fruits are star-shaped and split open to expose the seeds when ripe. There is a red pulp around each seed which is normally eaten by birds.

Distribution
Native to Sri Lanka and Southeast Asia. Also introduced to the other tropics worldwide.

Propagation: By stem cuttings or by seeds.

Uses: This plant is planted as an ornamental shrub. Its leaves can be used for wrapping food.

Note: *Dillenia suffruticosa* is among the few native species that can germinate and grow on nutrient poor substrate like white sands.

Dillenia suffruticosa *with yellow flower. The large leaves of this plant are used to wrap food;* Dillenia suffruticosa *fruits.*

Dillenia suffruticosa *planted in a water feature at MacRitchie Reservoir, Singapore.*

Echinodorus palaefolius (Nees & Mart.) J. f. Macbr. var. *latifolius* (Micheli) Rataj

Melati Air

Family Alismataceae

Echinodorus palaefolius are commonly used as aquarium plants. They are also used as submerged plants in aquatic ponds.

Features
A half-submerged, very tall delicate plant.

Leaves
Round leaves with a horizontal leaf base, which are blue-green in colour and veined. Plants grown underwater have narrower and longer leaves when compared to their terrestrial counterparts.

Root system
It has a fibrous root system.

Flowers
The flower stalks grow up to 1.5 m, with hundreds of white flowers borne throughout the year.

Fruits
Not available.

Distribution
Native to South America.

Propagation: By vegetative propagation (runners).

Uses: These plants are recognised as some of the most beautiful and robust aquarium species on the market.

Note: Although this species needs a nutrient rich substrate to grow well, low nutrient levels induce better flower colours.

(Top left) Echinodorus palaefolius *planted together with* Cyperus haspan *var.* vivipurus *and Water Lily in a pond at the Singapore Botanic Gardens; (Inset) The white flowers of* Echinodorus palaefolius. *(Top right)* Echinodorus palaefolius *is often used in water landscaping because of its attractive green foliage. (Bottom left)* Echinodorus palaefolius *planted beside the flowing water of an urban landscape. (Bottom right)* Echinodorus palaefolius *plants are widely available in the nurseries.*

Equisetum hyemale L.

Scouring Rush

Family Equisetaceae

Scouring Rush or Horsetail are ancient plants that were dominant in the latter part of the Paleozoic Era (360-250 million years ago). Many have gone extinct except for one genus with a few dozen species; a living relic from an age millions of years before the existence of dinosaurs!

Features
A non-flowering, rush-like, rhizomatous, evergreen perennial which typically grows 1-2 m tall.

Leaves
A whorl of tiny, stem-clasping, scale-like leaves which are fused into an ash-gray sheath ending in a fringe of teeth. Each sheath is set off and accentuated, both above and below, by thin, stem-ringing, black bands.

Root system
Shallow rhizomes.

Flowers
Not available.

Fruits
Pine cone-like fruiting heads which contain numerous spores.

Distribution
Native to Eurasia and North America.

Phytoremediation potential: It is able to accumulate silicon.

Propagation: By division of the clumps.

Uses: This species is a good plant for greening/covering a persistently wet and low spot where nothing else will grow. Scouring Rush is often grown in Japanese-style gardens.

Note: Stems of the plant have high silica content. Scouring Rush has been used to scour cooking utensils. The plant is harvested commercially in northern Mexico for polishing fine furniture.

Equisetum hyemale *used in water landscaping; (Inset) The stem of* Equisetum hyemale. *Note the tiny leaves above the black band.*

Hydrocotyle verticillata Thunb.

Whorled Pennywort

Family Araliaceae

Hydrocotyle verticillata is commonly known as the Whorled Pennywort and can be found growing all year round throughout Singapore wherever there is moist to wet soil. It grows in its natural habitat both as a bog plant and as a submerged plant in fast flowing rivers

Features
Hydrocotyle verticillata is a perennial fast-growing herb.

Leaves
Umbrella-like, toothed leaves that stand up straight from creeping stems. Their foliage are fleshy and usually shiny, which can be anywhere from 1-5 cm in diameter.

Root system
Trailing and spreading hair-like roots.

Flowers
The flowers are inconspicuous.

Fruits
Not available.

Distribution
A common marsh plant found globally.

Phytoremediation potential: It is able to accumulate a range of toxic heavy metals.

Propagation: By vegetative propagation.

Uses: For landscaping around a pond, it is used to create a "soft edge" between the water and taller plants such as the cattails.

Note: Interestingly, this species can also be planted as a floating plant.

The umbrella-like, toothed edge leaf (Top left), and small flowers (Top right) of Hydrocotyle verticillata. *(Middle) The umbrella-like leaves of the* Hydrocotyle verticillata *is useful as a groundcover. (Bottom)* Hydrocotyle verticillata *planted in a water feature (MacRitchie Reservoir, Singapore); (Inset)* Hydrocotyle verticillata *growing as a floating plant.*

Hymenocallis speciosa (L. f. ex Salisb.) Salisb.

Spider Lily

Family Amaryllidaceae

Hymenocallis species are grown for their showy white flowers. The genus name *Hymenocallis* is a Greek word which refers to the "beautiful membrane" connecting the stamens (pollen-bearing parts) of the flower. The common name Spider Lily comes from their flowers with long petals and sepals, which look like a spider. There are 63 species in this genus. They grow on moist soil or water up to 15 cm.

Features
A bulbous perennial with white spider-like flowers held above wide lush bright green leaves.

Leaves
The leaves are petioled, lanceolate and bright green. The blade is lanceolate.

Root system
Large and extensive fibrous root system.

Flowers
The flowers display petals that are either white or greenish white. The base of the anther filaments are expanded and fused into a trumpet-like structure.

Fruits
The fruits are in capsule form which contain one or more green seeds.

Distribution
Naturally found in the southeastern United States, Mexico, Central America, the Caribbean/West Indies and northern South America.

Propagation: By division of bulbs or by seeds.

Uses: This species is an attractive plant often grouped for landscaping at parks, public places and along roadside.

Note: The Spider Lily contains various alkaloids that may be poisonous when ingested.

Hyemenocallis speciosa *flowers have a distinctive floral membrane which connects to the stamens.*

Hyemenocallis speciosa *is planted as part of a bioretention swale to treat rainwater run off from the road.*

Ipomoea aquatica Forsk.

Kangkong

Family Convolvulaceae

Commonly cultivated as a potted herb, *Ipomoea aquatica* is adapted to a warm and moist environment. It flourishes naturally in waterways and does not require much care. It is also used extensively in Malay and Chinese cooking, especially in rural or kampung areas.

Features
Ipomoea aquatica is a semi-aquatic trailing vine which can grow extensively.

Leaves
The leaves are arranged alternately; simple with glabrous petioles, of 3-14 cm long. The blades are generally arrowhead shaped with tips pointed and held above water when the stems are floating.

Root system
Many adventitious roots which hang downwards at nodes.

Flowers
The flowers are showy and funnel-formed and can have petals which are pure white or white with a purple centre.

Fruits
The fruits are encased in an oval or spherical 1 cm wide capsule, holding 1- 4 grayish seeds which are often short and hairy.

Distribution
Native in the tropics.

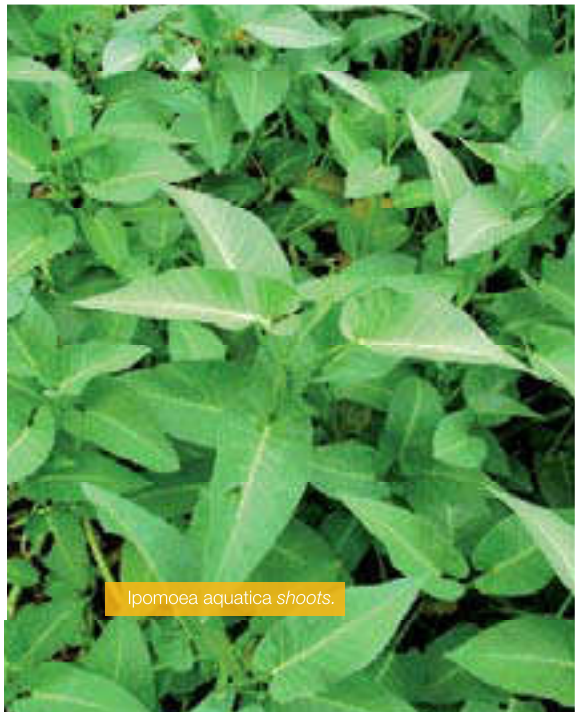
Phytoremediation potential: It is able to accumulate cadmium.

Propagation: By stem cuttings or by seeds.

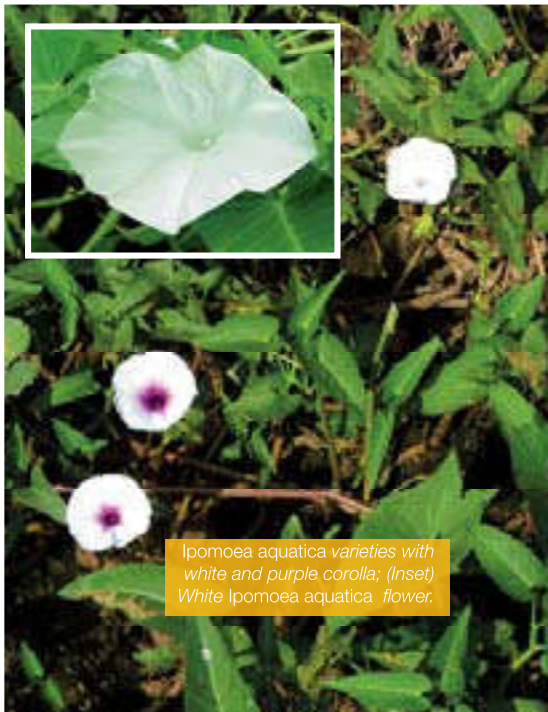
Uses: It may be used for landscaping purposes on the shallow side of waterbodies.

Note: This species is generally confined to the tropics and subtropics zones because it does not grow well when temperature is below 15˚C.

Ipomoea aquatica *grown in a farmland. It is a common local vegetable; (Inset) The planted* Ipomoea aquatica.



Ipomoea aquatica *shoots.*



Ipomoea aquatica *varieties with white and purple corolla; (Inset) White* Ipomoea aquatica *flower.*

Lepironia articulata (Retz.) Domin

Blue Rush

Family Cyperaceae

It is striking in appearance with its steely blue-green upright foliage and often forms huge swaths across the landscape. It can be grown in a large pot or container in a home garden pond where it may be used as a launching pad for emerging dragonflies.

Features
A tall slender rush with a dark green/grey cylindrical stem.

Leaves
The septa are close together and the leaf sheaths are bladeless and yellow-brown in colour.

Root system
Extensive and strong root system.

Flowers
The inflorescences are narrow-ovoid to narrow-ellipsoid, acute, and 1-4 cm long and 5-10 mm in diameter.

Fruits
The nuts are generally obovoid to subglobose in shape.

Distribution
Naturally found worldwide from Australia, Malaysia, New Caledonia to Madagascar.

Phytoremediation potential: It is able to accumulate lead.

Propagation: By seeds or by vegetative propagation.

Uses: This species makes an attractive rush for ornamental ponds and lakes. It is also used in constructed wetlands.

Note: This plant is known as a useful aquatic plant for water-filtering in natural waterbodies.

(Top) Lepironia articulata *planted in Sengkang Riverside Park, Singapore; (Inset) The inflorescence of* Lepironia articulata. *(Middle)* Lepironia articulata *is commonly planted with the other species such as Mangrove Ferns and Cattails. (Bottom) The taller variety of* Lepironia articulata, *is more bluish compared to the wild type* Lepironia articulata.

Limnocharis flava (L.) Buchenau

Yellow Burhead

Family Limnocharitaceae

The Greek words “Limno” and “charis” mean “pond” and “grace”, respectively. The attractiveness of this plant has facilitated its widespread usage globally for water landscaping.

Features
This species is a perennial, rhizomatous aquatic plant with milky sap that can grow to a height of 1 m tall.

Leaves
The leaf is pale green and triangular-shaped with distinctive transverse veins between the main longitudinal veins. The leaves are erect and covered with sheathing.

Root system
It has a short stout rhizome and numerous fibrous roots.

Flowers
It produces ‘octopus-like’ inflorescences consisting of up to 15 flowers. They have three pale yellow petals produced in umbel-like clusters.

Fruits
The compound fruits are spherical and made up of crescent shaped segments that eventually split off.

Distribution
A native of tropical and subtropical America originally.

Phytoremediation potential: It is able to accumulate cadmium.

Propagation: By vegetative propagation or by seeds.

Uses: *Limnocharis flava* is widely used in aquatic landscapes.

Note: This species is a perennial herb. However in ephemeral water-bodies and sites with pronounced dry seasons, it behaves like an annual.

The three-petalled flower of Limnocharis flava.

The flower buds of Limnocharis flava.

Limnocharis flava *in its natural habitat.*

Liparis ferruginea Lindl.

Bog Orchid

Family Orchidaceae

Liparis ferruginea is an endangered orchid in Singapore, and the only remaining population is found at the eastern part of Singapore.

Features
This is a terrestrial orchid species, typically found near freshwater areas.

Leaves
It has three or four simple leaves, with parallel veins. The lamina is about 30 cm long.

Root system
It has slender and creeping rhizomes.

Flowers
The raceme terminal is erect, straight and can extend to more than 50 cm long. The flowers are pale yellow green.

Fruits
Capsules which take 2-18 months to ripe.

Distribution
Native to Tropical Asia, Australia and Pacific Islands.

Propagation: By seeds or through plant tissue culture.

Uses: This plant is cultivated for its ornamental flowers.

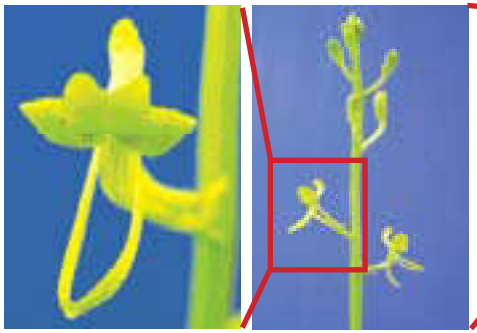
Note: *Liparis*, meaning greasy, refers to the smooth glossy sheen on their leaves.

Liparis ferruginea *grow naturally in waterlogged areas* (Copyright: Saifuddin Suran); *(Inset) The flower buds of* Liparis ferruginea

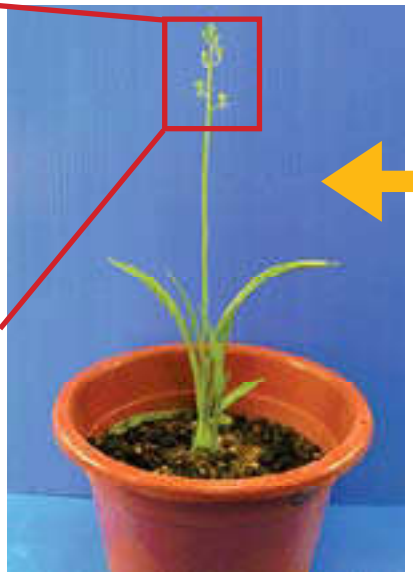
Mass propagation of the endangered orchid, *Liparis ferruginea*, through tissue culture technique:

Liparis seeds are sowed in artificial media containing mineral salts, sugar and plant growth regulators.

The seeds germinate into numerous seedlings.



The *Liparis* inflorescence and flower.



Seedlings of suitable size are transplanted into soil and acclimatized to natural environment. The plant will grow normally and form flowers.

The *Liparis* seedlings grow rapidly in the tissue culture flask. For transplantation into pots/planting bags, it is advisable to transplant the larger seedlings (at least 4 cm) in order to ensure a high rate of survival.

Lobelia cardinalis L.

Cardinal Flower

Family Campanulaceae

This is an attractive ornamental plant with bright red flowers. The flower has a characteristic "lip" petal near the opening of the flower. It won the first place in the Moldenke's poll of North American naturalists in the late 1940s as the showiest and most interesting wild herbaceous plant. The common name Cardinal Flower comes from the similarity of the flower's color to the miters of Roman Catholic Cardinals.

Features
It grows up to 1.2 m tall, and is found in wet places, stream banks and swamps.

Leaves
It has 10-15 cm lance-shaped leaves that are arranged alternately up the 0.6-1.5 m tall stems. The leaves have toothed edges and are dark green in colour.

Root system
It consists of a taproot system.

Flowers
The flowers have a velvety texture and a tubular structure with two lips.

Fruits
Not available.

Distribution
Native to North and South America.

Propagation: By vegetative propagation or by seeds.

Uses: The roots help treat intestinal ailments and syphilis. The leaves are used for bronchial problems and cold.

Note: The flowers are pollinated by hummingbirds. The plant contains alkaloids, which are potentially toxic when ingested.

(Top) The red flowers of Lobelia cardinalis *stand out against its dark green foliage, which makes it suitable for horticultural uses. (Bottom) The red flowers; (Inset) The anthers of the flowers.*

Ludwigia hyssopifolia (G. Don) Exell

Water Primrose

Family Onagraceae

Ludwigia is genus which contains about 75 species. The genus comprises a diverse range of aquatic or waterlogged tolerant plants, including submerged, floaters, and emergents. They commonly grow in shallow marshy areas, burrow pits and ditches. They flower all year round and that makes them suitable plants for water landscaping, The emergent Ludwigia species, *Ludwigia hyssopifolia is* one of the species commonly found in Singapore.

Features
It is a perennial herb that may be partially submerged or emergent, and grows up to 1 m tall.

Leaves
It has alternate leaves which are lanceolate, narrowly cuneate at the base and acuminate at the apex.

Root system
Long, fibrous root systems. Sometimes pneumatophores will arise from buried submerged roots.

Flowers
The individual flowers are found at the axils of each leaf. The flowers are borne singly at upper leaf axils. The petals are generally bright yellow to orange-yellow and elliptical.

Fruits
A thin-walled and woody cylindrical capsule containing numerous small seeds arranged in rows.

Distribution
Native to Africa, Asia and Pacific Ocean islands.

Propagation: By seeds or by stem cuttings.

Uses: *Ludwigia hyssopifolia* is used as a medicinal plant in India.

Note: The plant extract of *Ludwigia hyssopifolia* was found to have antibacterial properties.

(Top left) Ludwigia hyssopifolia *in its natural habitat. (Bottom left) The bright yellow flower of* Ludwigia hyssopifolia*. (Right)* Ludwigia hyssopifolia *growing naturally in a waterlogged area.*

(Top left) The yellow flower of Ludwigia octovalvis*, a relative of* Ludwigia hyssopifolia*. The flower petals are blunt-ended, unlike that of the* Ludwigia hyssopifolia *which are sharp-ended. (Bottom left)* Ludwigia octovalvis *planted in a waterbody at the Japanese Garden, Singapore. (Right)* Ludwigia octovalvis *growing naturally at the base of a drain. Note that its leaves are narrower and longer than that of the* Ludwigia hyssopifolia*.*

Lycopodium cernuum L.

Club Moss

Family Lycopodiaceae

Features
A herb with stiff erect stems and tiny leaves, termed microphylls.

Leaves
The scale-like leaves are soft and curved as bright yellow scales and they are arranged spirally on the branch.

Root system
Adventitious rhizomes.

Flowers
Not available.

Fruits
Not available.

Distribution
It is widely distributed globally.

The word "Lycopodium" can be loosely translated as "club-shaped wolf's claw". This genus is an ancient group of plants whose larger ancestors dominated the world's vegetation around 250 million years ago.

Phytoremediation potential: It is able to accumulate arsenic.

Propagation: By spores or by vegetative propagation.

Uses: The spores of the Club Moss are coated onto pharmaceutical pills in powder form. This helps to keep the pills from sticking to each other when they are packed together.

Note: Past research suggests that the plant is a potential source of an antibacterial agent against *Helicobacter pylori*, a bacteria that causes stomach ulcer.

The Lycopodium cernuum *plant with its scale-like leaves.*

Melastoma malabathricum L.

Sendudok

Family Melastomataceae

Melastoma malabathricum is a common native plant of Singapore and it occurs naturally in wastelands and secondary forests. The genus name means "black mouth" in Greek, which refers to the dark-coloured pulp; and the species name means "beautiful flower".

Features
A fast growing bushy evergreen shrub, up to 2 m tall, with dark green leathery foliage and contrasting red stems which are covered with bristly scales.

Leaves
The leaves, arranged in pairs on opposite sides of the stem, are usually hairy and have three prominent veins.

Root system
Well developed, extensive, strong root system.

Flowers
Bright yellow stamens with purple or sometimes white petals. Each flower has ten stamens; five of them are larger with yellow stalks and curved purple ends, and the other five are smaller with straight yellow ends.

Fruits
Blue-black fruit, which splits upon ripening to reveal black pulp in which numerous seeds are embedded.

Distribution
Native to tropical Asia, Australia and Polynesia.

Phytoremediation potential: It is able to accumulate aluminum.

Propagation: By seeds or by vegetative propagation.

Uses: This species helps to prevent soil erosion as it grows well in disturbed open-spaces around Singapore.

Note: In Malay folklore, this species is used in ceremonies to exorcise spirits. Chinese physicians value the white-flowered form for medicinal uses.

(Top left) The Melastoma malabathricum *flowers. (Top right) The flower of the white* Melastoma malabathricum *variety. (Middle left) The young plantlets of* Melastoma malabathricum *which have a tinge of purple on their new-grown leaves. (Middle right) The flower buds and fruit. (Bottom)* Melastoma malabathricum *growing in waterlogged environment.*

Mentha aquatica L.

Water Mint

Family Lamiaceae

Water Mint grows well in water. It is generally found at marshes, bogs, water courses, lakes and river shores.

Features
It is a herbaceous rhizomatous perennial plant growing to 90 cm tall. The stems are square in cross section, green or purple, and vary from being hairy to almost hairless.

Leaves
The toothed leaves are ovate to ovate-lanceolate, 2-6 cm long and 1-4 cm broad, green, and grow oppositely.

Root system
The rhizomes are wide-spreading, fleshy, and bear fibrous roots.

Flowers
The flowers are tiny, densely crowded and pink to lilac in colour.

Fruits
Not available.

Distribution
Native throughout Europe, except in the extreme north, and also found in Northwest Africa and Southwest Asia.

Phytoremediation potential: It is able to accumulate nickel, chromium and cadmium.

Propagation: By stem cuttings.

Uses: The essential oil derived from the leaves is antiseptic.

Note: This is a very useful plant for pond margins and bog gardens where it adds a splash of colour with minty scent. It also attracts butterflies.

(Top) The flowering shoots of Mentha aquatica. *(Bottom) Its white flowers.*

Monochoria hastata (L.) Solms

Arrow-Leaf Pickerel Weed

Family Pontederiaceae

This waterlogged tolerant species is an attractive ornamental plant with purple-blue flowers. This species produces numerous seeds, which are food for water birds.

Features
An emergent annual aquatic herb. The vegetative stems are often long and robust.

Leaves
Radical leaves with sheath broadened at base. The petioles are about 30-90 cm with triangular or triangular-ovate leaf blades, hastate base and acute apex.

Root system
They have well-developed and branched rhizomes.

Flowers
The flowering stems are erect and can reach 90 cm. The inflorescence of 10-40 flowers is in a dense spike of 6-9 cm long. The flowers are 13-16 mm long, and are purple or bluish in colour.

Fruits
The capsules are oblong and they contain brown seeds.

Distribution
Native to China and Southeast Asia.

Phytoremediation potential: It is able to accumulate mercury.

Propagation: By vegetative propagation or by seeds.

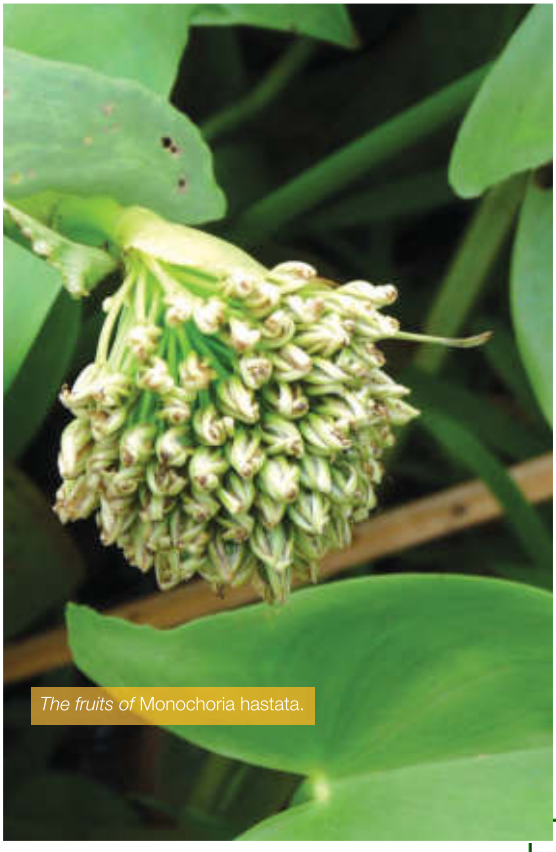
Uses: The leaves are eaten in some countries such as India and Indonesia.

Note: This species grows at a moderate rate and it requires full-sunlight condition for vigorous growth.

The habit of Monochoria hastata.

The leaf of Monochoria hastata. *Note that it is larger than the leaf of* Monochoria vaginalis *and has pointed lobes at the base of the blade.*

The inflorescence of Monochoria hastata.



The fruits of Monochoria hastata.

Monochoria vaginalis (Burm. f.) C. Presl ex Kunth

Oval-Leaf Pondweed

Family Pontederiaceae

This species can usually be found in rice fields, ditches and swamps. It can be easily confused with its close relative, *Monochoria hastata*, except that it is less robust and has narrower leaves.

Features
An emergent aquatic herb, with stems which can grow up to approximately 1.25 m long.

Leaves
The leaf blade is heart shaped with round base and acuminate apex.

Root system
The rootstocks are short, sub-erect or creeping, and spongy.

Flowers
The inflorescence of three to eight flowers is in a dense spike of 6-9 cm long. The flowers are 13-16 mm long, purple or whitish in colour.

Fruits
The capsules are ovoid to ellipsoid.

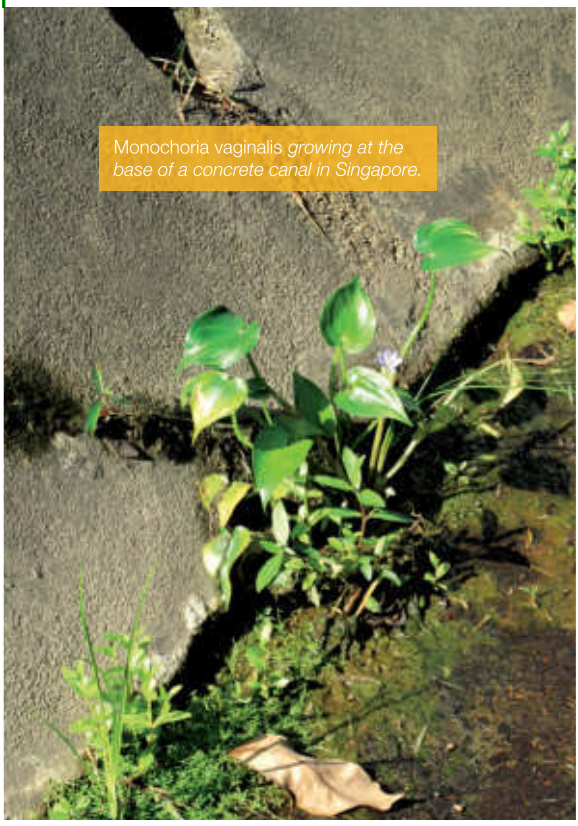
Distribution
Native to China, Southeast Asia, Africa and Australia.

Phytoremediation potential: It is able to accumulate lead and cadmium.

Propagation: By vegetative propagation or by seeds.

Uses: *Monochoria vaginalis* has been grown as an ornamental plant in our local water gardens.

Note: Typical of many aquatic annuals, the plant size, leaf shape, and flower number of *Monochoria vaginalis* are highly variable in relation to the water level.



Monochoria vaginalis *growing at the base of a concrete canal in Singapore.*

The purple flowers.

Monochoria vaginalis *growing naturally beside a paddy field in Perak, Malaysia.*

Pandanus amaryllifolius Roxb.

Fragrant Pandan

Family Pandanaceae

This is an indigenous species in the tropics. It does not require a lot of care and is seldom plagued by diseases or pests.

Features
It grows between 1-2 m tall with its main stem supported by aerial roots.

Leaves
The foliage is evergreen with slender leaves that are lush-green and smooth-edged measuring roughly 30-50 cm long. The leaves have a depressed center running from the axis outwards, and gradually flattening towards their tips.

Root system
Adventitious roots.

Flowers
The flowers are extremely rare.

Fruits
Not available.

Distribution
It is distributed over Southern India, peninsular Southeast Asia, Indonesia and Western New Guinea.

Propagation: By division of vegetative clumps.

Uses: These fragrant pandan leaves are well sought after due to their culinary usages, especially in the Asian countries of Malaysia, Indonesia, Thailand, Singapore and Sri Lanka.

Note: This plant is the only *Pandanus* species with fragrant leaves.

(Top left) The aerial roots of Fragrant Pandan. (Top right) The use of Fragrant Pandan in water landscapes at the Singapore Botanic Gardens and the Singapore Zoo (Bottom left). (Bottom right) Fragrant Pandan is used in the water feature at MacRitchie Reservoir, Singapore.

Pandanus pygmaeus Thouars

Dwarf Screw Pine

Family Pandanaceae

Pandanus pygmaeus is the smallest member of the *Pandanus* genus. It is also one of the most popular landscaping plants in the world.

Features
It is a dwarf plant which only grows to about 50 cm tall.

Leaves
The leaves are linear, and striped with green centres and bright yellow edges. The leaves are spirally arranged around the hidden stem. There are soft spines along the edges of the leaves.

Root system
Basal runners that root upon contact.

Flowers
The flowers are cream-coloured, produced in inconspicuous stalks. The male and the female flowers are found on separate plants.

Fruits
Not known.

Distribution
Native to Madagascar.

Propagation: By vegetative propagation (division or rhizome cuttings).

Uses: This species is planted as an ornamental groundcover along borders at parks and roadsides.

Note: Full sunlight is required for the yellow colour to develop on the leaves. Under shaded conditions, the leaves will become totally green.

Pandanus pygmaeus *growing beside a waterbody.*

Pandanus pygmaeus *planted in a rain garden at Balam Gardens, Singapore; (Inset) The striped leaves of* Pandanus pygmaeus.

Pityrogramma calomelanos (L.) Link

Silver Fern

Family Adiantaceae

Pityrogramma calomelanos is a fast-growing, medium-sized perennial fern that is noted for its powdery white or yellow lower blade surfaces. It is an arsenic hyperaccumulator that grows readily on arsenic-contaminated soils.

Features
It bears large tufted fronds that are erect to arching, presenting a lovely, cascading water-fountain appearance.

Leaves
The whole frond can reach up to 90-120 cm long. The blade is elongate-triangular and coloured medium to dark green on the upper surfaces. Its lower surfaces are heavily coated with a white or silvery powder called farina.

Root system
It has a short-creeping to sub-erect rhizome that is covered with brown scales.

Flowers
Not applicable.

Fruits
Not applicable.

Distribution
Native to Mexico, Central and South America, Tropical Asia, Australia and New Zealand.

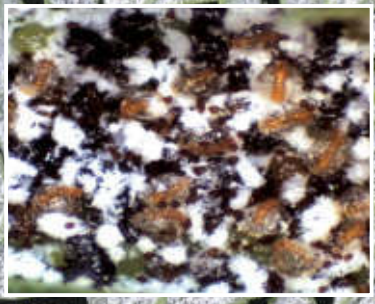
Phytoremediation potential: It is able to hyperaccumulate arsenic.

Propagation: By spores.

Uses: *Pityrogramma calomelanos* is an excellent container plant for porches, decks, patios or greenhouses. It is an ideal plant for group or mix plantings in garden borders/beds or beneath tall trees.

Note: The fronds grow with amazing perfection with as many as 30,000 regularly-spaced pinnules. It can tolerate waterlogged conditions.

The expanding young frond of Pityrogramma calomelanos.



Pityrogramma calomelanos *gets its common name from the silvery waxy powder on the underside of its frond; (Inset) The microscopic view of the sporangia of* Pityrogramma calomelanos.

Pityrogramma calomelanos *is planted with the other ferns such as* Stenochlaena palustris *and* Pteris vittata *in a water landscape at the Singapore Botanic Gardens.*

The rapid arsenic removal system uses the ability of Pityrogramma calomelanos *to hyperaccumulate arsenic in order to clean up arsenic-tainted water.*

Ploiarium alternifolium (Vahl) Melchior

Cicada Tree

Family Bonnetiaceae

Cicada tree is an attractive small tree that originates from the forest of Southeast Asia. It is a member of the small genus *Ploiarium*, which was formerly placed in the Tea Plant family

Features
A small to medium sized tree.

Leaves
The leaves are narrow with ratio of length to breadth about 5:1. The length of the leaf is about 7-10 cm long. The leaves are quite densely and spirally arranged along branches, which bear leaf scars of old leaves that have fallen off.

Root system
In swampy areas, it can develop stilt-roots.

Flowers
The small flowers (about 1.5-2 cm across) are borne on the ends of flowering branches, with five contorted petals and numerous stamens.

Fruits
The fruit is 2 cm long which splits vertically from bottom to reveal numerous seeds.

Distribution
Native to IndoChina, Malaysia, Singapore, Sumatra and Borneo.

Propagation: By seeds.

Uses: The wood of this plant is hard and heavy, and is valued for construction work.

Note: In very swampy ground, numerous slender aerial stilt-roots will grow from the trunk and descend perpendicularly to the ground.

The flowers and fruits (Inset) of Ploiarium.

Ploiarium alternifolium *planted with the other aquatic plants such as* Thalia *sp. in a waterbody.*

Ploiarium alternifolium *planted in a water feature at MacRitchie Reservoir, Singapore.*

Polygonum barbatum L.

Knotweed

Family Polygonaceae

This plant is commonly found in wetfields, along ditches and roadsides. It is commonly used in water landscaping due to its foliage and inflorescence.

Features
It is a perennial ascending herb which can grow up to 10 m long.

Leaves
The leaves are lanceolate to narrowly ovate, with acuminate apex and cuneate base. They are sometimes slightly hairy.

Root system
The roots develop from the nodes of the underground stems.

Flowers
The inflorescence is about 20 cm long. The flowers are greenish white with pink anthers. The bracts from which the flowers arise are hairy only on their edges.

Fruits
The fruits are in the form of achenes which are black, smooth, shining and about 2 mm long.

Distribution
Native to Africa, Afghanistan, India, Southeast Asia, and East Asia.

Phytoremediation potential: It is able to absorb nitrogen and phosphorus rapidly.

Propagation: By vegetative propagation (rhizomes or stolons) or by seeds.

Uses: The plant parts are used as traditional medicine in India.

Note: This species can grow either as an emergent or as a floater (in association with Water Hyacinth).

(Top left) The habit of Polygonum barbatum. *(Top right) The inflorescence of* Polygonum barbatum. *(Middle) In Mekong Delta (Vietnam) and Tonle Sap lake (Cambodia), this species behaves like a floating species in association with water hyacinth* (Eichhornia crassipes). *(Bottom) The plant performance of* Polygonum barbatum *under low level of nutrients in water was evaluated using a portable gas exchange system (Inset).*

Pontederia cordata L.

Pickerelweed

Family Pontederiaceae

The blue-violet flower spikes of this hardy water plant stand out against its glossy green, lance-shaped leaves. The Latin name of this species honours Guilio Pontedera who was a professor of botany at the University of Padua in Italy.

Features
A perennial with a cluster of erect arrowhead-shaped leaves arising from a single basal clump.

Leaves
The leaves are 10-20 cm across, shiny green and thick-spongy, standing up to 0.9 m tall on fleshy petioles.

Root system
The root system consists of long-running rhizomes and coarse fibrous roots.

Flowers
Pickerelweed produces showy 15-20 cm spires of violet-blue flowers standing on stalks of 0.6-0.9 m long. The individual flowers are about 2.5 cm across.

Fruits
The mature fruit of each flower has three cells, but only one of them develops a seed. This seed is large in size.

Distribution
Native to North and South America.

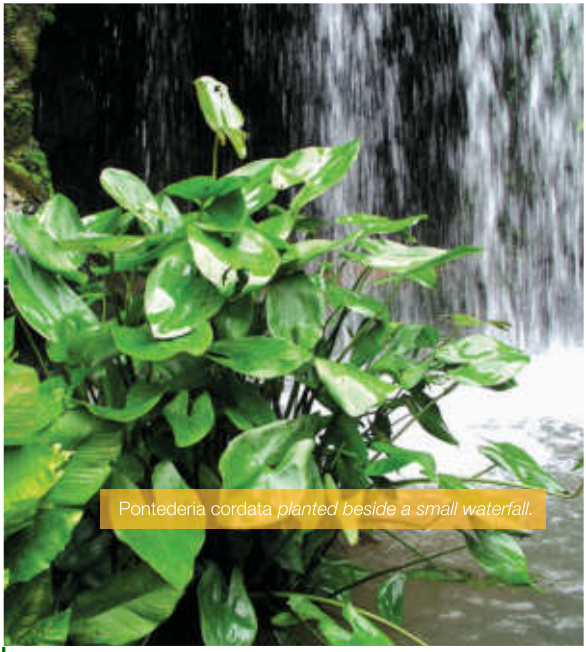
Propagation: By division of vegetative clumps.

Uses: This species is used in wetlands to treat polluted water.

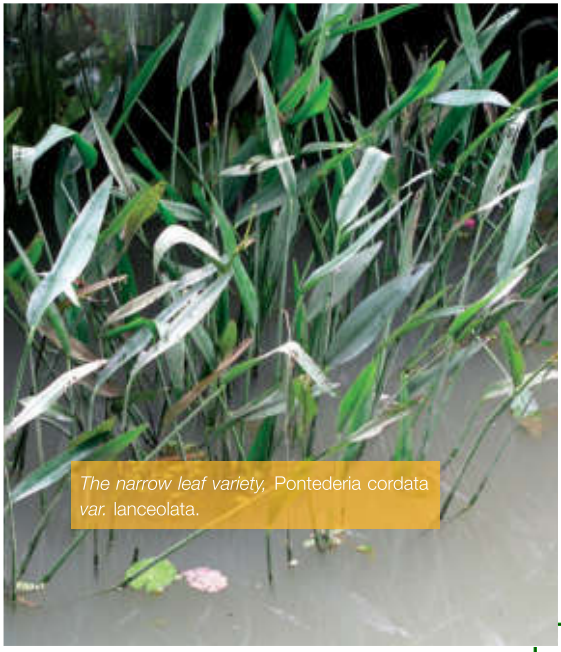
Note: Although the entire inflorescence will last for several days, each individual flower lasts only for a day.

The purple flowers of Pontederia cordata.

Pontederia cordata *is a favourite plant for water garden landscaping.*



Pontederia cordata *planted beside a small waterfall.*



The narrow leaf variety, Pontederia cordata *var.* lanceolata.

Portulaca sp.

Purslane or Portulaca

Family Portulacaceae

Portulaca flowers bloom only during the day and close at night.

Phytoremediation potential: It is able to accumulate copper. More importantly, *Portulaca oleracea* can also remove endocrine disruptors from the water.

Propagation: By seeds or by stem cuttings.

Uses: *Portulaca oleracea* has been widely cultivated as food for more than 2000 years. The juicy leaves are used in salads and cooked as a substitute for spinach. The American Indians and the Chinese also use *Portulaca oleracea* as a traditional medicinal herb.

Note: This plant usually appears in dense colonies after rain.

Features

It is a prostrate herb with fleshy, reddish stems.

Leaves

Thick, succulent leaves which are oval or lance-shaped and about 25 mm long.

Root system

The root system consists of a taproot.

Flowers

The small rose-like flowers are about 2 cm across and come in bright colours like rose pink, red, yellow, white, and orange. They occur at the leaf bases singly or in small terminal clusters. Some cultivars have double flowers that are up to 7 cm across.

Fruits

Each flower is replaced by a seed capsule that splits open around the middle to release the numerous small seeds.

Distribution

It has an extensive old-world distribution extending from North Africa through the Middle East and the Indian Subcontinent to Malaysia and Australasia.

The colourful flowers of Portulaca *sp.*

Portulaca *sp. is planted with the Bamboo Orchid* (Arundina graminifolia) *in an urban water garden (see lower right- hand side of photo).*

Pteris vittata L.

Brake Fern

Family Pteridaceae

Pteris vittata is a very efficient arsenic hyperaccumulator, i.e. arsenic is accumulated in the fronds. It was reported that the fronds can accumulate arsenic 100 times more than the concentration in the soil.

Features
Fertile fronds bear sporangia (spore producing structures) on the underside, and these spores form lines along the edge of each pinna.

Leaves
The fronds of the Brake Fern are dark green in colour and are divided only once.

Root system
Extensive rhizome system.

Flowers
Not applicable.

Fruits
Not applicable.

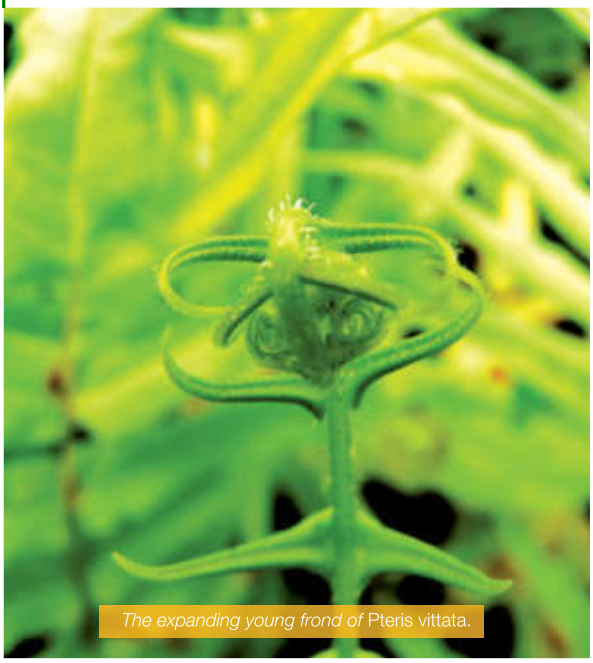
Distribution
Native to China but common in South Africa, U.S.A., Madagascar, Asia, Japan, Malaysia, and Australia.

Phytoremediation potential: It is able to hyperaccumulate arsenic.

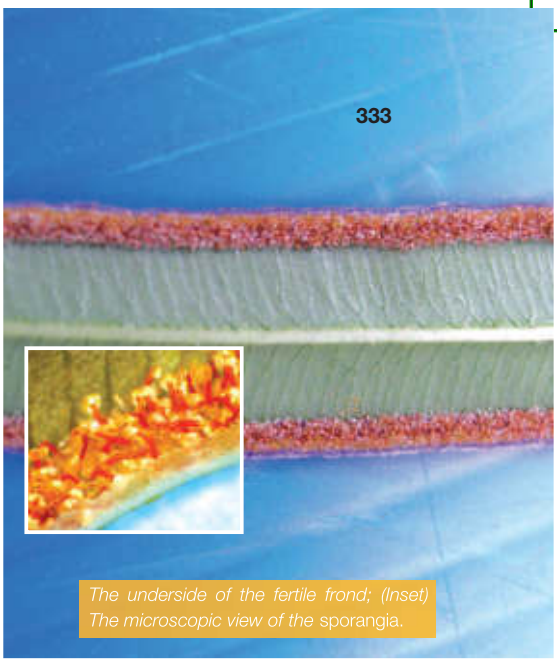
Propagation: By spores.

Uses: *Pteris vittata* is valued as a natural arsenic hyperaccumulator and is used in field based phytoremediation studies.

Note: *Pteris vittata* generally occurs in urban locations, such as on drains and old walls. It also grows in open grounds of the lowlands.



The expanding young frond of Pteris vittata.

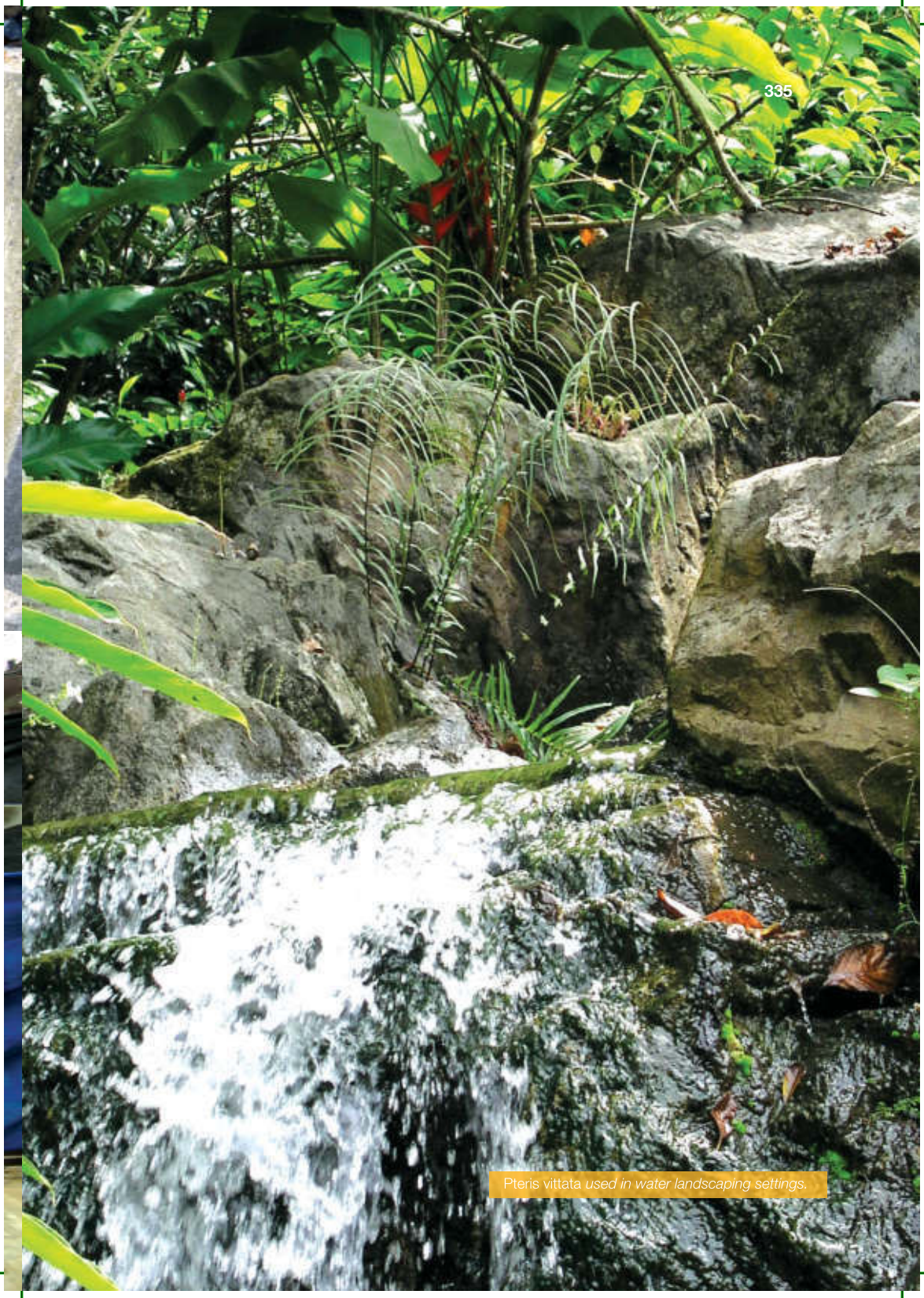


The underside of the fertile frond; (Inset) The microscopic view of the sporangia.

Pteris vittata *growing on an old concrete brick wall.*

Pteris vittata *used in a phytoremediating biotope.*

Pteris vittata *is used in the rapid arsenic removal system to purify water contaminated with arsenic (on the right of photo).* Pityrogramma calomelanos, *another arsenic hyperaccumulator species, can be used in a similar system (on the left of photo).*



Pteris vittata *used in water landscaping settings.*

Ruellia brittoniana Leonard

Mexican Petunia

Family Acanthaceae

Ruellia brittoniana has strikingly-coloured flowers which bloom attractively throughout the year. The gorgeous, funnel-shaped colourful blossoms can also attract bees and butterflies. The quantity of blossoms is related to the amount of light that the plant receives. The more direct sunlight it receives, the more flowers it produces.

Features
A tender evergreen perennial that forms colonies standing 0.9 m in height.

Leaves
The lance-shaped leaves are 15-30 cm in length and 2 cm wide.

Root system
The roots sprout from lower trunk.

Flowers
The blossoms are trumpet-shaped, about 3-5 cm in diameter and are borne at the tips of the stems. Varieties with white, pink, and many shades of blue are available.

Fruits
Inconspicuous and not showy.

Distribution
Native to Mexico.

Propagation: By seeds or by stem cuttings.

Uses: Mexican Petunia can also be grown indoors as a houseplant.

Note: This plant can tolerate a wide range of environmental conditions including variations in light, temperature and moisture. It is also an easy to grow plant that is seldom bothered by disease or pests.

Ruellia brittoniana *plants (Top left) and their shoots (Top right). (Bottom left)* Ruellia brittoniana *is also used as a roadside landscaping plant. (Middle and bottom right) The pink and purple varieties of* Ruellia brittoniana.

Sagittaria sagittifolia L.

Arrowhead

Family Alismataceae

Sagittaria comes from the latin word "sagitta", which means arrow, reffering to the characteristic leaf shape of the plants. *Sagittaria sagittifolia* is a hardy aquatic perennial which is commonly found in ponds, slow rivers and waterlogged areas. The Chinese consider the corms of *Sagittaria sagittifolia* auspicious and they are traditionally served as a delicacy during Chinese New Year.

Phytoremediation potential: It is able to accumulate cadmium, lead and zinc.

Propagation: By seeds or by underground tubers.

Uses: *Sagittaria sagittifolia* is used as an ornamental plant at the sides of water gardens as well as a bog plant.

Note: The tubers are cultivated and eaten for their high starch and protein content.

Features

This plant is a perennial marginal aquatic which can grow in still water to a depth of about 15 cm.

Leaves

The leaves are borne on triangular stalks that vary in length with the depth of the water in which the plant is growing. They do not float on the water but stand boldly above it. The arrow-shaped leaves are large and very glossy.

Root system

Creeping stolons or runners, which produce globose winter tubers composed almost entirely of starch. The root tubers are about the size of a small walnut. These underground corms are spherical, yellowish or brownish, with membranous scales on two or three rings.

Flowers

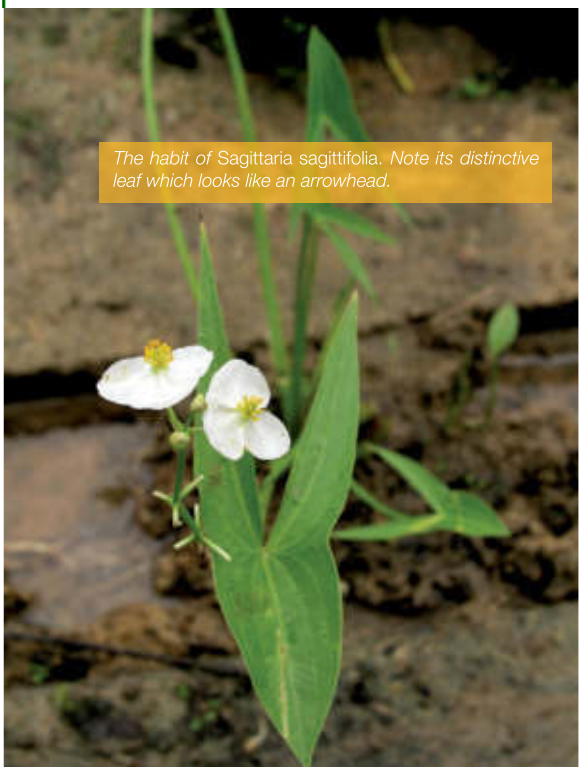
The flower-stem rises directly from the root. It bears several rings of buds and blossoms, three in each ring or whorl. Each flower is composed of three outer sepals and three large, pure white petals, with a purple blotch at their base.

Fruits

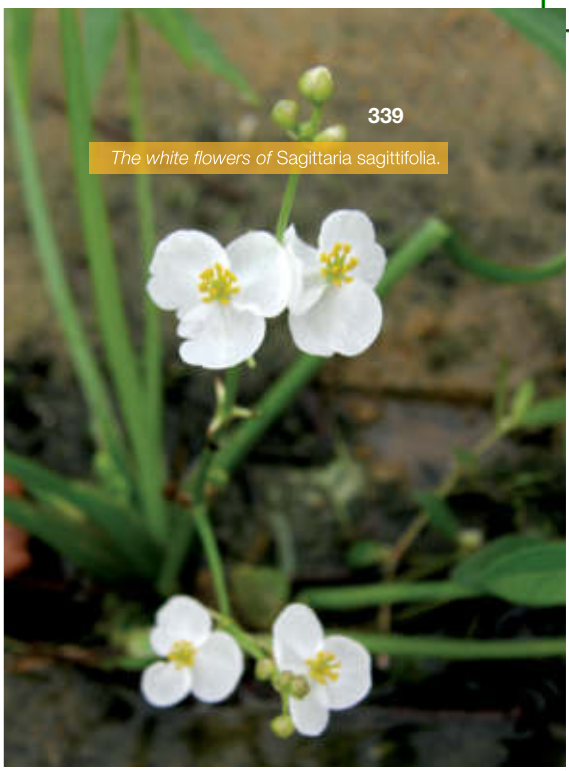
The fruit is in the form of an archene.

Distribution

Native to Europe and Northern Asia, as well as North America.



The habit of Sagittaria sagittifolia. *Note its distinctive leaf which looks like an arrowhead.*



The white flowers of Sagittaria sagittifolia.

Sagittaria sagittifolia *plants are often planted in water garden for their delicate arrow-shaped leaves.*

Scirpus mucronatus L.

Ricefield Bulrush

Family Cyperaceae

This species is also known as *Schoenoplectus mucronatus*. *Scirpus* is found widely and grows in wetlands and moist soil. Their seeds are eaten by many kinds of birds.

Features
A perennial with stout culms that are somewhat tufted, growing up to 1.5 m tall. Stems are three-angled with slightly concave sides and spongy.

Leaves
The leaves are brownish, bladeless sheaths with broadly ovate scales and a narrow green midvein. The leaves are mucronate (ending in a sharp point).

Root system
Extensive root system.

Flowers
The inflorescence is capitate, with the bract continuing beyond the inflorescence looking like a continuation of the stem. It contains 2-20 spikelets in a compact cluster. Spikelets are brownish, sessile, oblong, and many-flowered. The flowers are bisexual.

Fruits
The achene is obovoid, smooth, shining, and dark brown. It is three-angled, and two of the sides are narrower and more convex than the third.

Distribution
Found globally.

Propagation: By seeds or by division of clumps.

Uses: It is great as an ornamental plant to decorate a large pond or creek. The stems are also used for weaving and as strings.

Note: This plant is commonly planted in constructed wetlands.

Scirpus mucronatus *plants.*

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The spikelets of Scirpus mucronatus.

Scirpus mucronatus *growing in shallow water.*

Taxodium distichum (L.) Rich.

Bald Cypress

Family Taxodiaceae

The Bald Cypress belongs to an ancient group of conifers that once shared the landscape with dinosaurs. Today, they are confined to North America, and are relics of a former worldwide distribution.

Features
A large tree, reaching 25-40 m in height and with a trunk diameter of 2-3 m. The bark is gray-brown to red-brown with shallow vertical fissures and a stringy texture.

Leaves
It has compound leaves which look like feathers. They are arranged in two ranks on opposite sides of the stem.

Root system
They develop knee roots when growing in waterlogged area. Knee roots are a unique polymorphic structure of cypress trees. They start out as small swellings on the upper surface of a horizontal root and then protrude above the mud and water providing extra support.

Flowers
Not available.

Fruits
The seeds are triangular in shape.

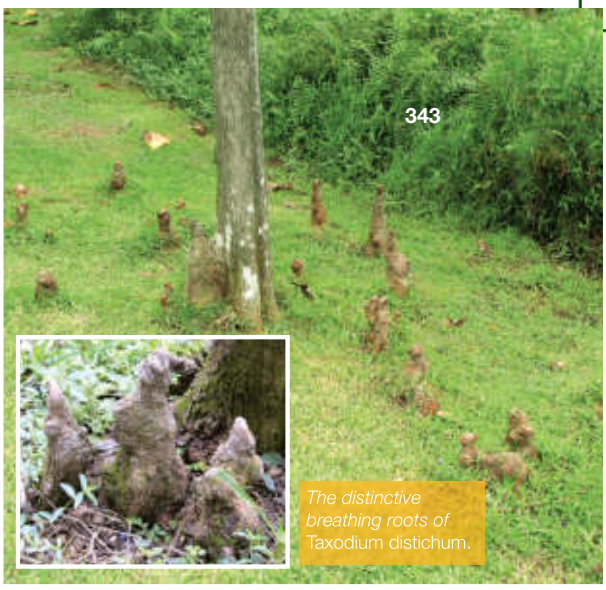
Distribution
Native to North America.

Propagation: By seeds.

Uses: This plant is cultivated for ornamental use and is best suited to wet and sandy areas. The trunk is also used for heavy construction, boats and bridges.

Note: *Taxodium distichum* wood is known as the eternal wood because it is extremely resistant to decay.

The leaves of Taxodium distichum.



The distinctive breathing roots of Taxodium distichum.

Young Taxodium *trees at Ang Mo Kio Town Garden West lake, Singapore.*

Thalia dealbata Fraser. ex. Roscoe.

Water Canna

Family Marantaceae

It is a wonderfully tall and lush plant with lance-shaped leaves and flowers which emerge at the end of a long, graceful and arching stem. The genus name honours a German botanist, Johann Thal.

Features
This is a tall, graceful, evergreen plant for growing at the sides of ponds, where it can stand up to about 1.7 m in height.

Leaves
The oval leaves are grayish green with a white dusting on the surface.

Root system
Dense root mass with a large root surface area.

Flowers
The small violet flowers bloom in summer followed by attractive seed heads. The flowers are small, purple, and quite numerous.

Fruits
Not available.

Distribution
Native to North America.

Phytoremediation potential: It is able to absorb permethrin, a chemical component in insecticide.

Propagation: By vegetative propagation (rhizomes, tubers, corms or bulbs).

Uses: *Thalia dealbata* is grown as an ornamental plant in tropical and temperate gardens.

Note: It is easy to grow on average soil with several inches of water.

Thalia dealbata *plants with Water Lily and* Cyperus haspan *var.* vivipurus *in a pond.*

The flowers of Thalia dealbata.

Thalia dealbata *and* Cyperus alternifolius *planted in a rain garden at Balam Gardens, Singapore.*

An "aquatic green hedge" is created by planting many Thalia dealbata *plants closely together.*

Thalia geniculata L.

Alligator Flag

Family Marantaceae

The common name of this *Thalia* is derived from its usefulness in "flagging" the presence of an alligator – as the alligator swims through the glade, it rustles the leaves, causing the leaves to swing back and forth.

Features
It is a large emergent that grows from a thick rhizome.

Leaves
The leaves are broadly lance-shaped, with rounded bases. The leaves grow together, sheathed at the base. The petioles and sheaths are green or occasionally red-purple and usually glabrous.

Root system
Dense root mass.

Flowers
The flowers are paired, with two flowering bracts that emerge on top of a tall flower stalk. The small purple flowers, about 2 cm long and irregular in shape, have three petals each.

Fruits
The fruit produced is a utricle with a single dark-coloured seed.

Distribution
Naturally it is found in Central Africa, United States, Mexico, Central and South America.

Propagation: By vegetative propagation (division of clumps) or by seeds.

Uses: This species is a graceful decorative plant for boggy places and shallow ponds/ pools. They serve well as accents among lower plants.

Note: *Thalia geniculata* provides cover as well as food for wetland birds.

The flowers of Thalia geniculata.

Thalia geniculata *is planted beside a pond.*

Thalia geniculata *is planted beside a small waterfall.*

Thalia *sp. is widely available in commercial nurseries.*

Typha angustifolia L.

Cattail

Family Typhaceae

This species is the only naturally occurring member of its family. The inflorescences look like brown, skewered sausages which make this species very distinctive. It is a good source of biomass for the production of biofuel.

Features
A slender perennial aquatic that grows up to 3 m tall with branched, creeping, stout rhizomes.

Leaves
The leaves are grass-like and linear, deep green in colour and sheathing at the base.

Root system
The roots are fibrous in dense mats at base of stems and from rhizome nodes.

Flowers
The inflorescences are cylindrical spikes, with the male parts separated from the female parts by a gap of 10 cm. The staminate flowers are yellowish to dark brown in colour while the pistillate flowers are reddish brown in colour.

Fruits
An achene, 5-8 mm long, with a broad and bluntly tipped apex.

Distribution
Globally distributed.

Phytoremediation potential: It is able to accumulate a range of heavy metals.

Propagation: By rhizomes or by seeds.

Uses: This plant is useful in wetland restoration, as dense *Typha* stands provide nesting sites for birds, spawning areas for fishes and protect shorelines from erosion.

Note: Most parts of the plant can be eaten.

Typha angustifolia *is a very versatile species and it can be planted in many settings: in pots (Top left), in a constructed wetland (Top right), and as a part of a water landscape (Bottom). (Inset) The fruit of* Typha angustifolia.

Typhonodorum lindleyanum Schott

Water Banana

Family Araceae

This giant swamp aroid is the only species in the genus *Typhonodorum*. It is an aquatic plant with giant spade leaves sprouting out from trunks in still water. Its appearance resembles that of the banana plant (*Musa* sp.), giving it the common name, "Water Banana". Due to its large size, this species draws attention when planted in water gardens.

Features
A large herbaceous and evergreen aquatic plant which grows up to 3 m tall.

Leaves
The leaves are large and have pointed tips. These arrowhead-like leaves are sheathed at the base.

Root system
Well-developed and extensive root system with short horizontal rhizomes.

Flowers
The unisexual flowers are in the form of spadix and are surrounded by a leafy spathe.

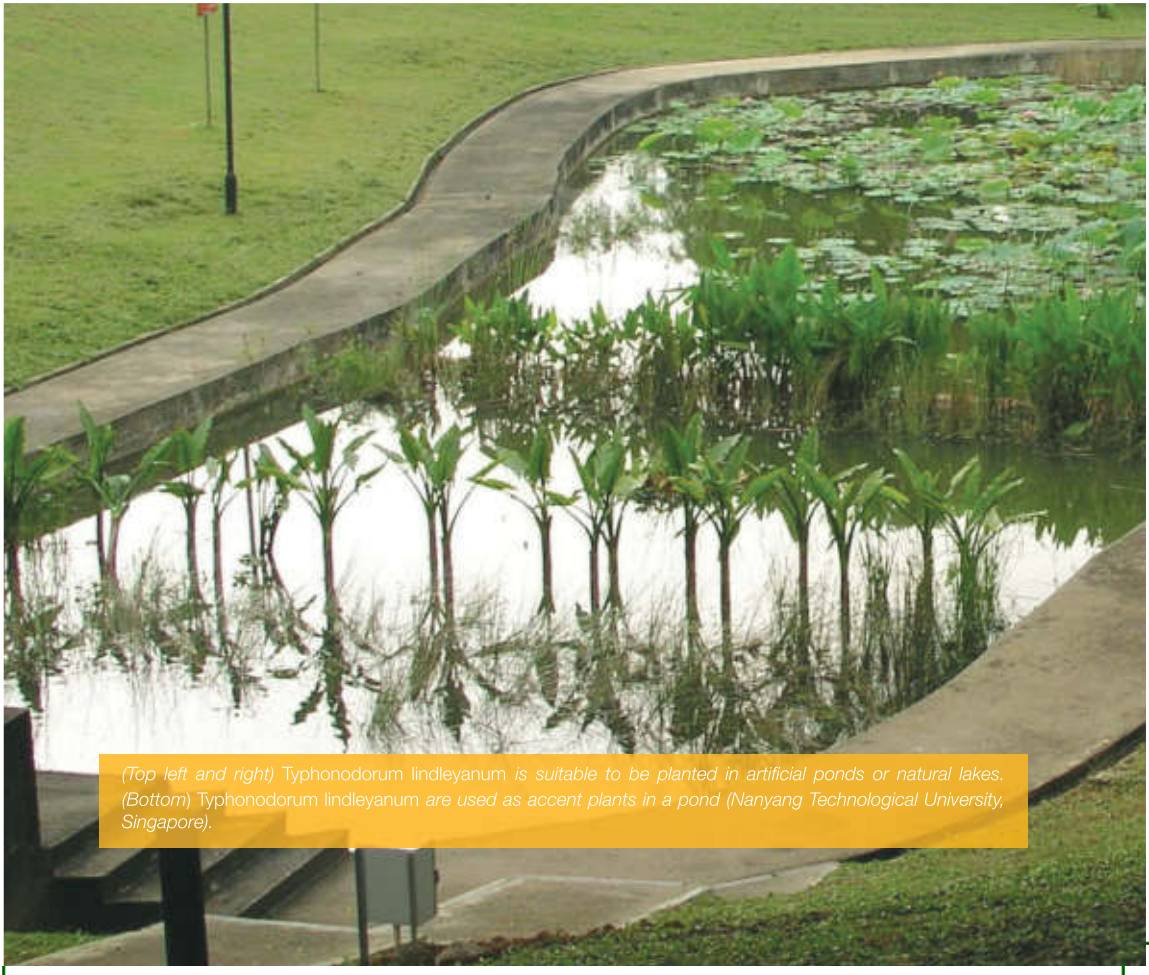
Fruits
The yellow berries are edible.

Distribution
Native to Madagascar.

Propagation: By tubers.

Uses: The fruits and seeds are harvested as food in Madagascar.

Note: The sap of the plant may cause skin irritation or allergic reactions.



(Top left and right) Typhonodorum lindleyanum *is suitable to be planted in artificial ponds or natural lakes. (Bottom)* Typhonodorum lindleyanum *are used as accent plants in a pond (Nanyang Technological University, Singapore).*

Zephyranthes candida (Lindl.) Herb.

Rain Lily

Family Amaryllidaceae

Rain Lily has an unusual characteristic of prolific flowering after rain. They can grow year-round in wet sites but tend to flower better during dry period. It is naturally found along rivers and in marshes. *Zephranthes* flowers looks similar to *Habranthus* flowers and both are called Rain Lilies.

Features
A clump-forming bulbous perennial plant.

Leaves
The leaves are deep glossy green and 3 cm wide.

Root system
Extensive root system.

Flowers
The flowers are erect in the perianth. Solitary, pure white six petalled cup-shaped flowers, 5 cm across on stems.

Fruits
The fruits are capsules with three lobes and contain numerous black seeds.

Distribution
Native to South America, which includes Argentina, Uruguay, Paraguay and Chile.

Propagation: By vegetative propagation (bulbs, division of vegetation clumps) or by seeds.

Uses: The flowers and dark green leaves make it a useful plant for edging or filling up small spaces.

Note: This species is the hardiest of the *Zephyranthes* genus and is easy to cultivate.

(Top) The habit of Zephranthes candida. *(Bottom) The flowers of* Zephranthes candida.

There is a wide range of plants which often grow naturally as emergent plants. A non-exhaustive list is provided here to illustrate the potential and the wide selection available for this group of plants.

Name	Family	Common Name	Habit
Acorus calamus L.	Acoraceae	Calamus	Herb
**Alstonia spathulata* Blume	Apocynaceae	Marsh Pulai	Tree
Alternanthera cultivars	Amaranthaceae	Alternanthera	Herb
Barringtonia acutangula (L.) Gaertn	Lecythidaceae	Indian Putat	Tree
**Blechnum indicum* Burm. f.	Blechnaceae	Swamp Water Fern	Fern
Blechnum gibbum (Lab.) Mett.	Blechnaceae	Dwarf Tree Fern	Fern
Brachiaria mutica (Forssk.) Stapf	Poaceae	Para Grass	Grass
Callistemon viminalis (Sol. Ex Gaertn.) G. Don	Myrtaceae	Weeping Bottlebrush	Tree
Celosia argentea L.	Amaranthaceae	Feather Cockscomb	Herb
Chamaedorea cataractarum Mart.	Arecaceae	Cascade Palm	Palm
Coix lacryma-jobi L.	Poaceae	Job's Tears	Grass
Costus spicatus (Jacq.) Sw.	Costaceae	Indian Head Ginger	Herb
Crataeva roxburghii R. Br.	Capparidaceae	Varana	Shrub
Crinum 'Menehune'	Amaryllidaceae	Crinum	Herb
Crinum thaianum Schulze	Amaryllidaceae	Onion Plant	Herb
Croton krabas Gagnep	Euphorbiaceae	Croton	Shrub
Cyperus aromaticus (Ridl.) Mattf & Kük	Cyperaceae	Navua Sedge	Sedge
**Cyperus compactus* Retz.	Cyperaceae	Rusiga	Sedge
**Cyperus digitatus* Roxb.	Cyperaceae	Finger Flatsedge	Sedge
Cyrtosperma johnstonii N. E. Brown	Araceae	Cyrtosperma	Shrub
**Cyrtosperma merkusii* (Hassk.) Schott	Araceae	Giant Swamp Taro	Herb
Dichromena latifolia Baldwin ex Elliot	Cyperaceae	White Bracted Sedge	Sedge
**Dillenia grandifolia* Wall. ex Hook. f. & Thoms	Dilleniaceae	Simpoh Daun Merah	Tree
**Dillenia indica* L.	Dilleniaceae	Indian Simpoh	Tree

**Dillenia reticulata* King	Dilleniaceae	Simpoh Gajah	Tree
Diospyros cambodiana Lecomte	Ebenaceae	Phtol	Tree
Dracaena sanderiana hort. Sander ex Mast.	Ruscaceae	Ribbon Plant	Herb
Dryobalanops oblongifolia Dyer	Dipterocarpaceae	Keladan	Tree
Duabanga grandiflora (Roxb. ex DC.) Walp	Lythraceae	Beremban Bukit	Tree
Elaeis guineensis Jacq.	Arecaceae	African Oil Palm	Palm
**Eleocharis dulcis* (Burm. f.) Trin. ex Hensch	Cyperaceae	Chinese Water Chestnut	Sedge
**Eleocharis retroflexa* (Poir.) Urb.	Cyperaceae	Common Spike Rush	Sedge
Eriocaulon longifolium Nees Ex Kunth	Eriocaulaceae	Pipewort	Herb
Eriocaulon truncatum Buch.-Ham. ex Mart	Eriocaulaceae	Pipewort	Herb
Eucalyptus camaldulensis Dehnh.	Myrtaceae	River Red Gum	Tree
Eucalyptus deglupta Blume	Myrtaceae	Deglupta or Mindanao Gum	Tree
Euterpe oleracea Mart.	Arecaceae	Acai	Palm
Fagraea crenulata Maingay ex C.B. Clarke	Gentianaceae	Cabbage Tree	Tree
**Fagraea fragrans* Roxb.	Gentianaceae	Tembusu	Tree
Fimbristylis globulosa (Lam.) Vahl	Cyperaceae	Globe Fimbry	Sedge
Fuirena umbellata Rottb.	Cyperaceae	Umbrella Sedge	Sedge
Glyptostrobus pensilis (Staunton ex D. Don) K. Koch	Cupressaceae	Chinese swamp pine	Tree
**Gmelina asiatica* L.	Verbenaceae	Asian Bushbeech	Shrub
Gratiola sp.	Scrophulariaceae	Hedgehyssop	Herb
**Hanguana malayana* (Jack) Merr.	Hanguanaceae	Common Susum	Herb
Helmholtzia acerifolia F. Muell.	Philydraceae	Helmhotzia	Herb
Hemigraphis alternata (Burm. f.) T. Anderson	Acanthaceae	Red Flame Ivy	Shrub
Hibiscus lasiocarpus Cav.	Malvaceae	Rosemallow	Shrub
Imperata cylindrica (L.) P. Beauv.	Poaceae	Cogongrass	Grass

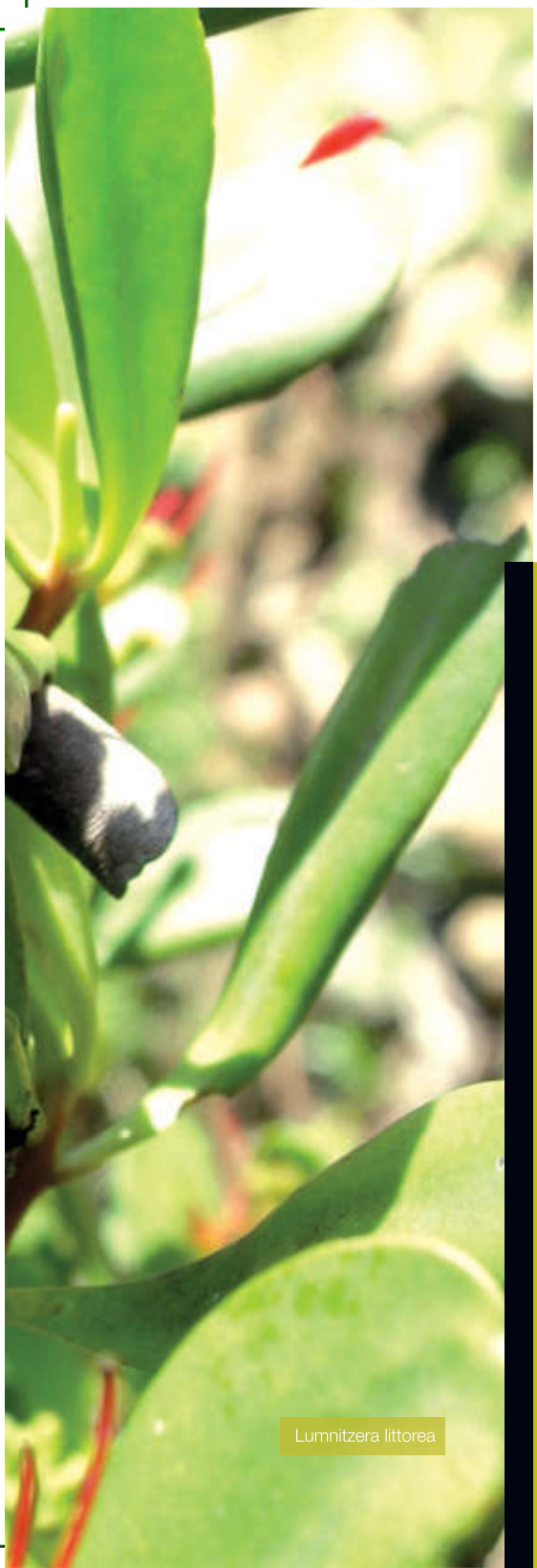
Juncus effusus L.	Juncaceae	Common Rush	Herb
Kerriodoxa elegans J. Dransf.	Arecaceae	White Elephant Palm	Palm
**Lasia spinosa* (L.) Thwaites	Araceae	Geli Geli	Herb
Leptospermum brachyandrum (F. Muell.) Druce	Myrtaceae	Weeping Tea-Tree	Tree
Licuala peltata Roxb.	Arecaceae	Licuala Palm	Palm
Licuala ramsayi (F. Muell.) Domin	Arecaceae	Australian Fan Palm	Palm
**Licuala spinosa* Thunb.	Arecaceae	Mangrove Fan Palm	Palm
Limnophila chinensis (Osbeck) Merr.	Plantaginaceae	Yellow Velvetleaf	Herb
Lindernia americana	Scrophulariaceae	Lindernia	Herb
Lobelia chinensis Lour.	Campanulaceae	Chinese Lobelia	Herb
Ludwigia octovalvis (Jacq.) P. H. Raven	Onagraceae	Primrose Willow	Herb
Lysimachia nummularia L.	Primulaceae	Creeping Jenny	Herb
**Magnolia candolii* (Blume) H. Keng var. singapurensis (Ridl.) Noot.	Magnoliaceae	Magnolia Tree	Tree
Menyanthes trifoliata L.	Menyanthaceae	Buckbean	Herb
Metroxylon sagu Rottb.	Arecaceae	Sago Palm	Palm
Miscanthus sinensis Anderss. var. *zebrinus* Beal.	Poaceae	Miscanthus	Grass
Monochoria elata Ridley	Pontederiaceae	Monochoria	Herb
Montrichardia arborescens (L.) Schott	Araceae	Moko Moko	Herb
Nepenthes sp.	Nepenthaceae	Pitcher Plant	Herb
Nymphoides peltata Kuntze	Menyanthaceae	Yellow Floating Heart	Herb
Ophiopogon jaburan (Siebold) Lodd. et al.	Ruscaceae	Lilyturf	Herb
Ophiopogon japonicus (Thunb.) Ker Gawl.	Ruscaceae	Japanese Lilyturf	Herb
Pachira aquatica Aubl.	Malvaceae	Guiana Chestnut	Tree
Persicaria hydropiper (L.) Delarbre	Polygonaceae	Water Pepper	Herb
Philydrum lanuginosum Gaertn.	Philydraceae	Frogmouth	Herb

Phoenix reclinata Jacq.	Arecaceae	African Wild Date	Palm
Phoenix roebelenii O'Brien	Arecaceae	Dwarf Date Palm	Palm
Phragmites karka (Retz.) Trin. Ex Steud.	Poaceae	Tall Reed	Grass
Phyla nodiflora (L.) Greene	Verbenaceae	Lippia	Shrub
Pteris ensiformis Burm. f.	Pteridaceae	Silver Lace/ Slender Brake Fern	Fern
**Pongamia pinnata* (L.) Pierre	Leguminosae	Indian Beech	Tree
Rhapis excelsa (Thunb.) A. Henry ex Rehder	Arecaceae	Lady Palm	Palm
Rhapis humilis Blume	Arecaceae	Slender Lady Palm	Palm
Rhynchospora corymbosa (L.) Britton	Cyperaceae	Matamat	Sedge
Roystonea oleracea (Jacq.) O. F. Cook	Arecaceae	Caribbean Royal Palm	Palm
Roystonea regia (Kunth) O. F. Cook	Arecaceae	Cuban Royal Palm	Palm
Saccharum sp.	Poaceae	Saccharum	Grass
**Schumannianthus dichotomus* (Roxb.) Gagnep	Marantaceae	Patidoi	Herb
Scirpus grossus (L. f.) Goetgh & D. A. Simpson	Cyperaceae	Coarse Bulrush	Sedge
Scirpus validus Vahl.	Cyperaceae	Soft-stemmed Bulrush	Sedge
Senna alata (L.) Roxb.	Leguminosae	Ringworm Bush	Shrub
Sesbania roxburghii Merr.	Leguminosae	Sesbania	Herb
Spathiphyllum cannifolium (Dryand.) Schott	Araceae	Spathiphyllum Lily	Herb
Sphagneticola trilobata (L.) Pruski.	Asteraceae	Pokok Serunai	Herb
Syzygium cumini (L.) Skeels	Myrtaceae	Java Plum	Tree
Terminalia cambodiana Gagne	Combretaceae	Cambodian Almond	Tree
Trimezia martinicensis (Jacq.) Herb	Iridaceae	Martinique Trimezia	Herb
Thrixspermum amplexicaule (Bl.) Rchb. f.	Orchidaceae	Trixspermum Orchid	Herb
Typha minima Funck ex Hoppe	Typhaceae	Dwarf Cattail	Herb
Vitex holadenon	Labiatae	Chaste Tree	Shrub

*Native to Singapore

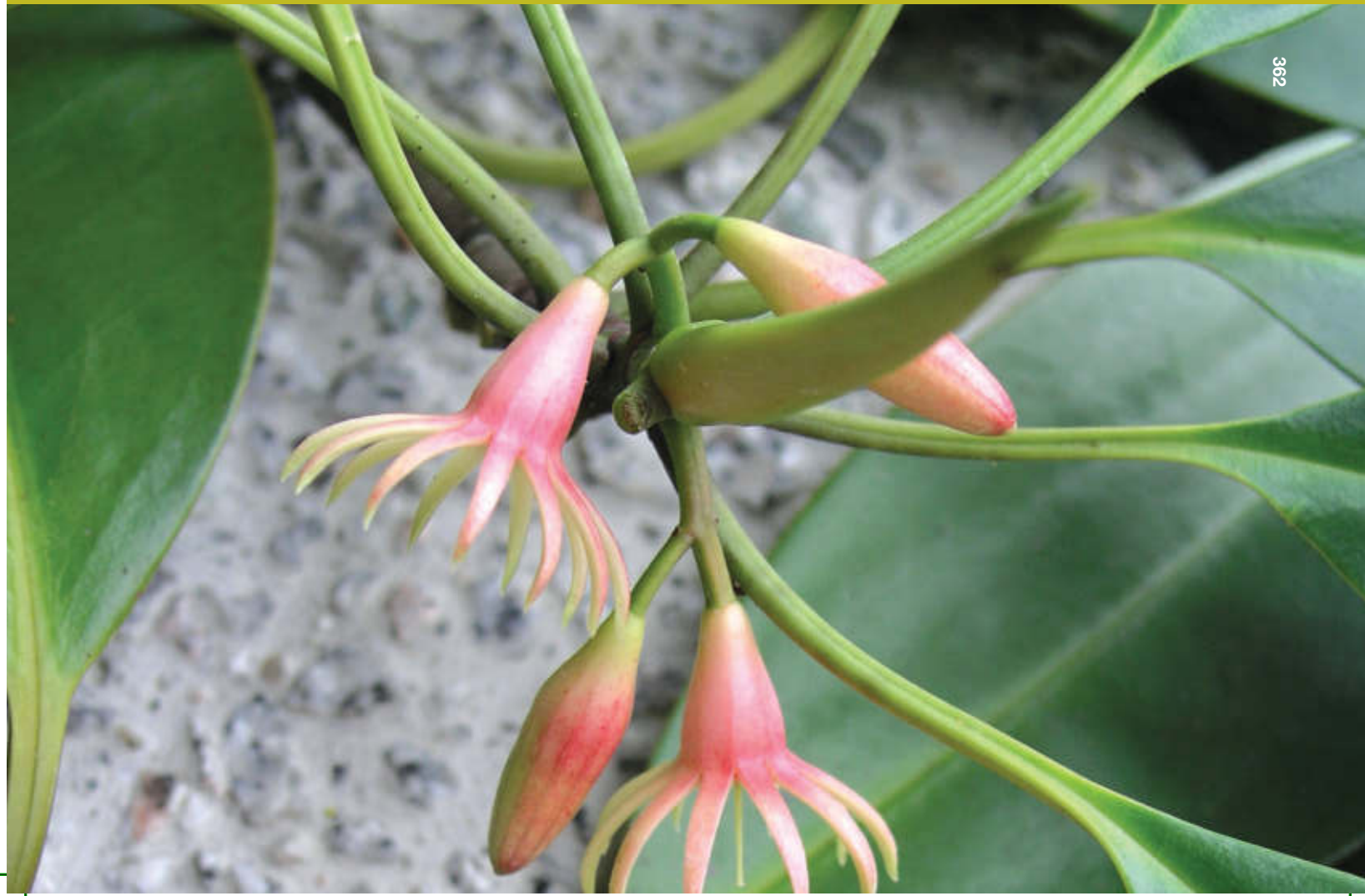
Dicaeum trigonostigma *on* Melastoma malabathricum *(Copyright: Teo Nam Siang)*

Aethopyga siparaja *on* Thalia geniculata *(Copyright: Teo Nam Siang)*



Lumnitzera littorea

Mangroves and the Other Plants of Coastal Habitat



Bruguiera hainesii *and* Bruguiera gymnorhiza

Cordia subcordata

Sonneratia caseolaris

Acanthus ebracteatus Vahl

Jejuru Hitam

Family Acanthaceae

Although *Acanthus ebracteatus* tolerates salty, seaside conditions, it needs abundant freshwater and is generally found growing along river banks subjected to tidal inundation. This species appears to be the most thorny among the three Sea Holly species.

Features
Hollow-stemmed, erect, shrubby herbs up to 1.5 m tall with many prickly, serrated-margin, sharp-pointed leaves.

Leaves
The leaf blade is dark green, stiff, and deeply lobed with sharp spines at each lobe's tip. The leaves curve in full sun but when in shade, they are flatter.

Root system
Shallow tap root system.

Flowers
The flowers grow in spikes at the branch tip. The younger petals are white, but turn brown when older.

Fruits
The capsules are squarish and slightly flattened. The capsule will explode when ripen to release the seeds.

Distribution
Native to Southeast Asia.

Phytoremediation potential: It is able to accumulate zinc.

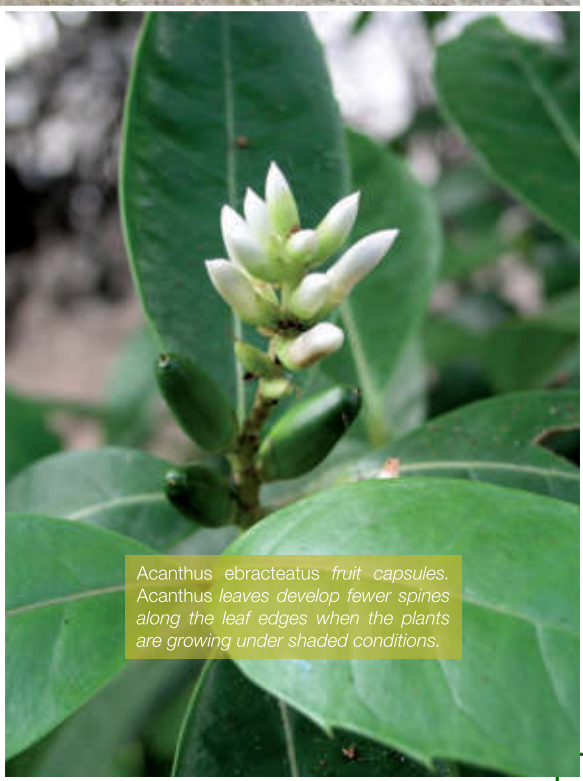
Propagation: By seeds or by cuttings.

Uses: Ground fresh bark is used as an antiseptic. The leaf extract is used to relieve rheumatism.

Note: The leaves are usually less thorny when grown in shaded areas. Forming the bushy undergrowth in the back mangroves, this species provides shelter for small creatures, as well as food for those that manage to graze on their thorny leaves.

Acanthus ebracteatus *in its natural habitat.*

Acanthus ebracteatus *inflorescence.*



Acanthus ebracteatus *fruit capsules.* Acanthus *leaves develop fewer spines along the leaf edges when the plants are growing under shaded conditions.*

The variegated form of Acanthus ebracteatus, *which can be a useful plant to add aesthetic elements to water landscaping.*

Acanthus ebracteatus *planted in fresh water at the Singapore Botanic Gardens.*

The variegated shoot.

Variegated Acanthus ebracteatus *plants are commercially available in nurseries*

Acanthus ilicifolius L.

Jejuru Putih

Family Acanthaceae

Acanthus ilicifolius is commonly seen in the back mangrove zones. Its shrubby nature and spiny leaves make it a prominent species. It is an ecologically-versatile species and flourishes on mud-flats, slopes and even ridges with different inundation and salinity.

Features
Erect herbs, up to 2.5 m tall, with spiny and often yellowish stems and leaves that resemble those of the Christmas Holly.

Leaves
The leaf blade is dark green and slightly lobed with a spine at each lobe's tip, especially under exposed conditions.

Root system
Sub-surface and aerial root system.

Flowers
The flowers are arranged in neatly organised spikes at branch tips. The flower petals are large, showy and light violet.

Fruits
The fruits capsules are squarish and slightly flattened. The fruit will explode when ripe to send its whitish, flat seeds flying up to 2 m away from the parent plant.

Distribution
Native to Southeast Asia, India, Polynesia and Australia.

Phytoremediation potential: It is able to accumulate copper, zinc and lead.

Propagation: By seeds or by cuttings.

Uses: Scientific studies have shown that *Acanthus ilicifolius* may be used as a potential chemoprotector against liver cancer (hepatic neoplasia).

Note: Although the flowers of this species are visited by sunbirds, large bees are suspected to be the main pollinators.

Acanthus ilicifolius.

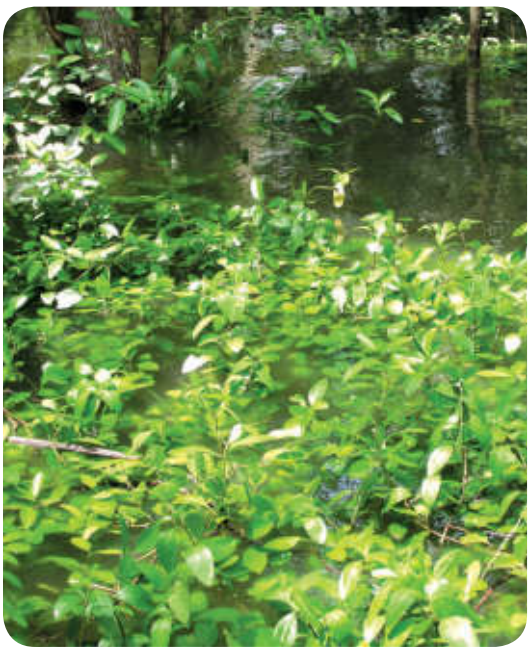
Fruit capsules of Acanthus ilicifolius.

Inflorescence of Acanthus ilicifolius.

Acanthus volubilis Wall.

Jejuru

Family Acanthaceae



This species grows slowly when compared to the other two *Acanthus* species. It is described as "unarmed" as the leaves are spineless.

Features
A semi-erect to climbing herb with thin, wiry spineless and dark-green stems.

Leaves
The leaf blades have smooth margins or can be slightly lobed. The leaves are mostly without spines.

Root system
The aerial roots emerge from the base of the lower surfaces of horizontal stem.

Flowers
The flowers are arranged in neatly organised spikes at the tip of the branches. The flower petals are white and they will turn brown when older.

Fruits
The fruits are very rare.

Distribution
Native to Southeast Asia and New Guinea.

Propagation: By cuttings.

Uses: According to Malay folklore, the powdered seeds are taken with water as a traditional blood cleansing medicine.

Note: It behaves more like a climber when compared to the other *Acanthus* species. In undisturbed forests, it may even be seen up in the mangrove forest canopies.

(Top left) The Acanthus volubilis *leaves are generally without spines. (Top right)* Acanthus volubilis *inflorescence and fruit capsules (Bottom left). (Bottom right) The comparison between the flowers of* Acanthus *species: (Top down)* Acanthus ebracteatus, Acanthus volubilis *and* Acanthus ilicifolius.

Acrostichum aureum L.

Piai Raya or Golden Leather Fern

Family Pteridaceae

Acrostichum aureum is a large understorey fern that can grow in the saline soils of the mangrove forest. It cannot tolerate constant flooding. Hence, it is often seen colonsing on the elevated ground of mud lobster mounds. Besides brackish water, it also grows in freshwater swamps and marshes.

Features
An erect fern, which forms massive tussocks of about 1-3 m tall.

Leaves
The fronds are typically dark green on top, but paler on the underside. The frond margins are somewhat uneven and wavy in appearance. The fronds measure approximately 1 m in length, and 12-50 cm in width, but they can grow up to 4 m long. There are 24-30 pairs of alternate pinnae (leaflets) that are non-overlapping. These pinnae are rounded at the tips.

Root system
Fibrous typical rhizomes which are covered with scales.

Flowers
Not applicable.

Fruits
Not applicable.

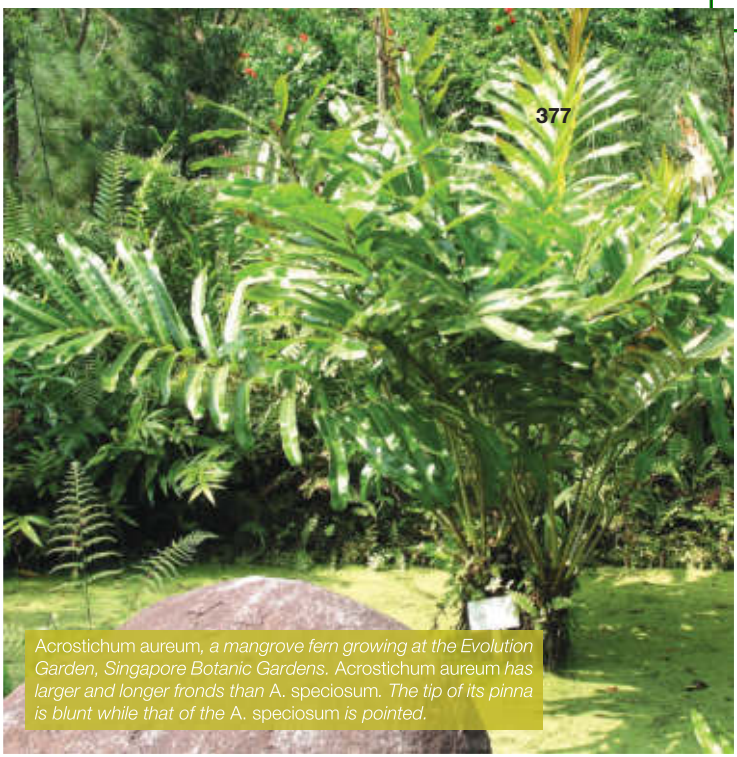
Distribution
Native to tropical and subtropical areas worldwide.

Propagation: By spores or by division of vegetative clumps.

Uses: The dried parchment-like fronds are used as roof thatching. In India, the fronds are used as a treatment for snake bites.

Note: *Acrostichum aureum* is more sun-loving compared to *Acrostichum speciosum*. Not all the pinnae on a frond are reproductive. In *Acrostichum aureum*, only five to eight pairs of the pinnae at the tip of a frond are the reproductive parts.

Unlike other ferns, the reddish brown sporangia of mangrove ferns cover the entire apical part of the underside of fertile fronds. The spores are wind dispersed.



Acrostichum aureum, *a mangrove fern growing at the Evolution Garden, Singapore Botanic Gardens.* Acrostichum aureum *has larger and longer fronds than* A. speciosum. *The tip of its pinna is blunt while that of the* A. speciosum *is pointed.*

Acrostichum aureum *in a constructed wetland park at Sengkang, Singapore.*

Acrostichum speciosum Willd.

Piai Lasu

Family Pteridaceae

Compared to *Acrostichum aureum, Acrostichum speciosum* is found in areas more frequently inundated by tides and with less light.

Features
A coarse fern that grows in large clumps in brackish swamps, often growing amongst mangroves.

Leaves
The fronds can be up to 2 m long. These fronds are made up of smaller pinnae, each up to 15 cm long. The fertile pinnae are shorter and narrower than the sterile pinnae. When fertile, the lower surface of the fertile pinnae is completely covered with dark brown sporangia.

Root system
The rhizomes bear polished, dark brown scales, up to 8 mm long, spreading onto the stipe bases.

Flowers
Not applicable.

Fruits
Not applicable.

Distribution
Native to tropical and Southeast and northern Australia.

Propagation: By spores or by division of vegetative clumps.

Uses: The pounded rhizomes are used to treat wounds and boils.

Note: Between the two mangrove fern species, *Acrostichum speciosum* is less commonly used for landscaping and horticultural purposes. This species is the preferred nest materials for the Purple Heron *(Ardea purpurea)*. These herons will nest at the base of these dense mangrove ferns.

(Top left and bottom) Acrostichum speciosum *growing on Mud Lobster mounds in a natural mangrove forest. This mangrove species is useful as an attractive green hedge when one encounters both waterlogged and deep shaded conditions during any landscaping exercises. (Top right) The pointed pinna tip of* Acrostichum speciosum.

Ardisia elliptica Thunb.

Shoe-Button Ardisia

Family Myrsinaceae

Ardisia elliptica is an evergreen tree which is shade and waterlogged tolerant. It has attractive fruits and is a popular ornamental plant.

Features
A tropical understorey shrub that can reach heights of up to 5 m.

Leaves
The leaves are oblong to oval, arranged in an alternate manner. It is smooth, leathery and pointed at its tip and is about 8-20 cm long.

Root system
It has strong taproots that produce highly branched lateral roots.

Flowers
The flowers are star-shaped (13 mm wide) and have pale violet petals.

Fruits
The fruits are round and berry-like. When the fruits are young, they are white, gradually they will turn red, dark purple and black when ripe.

Distribution
Native to the west coast of India, Sri Lanka, Indochina, Malaysia, and Indonesia.

Propagation: By seeds.

Uses: This plant is used ornamentally as a foundation shrub, specimen, screen, or hedge. It also works well in coastal areas and sand dune plantings.

Note: Seedlings and young plants can survive in deep shade conditions for several years. Whenever there is a chance, juveniles will take advantage of such breaks in the canopy layer and quickly mature to reproductive adulthood.

The Ardisia elliptica *plant (Top left), its flowers (Top right), shoots (Middle left), and fruits (Middle right). (Bottom left)* Ardisia elliptica *is waterlogged tolerant and can be planted in wet soils. (Bottom right)* Ardisia elliptica *planted as an ornamental plant at the Chinese Garden, Singapore.*

Bruguiera gymnorhiza (L.) Lamk.

Tumu

Family Rhizophoraceae

Bruguiera gymnorhiza is one of the most attractive mangrove tree species for ornamental landscaping. Past studies have revealed that this species can grow well in freshwater conditions.

Features
A tree which grows up to 15 m tall with brown to almost black bark.

Leaves
Arranged in an opposite manner, the leaves have elliptic-oblong and leathery blades. The stipules are often reddish.

Root system
Buttresses and knee roots are present.

Flowers
There is one flower per leaf angle. The sepals are shiny red in full sun and yellowish in the shade.

Fruits
The seeds germinate in the fruit. The hypocotyls can grow up to 20 cm in length and 3 cm in width. The fruits are cigar-shaped, slightly angular with a blunt narrow tip.

Distribution
Native to East Africa, Southeast Asia, southern Japan, Micronesia and Polynesia. Locally present in most sites.

Phytoremediation potential: It is able to absorb pyrene.

Propagation: By propagules.

Uses: The timber is used as firewood, charcoal, house-posts and rafters.

Note: The pneumatophores are covered with many lenticels which allow air but not water to enter the root.

(Top left) Bruguiera gymnorhiza *fruits have shiny red sepals that lie flat against the seedling (top right). (Bottom)* Bruguiera gymnorhiza *can be planted as an ornamental bonsai plant.*

Bruguiera sexangula (Lour.) Poir.

Tumu Putih

Family Rhizophoraceae

Previously thought to be extinct in Singapore, *Bruguiera sexangula* was recently rediscovered on Pulau Tekong. It is similar to *Bruguiera gymnorhiza* in its ability to grow in prolonged freshwater conditions.

Features
A tree which grows up to 12 m tall with grey bark.

Leaves
The leaves are elliptic-oblong, acute at both ends. The stipules are green to yellow green.

Root system
Buttresses and knee roots are present.

Flowers
Solitary, at the upper nodes of shoot. The flowers have calyxes 10-12 lobes are usually yellow, and have a distinct ridge on the outside.

Fruits
The fruit is fat and angular, with ridged hypocotyl (6-8 cm long), narrow at both ends. The calyx lobes are extended away from the hypocotyl.

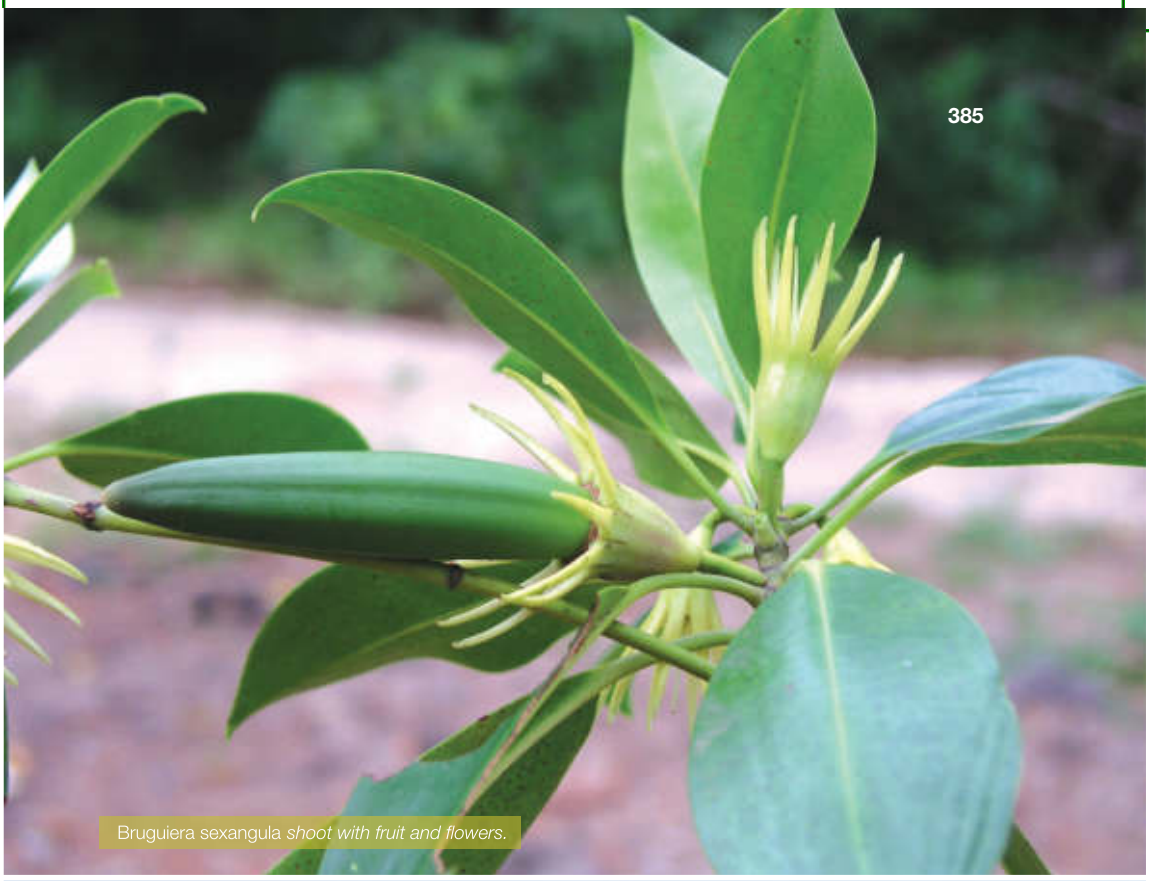
Distribution
Native to India, Sri Lanka, Southeast Asia, New Britain, East New Guinea, Australia, Philippines and China.

Phytoremediation potential: It is able to absorb cadmium.

Propagation: By propagules.

Uses: The juice from the fruits may be used to treat sore eyes, shingles or treat burns. The timber can be used as poles, firewood and made into charcoal.

Note: Sometimes mistaken for Tumu *(Bruguiera gymnorhiza)*, *Bruguiera sexangula* differs in having smaller, thinner leaves, a yellow-coloured calyx, and the flower petal tips are blunt without hairy tassels.



Bruguiera sexangula *shoot with fruit and flowers.*

The red calyx of Bruguiera gymnorhiza, *yellow calyx of* Bruguiera sexangula *and the pink calyx of* Bruguiera hainesii.

Casuarina equisetifolia L.

Common Rhu

Family Casuarinaceae

Casuarina equisetifolia is the most widespread tropical species from the family Casuarinaceae, as it is widely cultivated in many parts of the world.

Features
A gymnosperm-like tree with needle-shaped leaves.

Leaves
Fine grayish needle like leaves.

Root system
Deep fibrous root system.

Flowers
Reddish brown in the male and red in the female.

Fruits
Cone-like fruits.

Distribution
Native to Southeast Asia.

Propagation: By seeds.

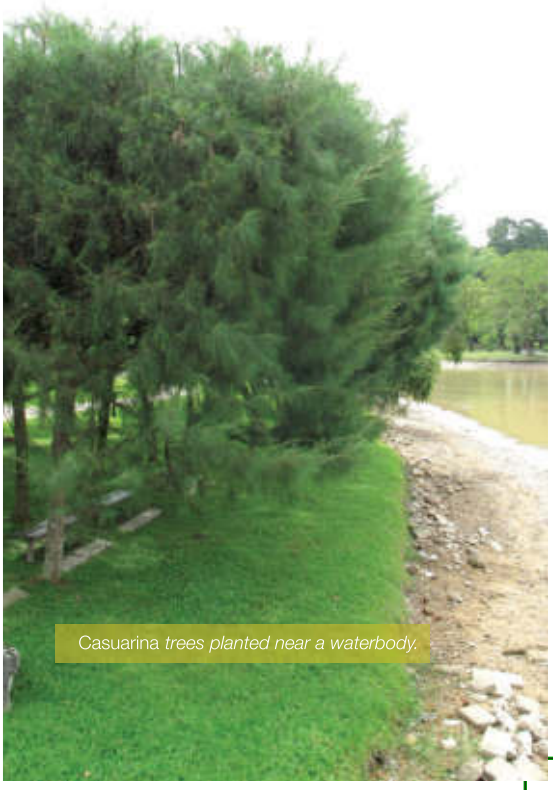
Uses: This plant is a common tropical seashore tree and is often planted as a windbreak.

Note: The species name *"equisetifolia"* refers to the resemblance of the leaves to a horse's tail.

Young Casuarina equisetifolia *plant.*

The mature and young (Inset) fruits.

Casuarina equisetifolia *as an ornamental bonsai plant (Chinese Garden, Singapore).*



Casuarina *trees planted near a waterbody.*

Conocarpus erectus L. var. *sericeus* E. Forst. ex DC.

Silver Buttonwood

Family Combretaceae

Conocarpus erectus is an ideal landscape plant for seaside plantings where it thrives with little attention. This tree is very versatile and can grow in soils with varying conditions, i.e. acidic to alkaline, clayey to sandy, and dry to wet conditions.

Features
A low branching shrub with several trunks, but can grow up to 15 m tall and 6 m wide.

Leaves
The leaves are oblong to lance-shaped and arranged alternately. They are covered with a dense mat of silky hairs which imparts a beautiful silver-gray colour to the plant.

Root system
The root system consists mainly of laterals and fine roots that are dark brown and have a corky bark.

Flowers
This plant has dense, round white flower clusters.

Fruits
The fruit is a cluster of red to brown, small scaly, two-winged cone-like seeds (5-15 mm long). The seed heads burst when ripe, and the seeds are dispersed by water.

Distribution
Native to shorelines in tropical Americas.

Propagation: By cuttings or by seeds.

Uses: This species is ideal as an informal hedge or as a specimen tree. Silver Buttonwood, with its small, silver leaves and contorted trunk, is also a favourite subject for bonsai.

Note: It is a hardy tree and does well in urban setting. It can be planted along carparks and along streets, where air pollution, compacted soils and poor drainage would preclude other trees.

The distinctive silver leaves of Conocarpus erectus.

Its brown fruits.

Conocarpus erectus *can be planted on a floater which will allow it to perform phytoremediation in a freshwater body.*

Crinum asiaticum L.

Crinum Lily

Family Amaryllidaceae

Crinum Lily is found both in mangroves and coastal forests. There are only two wild populations left in the northern and western regions of Singapore. However, it is widely planted as an ornamental for its attractive form and flowers.

Features
A large plant that may reach 2 m in height.

Leaves
The dark green strap-like leaves are held erect and arranged in a spiral rosette to form clumps up to 1.5 m in height by 2 m in width.

Root system
Extensive root system when fully grown.

Flowers
Each flower is about 20 cm across in diameter, with six white, elongated lobes connected to a narrow tube. The flowers grow together in a bunch on the top of a long, thick stalk.

Fruits
The fruits resemble greenish-white eggs, each containing one to a few seeds.

Distribution
Native to Singapore, Malaysia and parts of Indonesia.

Phytoremediation potential: It is able to accumulate selenium.

Propagation: By division of the bulbs.

Uses: *Crinum asiaticum* has high ornamental value due to its attractive leaves and flowers. Furthermore, this impressive plant is easy to grow and requires little care.

Note: The bulb from which the whole plant grows may weigh 5-9 kg. The leaves and bulb contain lycorine, an alkaloid which is used as an emetic (to induce vomitting).

(Left) The large Crinum asiaticum *together with its white flowers are very attractive when planted in a garden* (Copyright: Patricia Yap)*; (Inset) the fruits. (Right) The flowers of the different varieties of* Crinum *sp.*

(Top left) Crinum asiaticum *used in landscaping. (Bottom left) The yellow variety of* Crinum asiaticum *brings colour diversity to the garden. (Right)* Crinum *sp. is widely available in the nurseries.*

Cryptocoryne ciliata (Roxb.) Fischer ex Wydle

Ciliata

Family Araceae

Cryptocoryne ciliata is one of the few species of *Cryptocoryne* that grows well in brackish water. It naturally inhabits tidal areas alongside other mangrove species.

Features
A marsh plant with large, thick leaves and tall thick stems.

Leaves
The long leaf petioles are leathery. The leaves are lanceolate in shape and the edges are slightly wavy.

Root system
It produces runners.

Flowers
The flowers give off a pumpkin-like smell.

Fruits
The compound fruit is nearly spherical and splits open to reveal large, green, fleshly, oval seedlings.

Distribution
Native to India, Southeast Asia and New Guinea.

Propagation: By runners.

Uses: *Cryptocoryne ciliata* has a high tolerance to a wide range of water conditions; hence, it can be cultivated and sold as an ornamental plant.

Note: It prefers a nutrient rich soil.

The natural habitat of Cryptocoryne ciliata *beside a stream. (Inset)* Cryptocoryne ciliata *(Copyright: Lo Shiang Huei).*

This species is also tolerant of salty waters and can grow with the mangrove palm Nypa fruticans *under certain environmental conditions.*

Dolichandrone spathacea (L. f.) K. Schum.

Mangrove Trumpet-Tree

Family Bignoniaceae

Listed as a critically endangered species in Singapore, several of these beautiful trees have now been replanted at Sungei Buloh Wetland Reserve.

Features
A small tree which grows up to 5 m tall.

Leaves
The pinnate leaves are made up of two to four thin leaflets of 6-20 cm long and arranged opposite to one another. The young leaves are slightly pinkish.

Root system
The roots are anchored.

Flowers
The trumpet-shaped white flowers are around 15-20 cm long.

Fruits
The fruits are about 45 cm in length which are flattened and curved like a bean pod. The seeds are rectangle and square in shape.

Distribution
Native to South and Southeast Asia.

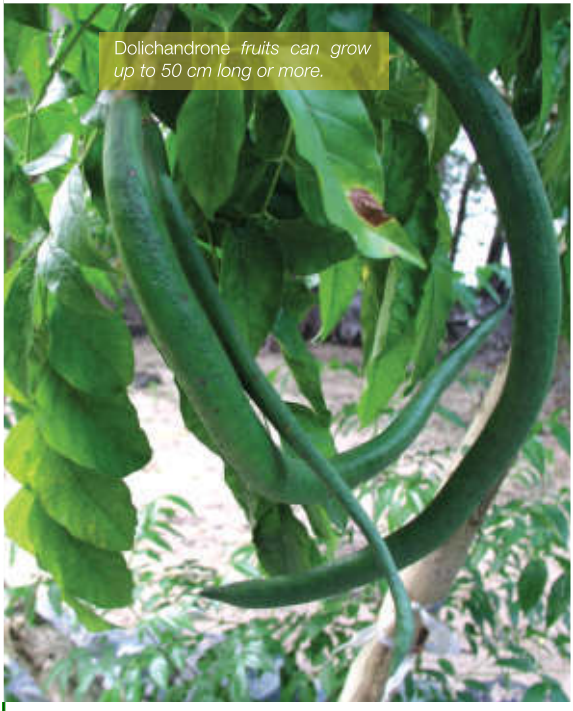
Propagation: By seeds.

Uses: The wood is used to make firewood, clogs, wooden shoes, the traditional "wayang kulit" masks and saddles.

Note: As the nectar is accumulated at the bottom of the trumpet shaped flower, the only pollinator which can get to the nectar is the Long Tongue Moth.

The habit of Dolichandrone spathacea.

The shoot of Dolichandrone spathacea.



Dolichandrone *fruits can grow up to 50 cm long or more.*

The buttress root of Dolichandrone spathacea.

Ipomoea pes-caprae (L.) R. Br.

Sea Morning Glory

Family Convolvulaceae

Pes means “foot”, and caprae means “goat”; the name refers to the shape of the leaf which is unlike any other terrestrial Morning Glory plants. The leaves are notched at the apex, creating two equal lobes which must have looked like the imprint of a goat’s foot to Professor Linnaeus who named the plant.

Features
An evergreen vine with a large, thick root that can be 3 m long and 5 cm in diameter.

Leaves
The leaves are alternate and can reach 10 cm in length. Each leaf is rounded and not toothed but is usually folded on the mid-vein and may be notched at the apex.

Root system
The stem runs along the ground, rooting at the nodes. The roots are thick and adventitious.

Flowers
The funnel-shaped flowers are pink or lavender purple in colour. They are about 5 cm long.

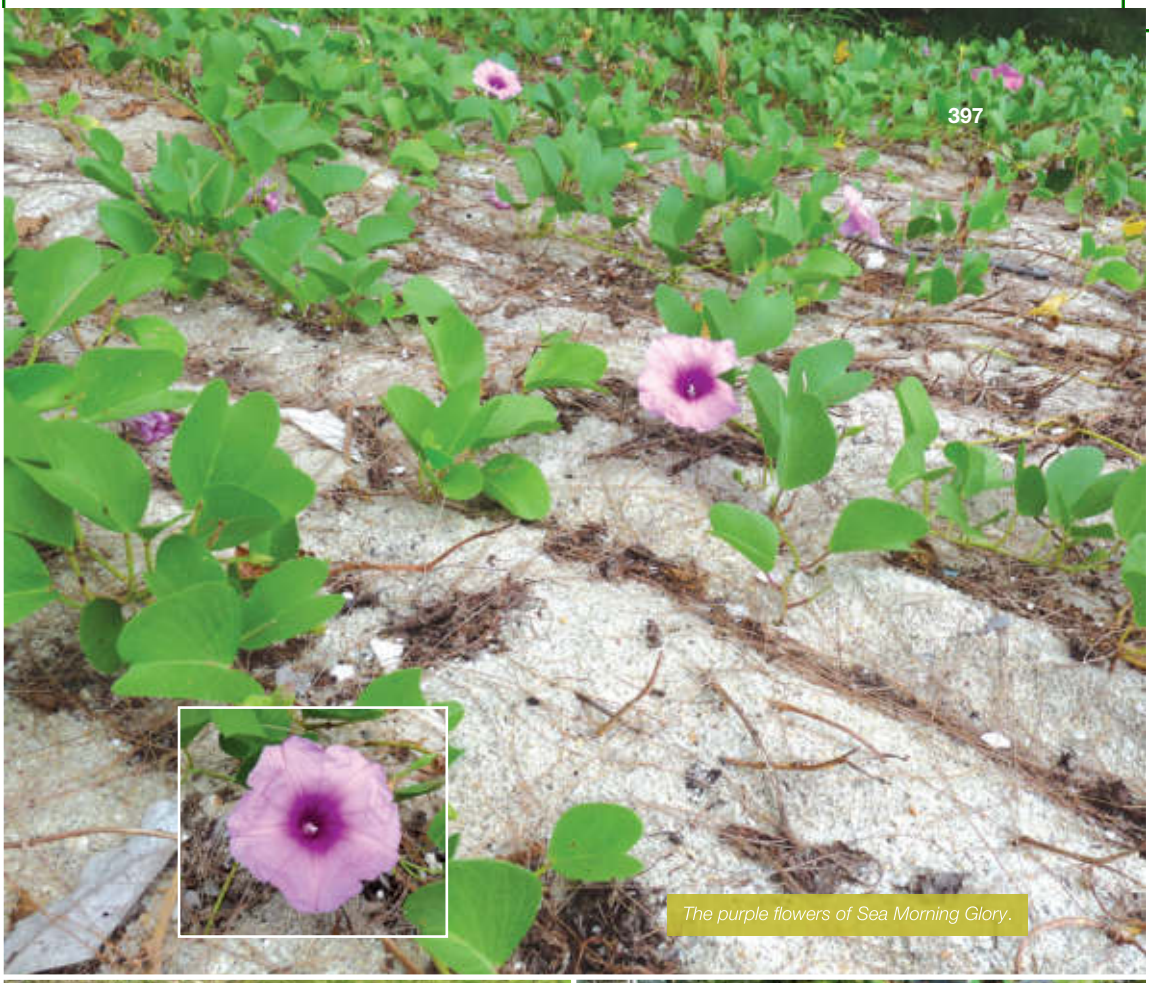
Fruits
The fruits are small, round, dry capsules, and each contains four black seeds with dense hair.

Distribution
Native to coastal areas in tropical regions worldwide, ranging from Somaliland to tropical Asia.

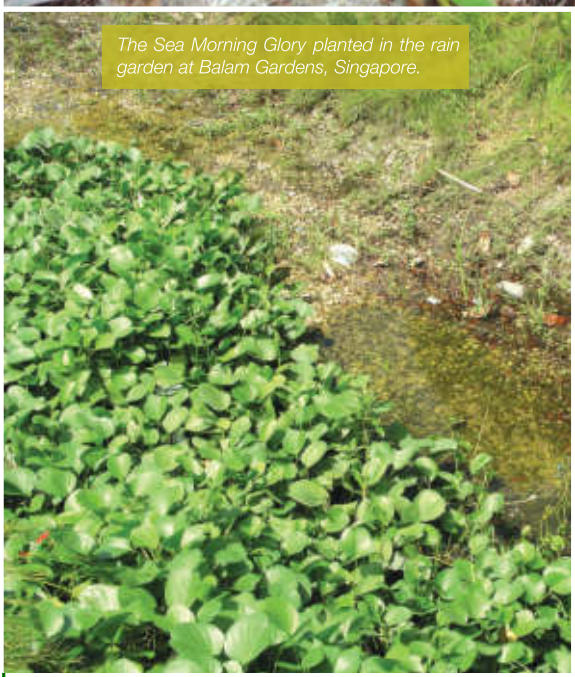
Propagation: By cuttings or by seeds.

Uses: It is used as a sand binder for windswept beaches. Its ability to stabilise sand dunes is the first line of defense against damaging storms. The seeds are reported to be a good remedy for stomach-ache and cramps.

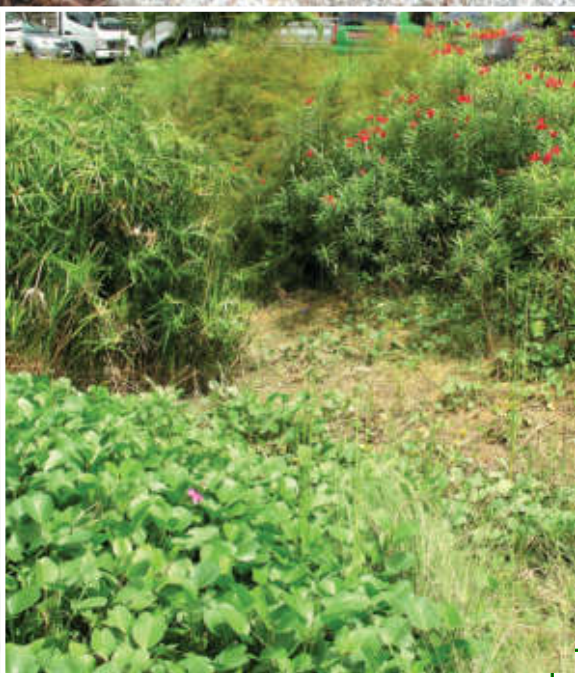
Note: The Sea Morning Glory is known to recover well following hurricanes and tropical storms which sometimes inundate beach areas with seawater and heavy winds.



The purple flowers of Sea Morning Glory.



The Sea Morning Glory planted in the rain garden at Balam Gardens, Singapore.



Lumnitzera littorea (Jack) Voigt

Teruntum Merah

Family Combretaceae

Lumnitzera littorea, a non-viviparous mangroves species, is one of the most aesthetically-pleasing trees in the mangrove habitat. The flowers are frequently visited by birds, bats and bees for nectar. This species is increasingly used for ornamental purposes as it is able to grow under freshwater conditions and can even be cultivated successfully as a bonsai.

Features
A tree with buttresses which can grow to about 8 m tall. It has fissured dark brown bark.

Leaves
The small alternate leaves, which are almost stalkless, are light green and narrowly drop-shaped. These fleshy leaves grow to about 7 cm long with an indentation at the end.

Root system
Above-ground roots are not usually present, though small knee type above-ground roots may be present.

Flowers
Bright red flowers, growing at the leaf angles.

Fruits
The fruit is about 2 cm long, green and capsule-shaped.

Distribution
Native to East Coast of Africa, Southeast Asia, Australia and Polynesia.

Propagation: By seeds or by cuttings.

Uses: The wood is used as firewood, timber; and for building bridges, wharves and flooring. The leaves are used as a remedy for sprue.

Note: In China, *Lumnitzera littorea* is an endangered species, restricted to small regions of Hainan Island.

(Left) Lumnitzera littorea *has bright red flowers. (Right) The fruits of* Lumnitzera littorea.

Lumnitzera littorea *can be planted under freshwater conditions: (Left) it is planted as a bonsai plant due to its lovely red flowers; (Right) it is planted in the Kallang River, near Kolam Ayer, Singapore.*

Lumnitzera racemosa Willd.

Teruntum Bunga Putih

Family Combretaceae

This plant is a non-viviparous mangrove species and the seeds are similar to those of terrestrial plants. It is normally propagated by commercial nursery using seedlings and wildlings.

Propagation: By seeds or by cuttings.

Uses: The main trunk provides a hard and durable timber and is used for wooden house construction. It is also sometimes used in boat building. It is considered as excellent firewood, and high quality charcoal is prepared from larger stems.

Note: *Lumitzera racemosa* is an ornamental plant because of its beautiful white flowers and conical crown. The germination rate of the seeds decreases with increasing salinity.

Features
Similar to *Lumnitzera littorea*, except that this plant is usually smaller and grows up to about 4 m tall only.

Leaves
The leaves are succulent and small, up to 4 cm in length, 2 cm in width and are bright green. The shape is obovate, which is broadest above the middle of the leaf, and the apex is rounded or emarginated with an indent at the tip of the leaf. The petiole is often absent and leaves are sessile.

Root system
No well-developed above ground root system was observed but in moist environments, small looping lateral roots may develop.

Flowers
The flowers are up to 1 cm in length, exhibiting five small white petals arranged alternately to its sepals.

Fruits
The fruit is fleshy and flattened while on the tree, but fibrous after floating in water. The fruits are about 2 cm long, green and capsule-shaped. The mature fruits are brown in colour.

Distribution
This species can be found from eastern Africa to the Western Pacific to Southeast Asia, Australia and Polynesia.

The flowering shoots (Top left) and the white flowers (Top right) of Lumnitzera racemosa*. (Middle left) Caterpillar feeding on the flower. (Middle right) The trunk and roots of* Lumnitzera racemosa*. (Bottom) The white flowers of* Lumnitzera racemosa *and red flowers of* L. littorea.

Melaleuca cajuputi Powell

Gelam

Family Myrtaceae

Melaleuca cajuputi is the source of the essential oil, cajuput or cajeputol. It has been cultivated in Asia for several centuries for oil production.

Features
A big tree which can grow up to 20 m tall. The trunk is often twisted with the light brown bark becoming flaky.

Leaves
The leaf blade is dark green and slightly lobed with a spine at each lobe's tip, especially under exposed conditions.

Root system
Extensive root system, sometimes it will develop aerial adventitious roots.

Flowers
The inflorescence spikes are white and feathery and densely flowered. The flowers are in triads and have five petals.

Fruits
The fruits are capsular.

Distribution
Native to Indochina, Malesia and Australia.

Propagation: By seeds.

Uses: The oil extracted from the leaves is traditionally used as medicine to treat a wide range of diseases, such as gout, rheumatism, cholera and wounds.

Note: This waterlogged tolerant plant is primarily found in coastal areas of the hot humid tropics.

(Top left) The leaves of Melaleuca cajuputi *are elliptic with pointed tips, which resemble those of* Acacia *sp. (Top right) The distinctive flaking bark of* Melaleuca cajuputi*. (Left) The inflorescence and fruit capsules (Inset) of* Melaleuca cajuputi*. (Right) The* Melaleuca cajuputi *plants are commonly planted beside a waterbody as they are waterlogged tolerant plants.*

Nypa fruticans Wurmb

Nipah Palm

Family Arecaceae

This palm forms dense growths in brackish water especially along river banks throughout Southeast Asia. It is common in Singapore, where its characteristic fruits can be seen along the shore.

Features
A plant which has a creeping, horizontal stem from which the branches with erect tips arise.

Leaves
Feather-like fronds, up to 9 m long, forming a rosette at each branch tip.

Root system
No above ground roots.

Flowers
Globular inflorescence of female flowers at the tip, with catkin-like red or yellow male flowers on the lower branches.

Fruits
The fruits are woody, flattened sideways and ridged lengthwise, bearing one to three seeds each. The fruits grow in bunches.

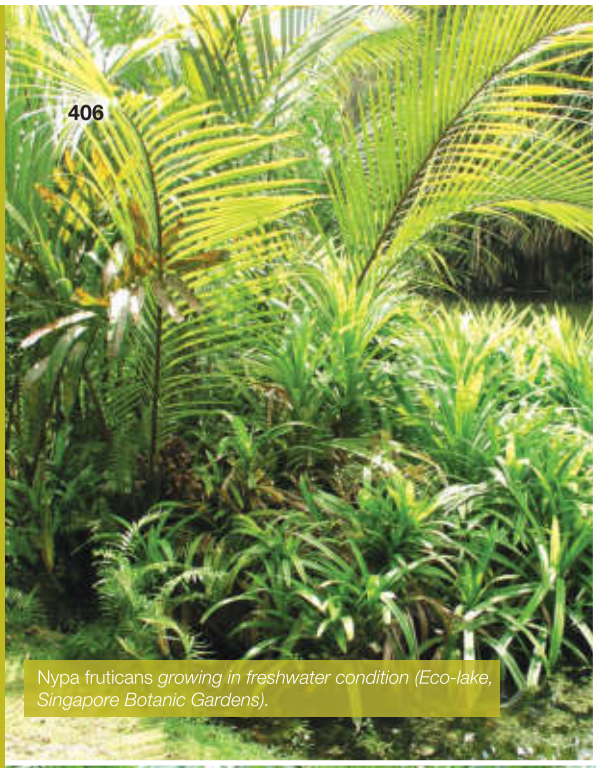
Distribution
Native to the coasts and rivers flowing into the Indian and Pacific Oceans, from Bangladesh to the Pacific Islands.

Propagation: By seeds.

Uses: Mature leaves are used in the making of thatched roofs. The sap from the inflorescence can be boiled down to palm sugar (gula Melaka). Its seeds are made into a sweet preserved food commonly known as “attap chee” used in a local dessert.

Note: This palm protects the land after storms as new fronds emerge quickly after being damaged.

(Top) A pure stand of Nypa fruticans *at the beach. (Middle left) The inflorescence of the* Nypa fruticans*. (Middle right) The fruit of* Nypa fruticans *is an aggregate of 40-60 woody drupes and it is dispersed by water. (Bottom left) The seed is made into a local delicacy called "attap chee".*



Nypa fruticans *growing in freshwater condition (Eco-lake, Singapore Botanic Gardens).*

Nypa fruticans *is planted as an ornamental plant, together with Water Lily in an urban setting (Ho Chi Minh City, Vietnam).*

Nypa fruticans *plants occur naturally under freshwater conditions with* Eichhornia crassipes *in the Mekong Delta area (Vietnam).*

Small rivers lined with Nipah Palms are common throughout the Mekong delta region

Pandanus tectorius Parkinson

Screw Pine

Family Pandanaceae

Pandanus tectorius is one of the most useful trees to Pacific Islanders. The leaves are woven or plaited into mats, thatch, sails, baskets, hats, local fans, etc. They occur naturally at coastal regions, such as mangrove margins and beaches.

Propagation: By stem cutting.

Uses: The Screw Pine is widely planted as an ornamental plant in home gardens. In the island countries of the Pacific where it is too dry to cultivate breadfruit and most root crops, the fruit serves as an important source of carbohydrate.

Note: *Pandanus tectorius* trees are either male or female.

Features

A small tree that grows up to 6-9 m in height and 4-5 m in diameter. The trunk is stout and the branches grow at wide angles to it.

Leaves

The distinctive, long blade-like leaves are about 5 cm wide and over 0.5 m long. Most varieties have spines along the edges and on the midribs of the leaves. The leaves are spirally arranged towards the ends of the branches.

Root system

Thick, slightly spreading prop roots originating from the lower part of the trunk.

Flowers

The flowers are dioecious (the plant only bears either female or male flowers). The male flowers are tiny, fragrant and surrounded by white to cream colored bracts. The female flowers are pineapple-like.

Fruits

The fruit is a round or oval head consisting of numerous segments called drupes. The color of the fruit ranges from yellow to orange to reddish when ripe.

Distribution

Native throughout the Pacific islands and parts of Southeast Asia and northern Australia.

(Top) Pandanus tectorius *growing in brackish water. (Bottom left) The male inflorescence of* Pandanus tectorius*; (Inset) The small white male flowers arranged in racemes. (Bottom right) The ripe fruits of* Pandanus tectorius*.*

Pandanus tectorius *planted in a constructed wetland at Commonwealth Secondary School, Singapore.*

The variegated form of Pandanus tectorius *is commonly used for landscaping.*

Pandanus tectorius *and its variegated form at the Singapore Botanic Gardens*

Phoenix paludosa Roxb.

Mangrove Date Palm

Family Arecaceae

Phoenix is a genus with 13 species of palms. This genus is unique among the other palms of the subfamily Coryphoideae in that the *Phoenix* species have pinnate rather than palmate leaves. *Phoenix paludosa* or Mangrove Date Palm is indigenous to the coastal regions of South and Southeast Asia. It can be found in the inland margin of the mangrove forest, which is usually dominated by *Nypa fruticans*.

Features
A medium sized palm with a long blackish strip on the petiole and sheath. It grows in swampy jungles up to 4 m tall.

Leaves
The arching leaves are 2-3 m long, with narrow, drooping leaflets that are light green on top and grayish below.

Root system
Thin knee-like pneumatophores.

Flowers
The flowers have three lobes and three petals.

Fruits
The dense cluster of fruits are berry-like, fleshy and purple to black in colour.

Distribution
Native to southern Asia.

Propagation: By seeds.

Uses: No known use.

Note: This is one of the least commonly grown *Phoenix* in cultivation.

Phoenix paludosa *growing along the river.*

Phoenix paludosa *and other mangrove plants.*

Fruits of Phoenix paludosa.

Podocarpus polystachyus R. Br. ex Endl.

Sea Teak

Family Podocarpaceae

This beautiful tree has reddish brown bark which contrasts with the light-green new leaves and the darker green mature leaves. The cream-coloured male cones resemble miniature corn-cobs, after which this gymnosperm is botanically named.

Propagation: By stem cuttings or by seeds.

Uses: The timber, called podo wood, is commercially exploited. The pale fawn, moderately hard timber, is particularly suitable for house-building or cabinet work. The tree is also planted ornamentally as a bonsai.

Note: Once pollinated, each female cone consists of a fleshy base which will turn dark red when ripe. This rich colouration attracts birds which will eat the cone and scatter the seeds.

Features
The trees are 1-20 m tall and the bark is reddish brown and narrowly fissured.

Leaves
The leaf blades are long and narrow in young plants, and oval-shaped in older plants.

Root system
Buttress roots.

Flowers
Each tree produces cones rather than flowers. Male plants produce clusters of cream-coloured cones which shed whitish, powdery pollen. Female plants produce a highly modified cone consisting of a fleshy receptacle and ovule.

Fruits
The berry-like female fruits are swollen and brightly coloured in red or purple.

Distribution
Native across the region, from southernmost Thailand and Peninsular Malaysia, through the Riau Archipelago to Borneo, the Philippines, the Moluccas, West New Guinea and Taiwan.

(Top left) The Podocarpus polystachyus *planted in Singapore Botanic Gardens. (Top right) The shoots of* Podocarpus polystachyus*. (Bottom left) The male stobili of* Podocarpus *sp. (Bottom right) The female cones of* Podocarpus *sp. Each female cone has a fleshy base which turns dark red when ripe.*

(Top) Podocarpus *sp. is widely used for landscaping at the Chinese Garden, Singapore. (Middle left)* Podocarpus *sp. planted in pot as an ornamental plant at Hanoi, Vietnam. (Middle right)* Podocarpus *sp. is widely available in the nurseries. (Bottom) Young coppicing shoots of* Podocarpus *are useful materials for propagation.*

Podocarpus *trees planted beside a waterbody (Chinese Garden, Singapore)*

Scaevola taccada (Gaertn.) Roxb.

Ambong Ambong

Family Goodeniaceae

This attractive shrub plant is a good choice for coastal parks, as it grows best on sandy or rocky beaches and is very tolerant of seawater. This tolerance makes it suitable as a screen against salt-spray.

Features
Large evergreen shrubs which can reach 3-5 m in height.

Leaves
The leaves are paddle-shaped and spirally arranged. The glossy, light-green leaves are 5-15 cm in length.

Root system
Sturdy and strong root system.

Flowers
The flowers are produced throughout the year and they are composed of five white to pale purple petals in a distinctive fan shape, which are split down one side.

Fruits
The fleshy white fruit contains lightweight, buoyant seeds.

Distribution
Native to Tropical Asia.

Propagation: By cuttings.

Uses: It was introduced to coastal areas for erosion control. According to Malay folklore, this plant has many medicinal uses. Its leaves may be eaten to cure indigestion, and the pith was used to stop diarrhoea. This species is commonly used in landscaping in Southeast Asia.

Note: This plant is able to quickly colonise an area because it roots easily wherever the branches come in contact with the ground.

(Top left and right) Scaevola taccada *growing at the seaside. (Bottom left) The shoots and white flowers (Bottom right).*

Sonneratia caseolaris (L.) Engl.

Berembang

Family Lythraceae

Sonneratia caseolaris is normally found where the water salinity is low, situated somewhat away from the shoreline, near the banks of tidal rivers. This species provides a suitable habitat for the fireflies.

Phytoremediation potential: It is able to accumulate iron.

Propagation: By seeds.

Uses: The edible fruit, which tastes like cheese, can be eaten raw. The fermented fruit juice is said to be effective in arresting hemorrhage.

Note: Unlike the oval to oblong shaped leaves produced by a mature tree, the younger plants have very slender leaves. Mature fruits detach easily from the calyx. These fruits float in the water and can be easily collected during low tide.

Features

A small- to medium- sized evergreen tree (8-10 m tall) with open spreading crown, horizontal branches and slender twigs. The bark is gray and flaky in the older trees.

Leaves

The leaves are simple and shiny, and are arranged oppositely. The leaves are 4-8 cm long and oval to oblong in shape. The petioles are short and have a reddish-pink base. The leaf apex is rounded with a prominent curved tip.

Root system

The pneumatophores are peg like, 50-90 cm tall and up to 7 cm in diameter, with a spongy outer surface.

Flowers

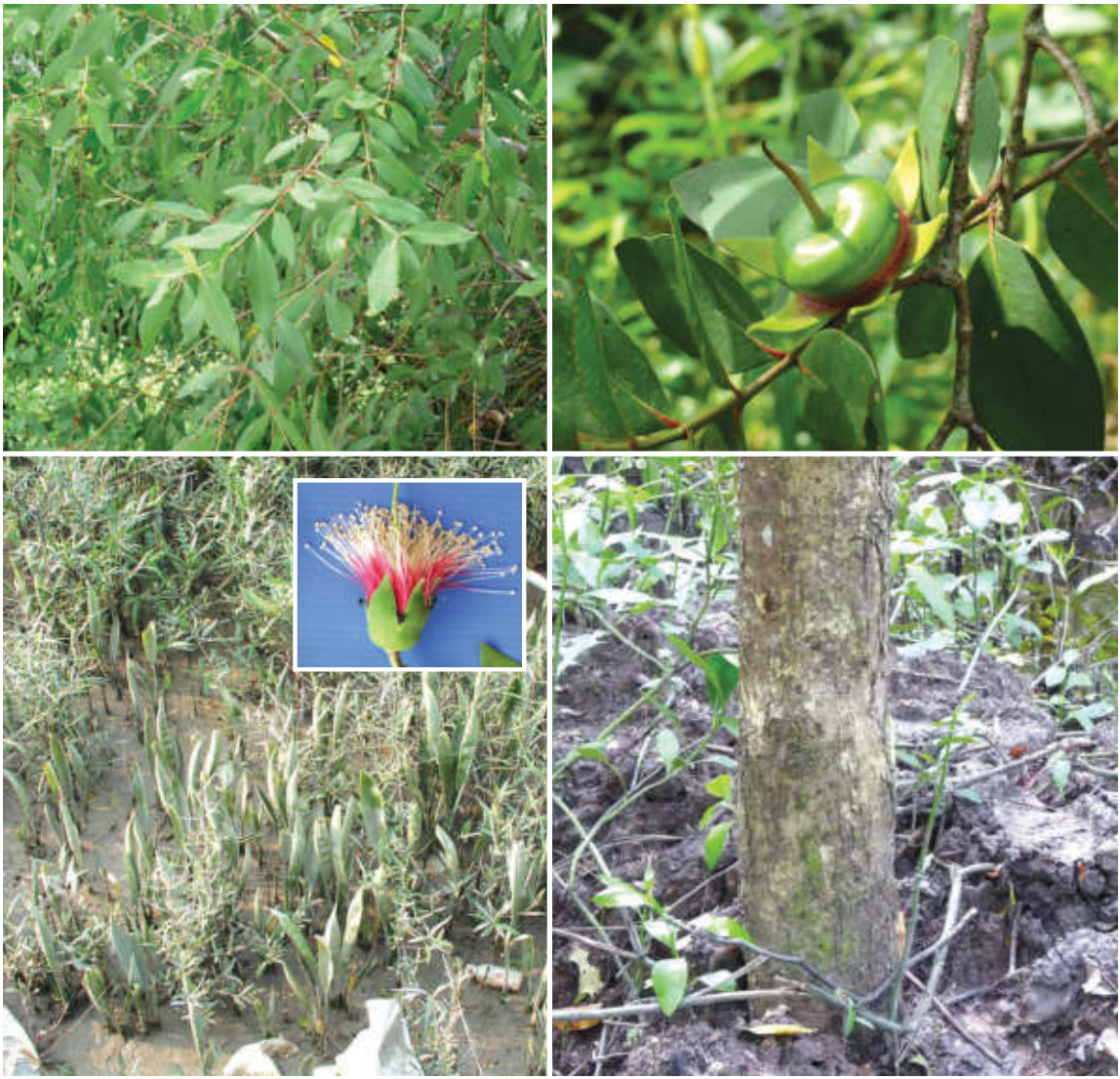
The flowers are large, 8-10 cm wide with prominent red and white stamens. Each flower consists of six to eight lobed green calyx and red petals. The nectar is plenty in the calyx. The flowers open only in the late evening and last for one night only.

Fruits

The green fruit is round and flattened, with horizontally extended calyx.

Distribution

Native to East Africa, Australia, Micronesia and New Caledonia. In Singapore, only fewer than 20 trees are found at Woodlands Town Garden, Sungei Buloh, Pulau Ubin, and the upper reaches of Sungei Seletar.



(Top left) Sonneratia caseolaris *shoots. Note the pointed tip of the leaves, which are different from the rounded leaves of* Sonneratia ovata*. (Top right)* Sonneratia caseolaris *fruit. The calyx is flat, unlike the cup-shaped one of* S. ovata*. (Bottom left) Young* Sonneratia caseolaris*, which have more slender leaves, growing among the salt tolerant* Cryptocoryne ciliata*. (Inset)* Sonneratia caseolaris *flower. (Bottom right) The trunk of* Sonneratia caseolaris *(Sungei Buloh Wetland Reserve, Singapore).*

Sonneratia ovata Back.

Gedabu

Family Lythraceae

Sonneratia ovata generally grows better on the landward-side of the mangroves, on muddy soils inundated only by spring tides.

Features
A columnar tree, growing up to 2-20 m tall.

Leaves
These leaves are simple and growing oppositely on 2-15 mm long petioles. The upper surface of the leaf is glossy with fine lateral veins. The leaf blade is usually ovate to broadly ovate.

Root system
Thin, pointed, pneumatophores about 20 cm long.

Flowers
The flowers are bisexual, usually in terminal groups of two or three. Petals are absent.

Fruits
The fruit is a flattened globose berry. It is dark green when young, and turns yellowish-green when ripe.

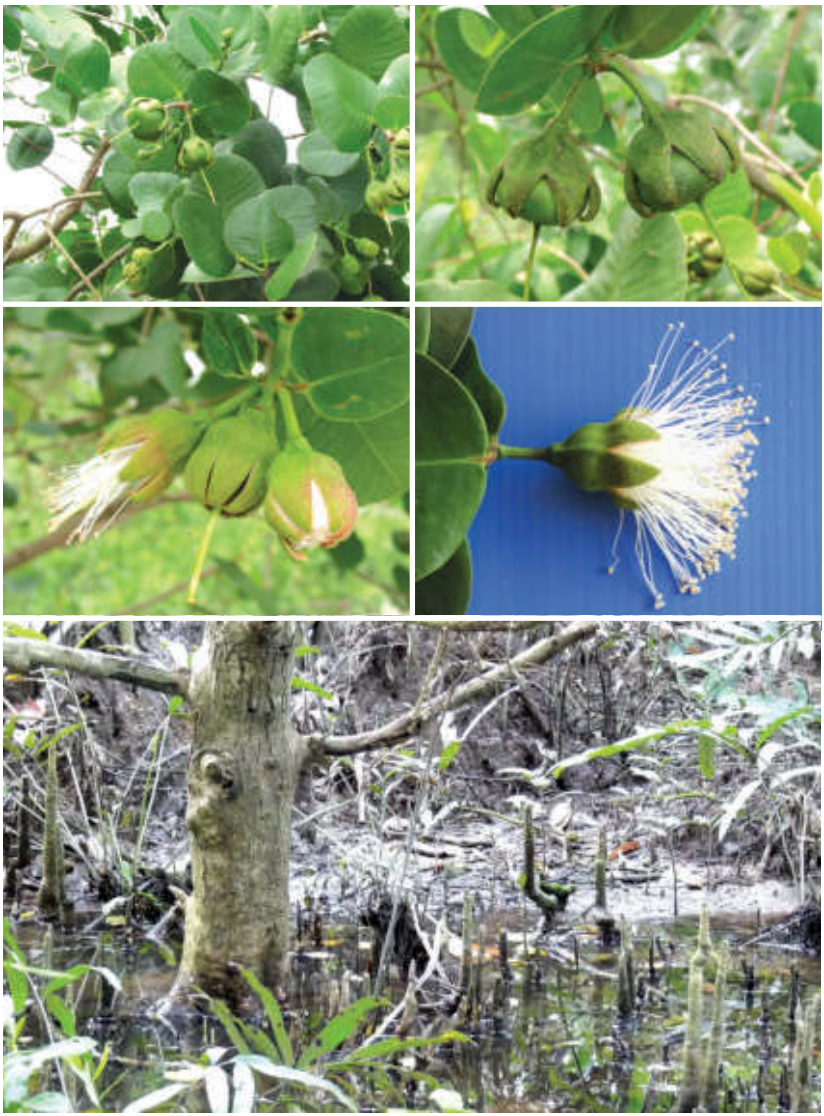
Distribution
It is found scattered in widely separate localities from China and Thailand through Peninsular Malaysia.

Phytoremediation potential: It is able to accumulate copper, manganese, zinc, cadmium, and lead.

Propagation: By seeds.

Uses: The fruit is applied in poultices to relieve sprains.

Note: The flowers are ephemeral, lasting for only one night. Bats and nectar-feeding birds are believed to be the pollinators.



(Top left) The leaves of Sonneratia ovata *are broad egg-shaped and have a peculiar corrugation on the leaf surfaces that make identification of this species easier. (Top right) The round and developing fruits. (Middle left)* Sonneratia ovata *flower bud and unopened flower. (Middle right) The fully-opened flowers of* Sonneratia ovata*. (Bottom) The trunk and pneumatophores of* Sonneratia ovata *growing in an inundated area (Sungei Buloh Wetland Reserve, Singapore).*

Stenochlaena palustris (Burm. f.) Bedd.

Climbing Swamp Fern

Family Blechnaceae

This fern species has a creeping stem and forms thickets on the ground; but when come in contact with the base of a tree trunk, it grows upward using the trunk as support. Indigenous people in Central Kalimantan and South Kalimantan believe that this fern is good for health, especially as a source of iron. It is also used as a medicine for skin disease, malaria and fever.

Features
A moderate to large, high-climbing, long creeping fern with its base rooted to the ground.

Leaves
The fronds are hard textured, feather-form and dark green. The fronds are widely spaced with glabrous stipes. The fronds are dimorphic with the sterile lateral pinnae usually articulate and basal, while the fertile pinnae are narrow and linear.

Root system
The rhizomes are climbing or scrambling, and are naked and green, apically bearing many scales. These rhizomes are radially symmetric.

Flowers
Not applicable.

Fruits
Not applicable.

Distribution
Native to Africa, Asia, the Philippines and Indonesia eastwards into the Pacific as far as Tonga and Samoa.

Propagation: By spores.

Uses: This fern is suitable for the home or a greenhouse as its growth can be controlled in a basket or container.

Note: *Stenochlaena palustris* is eaten as a popular vegetable in Sarawak, where it is usually flavored with shrimp paste.

Stenochlaena palustris *fronds (Top left) and a climbing shoot growing along the stem of a* Rhizophora *tree (Top right). (Bottom) This fern species is able to colonise open green spaces by producing shoots that grow vigorously along the grass-covered ground. Note the young red-coloured fronds.*

(Top left and right) Stenochlaena palustris *plants are planted along the edges of waterbodies. (Bottom)* Stenochlaena palustris *plants are able to grow in crevices on the rock embankments that line our waterways and waterbodies.*

Stenochlaena *and* Hanguana *plants are an interesting combination of native plants to soften the edge of a concrete lined pond.*

Taliparitiliaceum (L.) Fryx.

Sea Hibiscus

Family Malvaceae

Talipariti is the newer scientific name for the familiar Sea Hibiscus. This waterlogged tolerant species is a beautiful beach forest tree. It produces flowers all year round. However, each flower lasts for only a day, opening at about 9 am and closing at about 4 pm.

Phytoremediation potential: It is able to absorb polycyclic aromatic hydrocarbons.

Propagation: By cuttings or by seeds.

Uses: This waterlogged tolerant plant is frequently planted in beach parks as it makes an excellent salt spray screen.

Note: An infusion of Sea Hibiscus roots or shoots and leaves is reputed to be a good treatment for fever.

Features

A spreading tree with multiple branching. It can grow up to 15 m tall.

Leaves

The leaves are spirally arranged, and the blades are heart shaped with a pointed tip. The leaves are slightly toothed, dark green above and whitish and short-hairy below.

Root system

Aggressive, deep root system.

Flowers

The few-flowered inflorescences are found at the branch tips or leaf angles. The petals are bright yellow which fades to a dull orange, with a maroon eye. The filaments of the stamens are joined together into a light yellow tube and the stigmas are a deep crimson purple.

Fruits

The capsules are somewhat spherical, topped by the persistent sepals.

Distribution

Found throughout the tropics.

The yellow flower of Taliparitiliaceum.

The distinctive heart-shaped leaves.

*Sap feeding Cotton Stainer Bugs (*Hemipterans*) are commonly found on the leaves of* Taliparitiliaceum.

(Top left) Coppice shoots are formed readily at the base of Talipariti *trees and this explains in part the widespread distribution of this species. (Top right) The bark of* Talipariti tiliaceum*. Bottom)* Talipariti tiliaceum *and* Avicennia alba *at the mangrove area of Woodlands Town Garden.*

(Left) The variegated form of Talipariti tiliaceum*. (Right) The other variety of* Talipariti tiliaceum, Talipariti tiliaceum *var.* purpurascens*, has more purplish leaves; (Inset) the orange flower of* Talipariti tiliaceum *var.* purpurascens.

The use of Talipariti tiliaceum *and other plants such as* Acrostichum *in phytoremediation.*

Thespesia populnea (L.) Sol. ex Corrêa

Portia Tree

Family Malvaceae

Like other mangrove associates, this medium-sized tree provides shelter and food to many creatures found along the coastlines and mangroves. This waterlogged tolerant species resembles the sea hibiscus.

Features
A small, evergreen tree averaging 6-10 m in height, with short and often crooked stem and a broad, dense crown.

Leaves
The leaves are spirally arranged, green on the upperside and light green on the underside. The hairless leaves are heart-shaped and gradually narrow to the tip. The blades are slightly fleshy.

Root system
Non-aggressive root system.

Flowers
The flower has a maroon eye while the petals are yellow and turns purple with age. The stamens are joined into a pale yellow tube and the stigmas are pale yellow.

Fruits
The fruit is flattened spherical and crowned by the disc-like sepals.

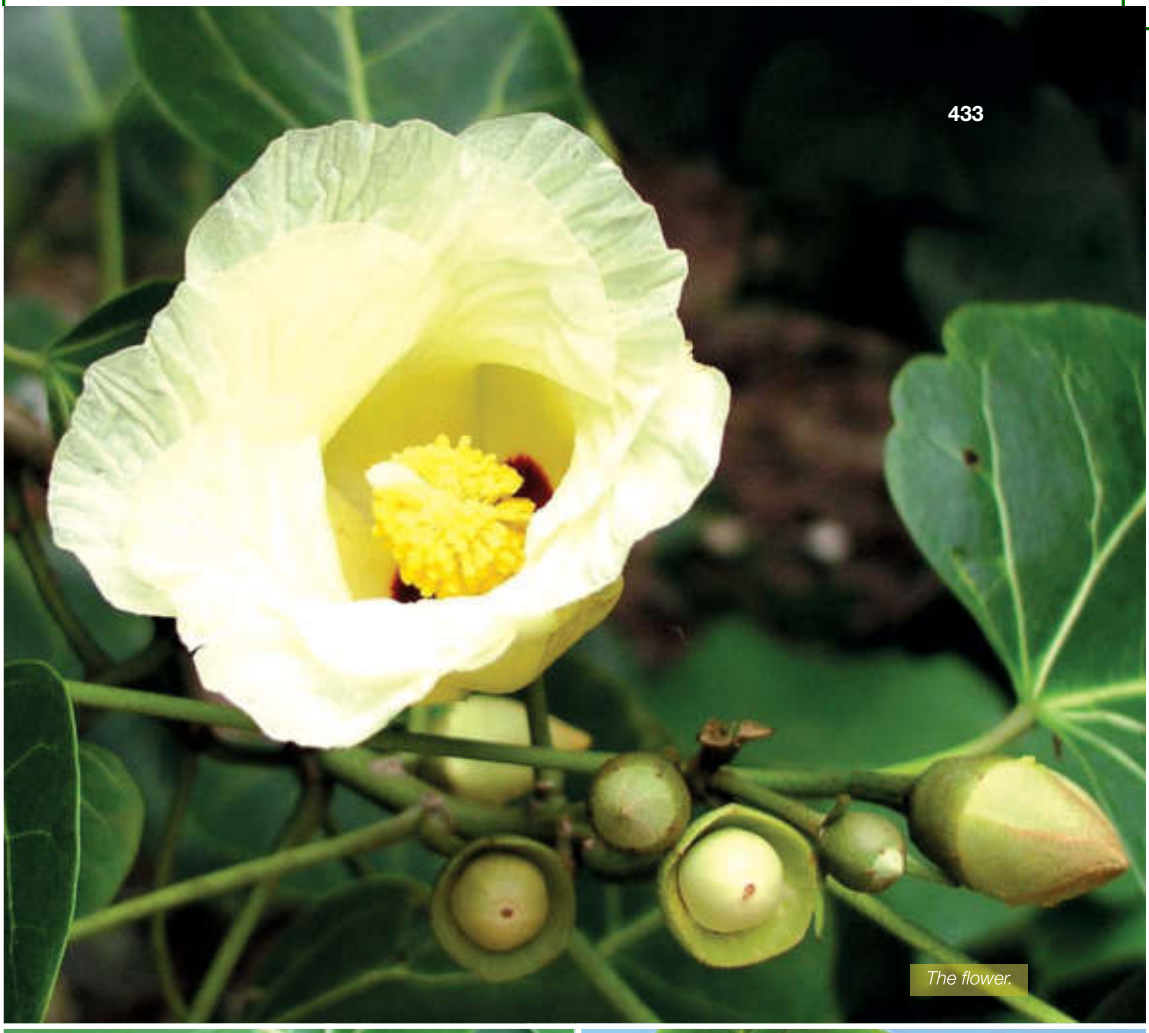
Distribution
Originated in India, but is a common plant of coastal strands across Old World tropics.

Phytoremediation potential: It is able to degrade petroleum hydrocarbons.

Propagation: By cuttings or by seeds.

Uses: *Thespesia populnea* has the potential to be used as an ornamental tree because of the neat crown shape and pretty flowers. The leaves also help add appeal to the tree because they are shiny, and also because their large size can provide an interesting visual contrast.

Note: The leaf and flower buds are said to be edible (raw or cooked). The seeds can be applied to scabies and other skin diseases, and are rubbed on swollen joints.



The flower.

The flower buds.

The fruits.

Xylocarpus granatum J. Köenig.

Nyireh Bunga

Family Meliaceae

Xylocarpus granatum is commonly described as occurring in the upper intertidal zone of mangrove forests. Its fruits look like cannonballs, so the tree is sometimes called “Cannonball Tree”.

Phytoremediation potential: It is able to accumulate boron, iron, copper, manganese and zinc.

Propagation: By seeds.

Uses: The wood is used in boat-building. The bark is used for tanning and when dyed on cloth, it gives an umber colour.

Note: The root is used as a remedy against cholera and dysentery in Malay folklore medicine.

Features

A 3-8 m tall tree with long buttresses which snakes laterally. The bark is smooth, unfissured and thin. It displays a pattern of light-brown to orange patches which are caused by the peeling of the bark.

Leaves

The leaves are light green in color with a rounded apex and on average 10 cm long and 4 cm wide. The petiole of the leaf is short and corky. The leaves are pinnate with the leaflets bright light green when young, and dark green when old.

Root system

The above ground root system of *Xylocarpus granatum* is often absent in young individuals. Older individuals often display above-ground ribbon like roots and buttresses.

Flowers

The flowers of *Xylocarpus granatum* are very small with white petals about 8 mm across and are fragrant.

Fruits

A big fruit resembling the size of a small coconut. It is characterised by a hard, lignified capsule, in which several seeds are enclosed.

Distribution

A wide distribution occurring from East-Africa to Southeast Asia.

The characteristic flaking bark of Xylocarpus granatum.

The flowers (Top right), fruit and seeds (Middle right) of Xylocarpus granatum.

Buttress roots of Xylocarpus granatum.

Other mangroves which can be grown in a freshwater environment:

Name	Family	Common Name	Habit
* *Allophylus cobbe* (L.) Reausch.	Sapindaceae	Allophylus	Tree
* *Barringtonia asiatica* (L.) Kurz	Lecythidaceae	Putat Laut	Tree
**Bruguiera hainesii* C. G. Rogers	Rhizophoraceae	Berus Mata Buaya	Tree
Callistemon viminalis (Sol. ex Gaertn.) G. Don	Myrtaceae	Weeping Bottlebrush	Tree
* *Calophyllum inophyllum* L.	Clusiaceae	Borneo Mahogany	Tree
**Cassine viburnifolia* (Juss.) Ding Hou	Celastraceae	Barak Laut	Tree
**Cerbera manghas* L.	Apocynaceae	Pong Pong or Pink-eyed Cebera	Tree
**Cerbera odollam* Gaertn.	Apocynaceae	Pong Pong or Yellow-eyed Cebera	Tree
* *Cordia subcordata* Lam.	Boraginaceae	Sea Trumpet	Tree
* *Cynometra ramiflora* L.	Leguminosae	Katong Laut	Tree
* *Guettarda speciosa* L.	Rubiaceae	Sea Randia	Tree
Gymnostoma rumphianum (Miq.) L. A. S. Johnson	Casuarinaceae	Weeping Rhu	Tree
* *Heritiera littoralis* Aiton	Sterculiaceae	Dungun	Tree
* *Intsia bijuga* (Colebr.) Kuntze	Leguminosae	Kwila	Tree
* *Oncosperma tigillaria* (Jack) Ridl.	Arecaceae	Nibung Palm	Palm
**Pemphis acidula* J. R. & G. Forst.	Lythraceae	Pemphis	Tree
* *Peltophorum pterocarpum* (DC.) Backer ex K. Heyne	Leguminosae	Yellow Flame	Tree
* *Pterocarpus indicus* Willd.	Leguminosae	Angsana	Tree
**Rapanea porteriana* Wall. ex A. DC.	Myrsinaceae	Mutton Wood	Shrub
* *Scyphiphora hydrophyllacea* L.	Rubiaceae	Chengam	Tree
Sesuvium portulacastrum (L.) L.	Aizoaceae	Sea Purslane	Herb
* *Terminalia catappa* L.	Combretaceae	Sea Almond	Tree

*Native plants

Bruguiera hainesii *(tree with pinkish white flowers; Rhizophoraceae) is a globally endangered mangrove species. At present, there are only three known mature trees in Singapore.*