

Gardenwise



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Message from the CEO...

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Front Cover Illustration:
Mr Maulud bin Elin Holding
A 16 Kg *Dioscorea* Tuber



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The history of the Singapore Botanic Gardens spans nearly a century and a half, and has been well documented in the books **"Singapore Green"** and **"Visions of Delight"** by former staff Bonnie Tinsley. We now need new editions to these books, as the Gardens enters a new chapter in its history.

In 1973, the Singapore Botanic Gardens merged with the Parks and Trees Branch of the Public Works Department to form the Parks and Recreation Division of that department. The title of Director of the Singapore Botanic Gardens was re-designated as "Deputy Commissioner of the Parks and Recreation Division". In 1976, the Parks and Recreation Division was accorded departmental status. By the early 1980 s, many of the functions of the Gardens had been given over to different branches in the Parks and Recreation Department, and the Gardens was reduced in status to that of a branch in the Research and Development Division.

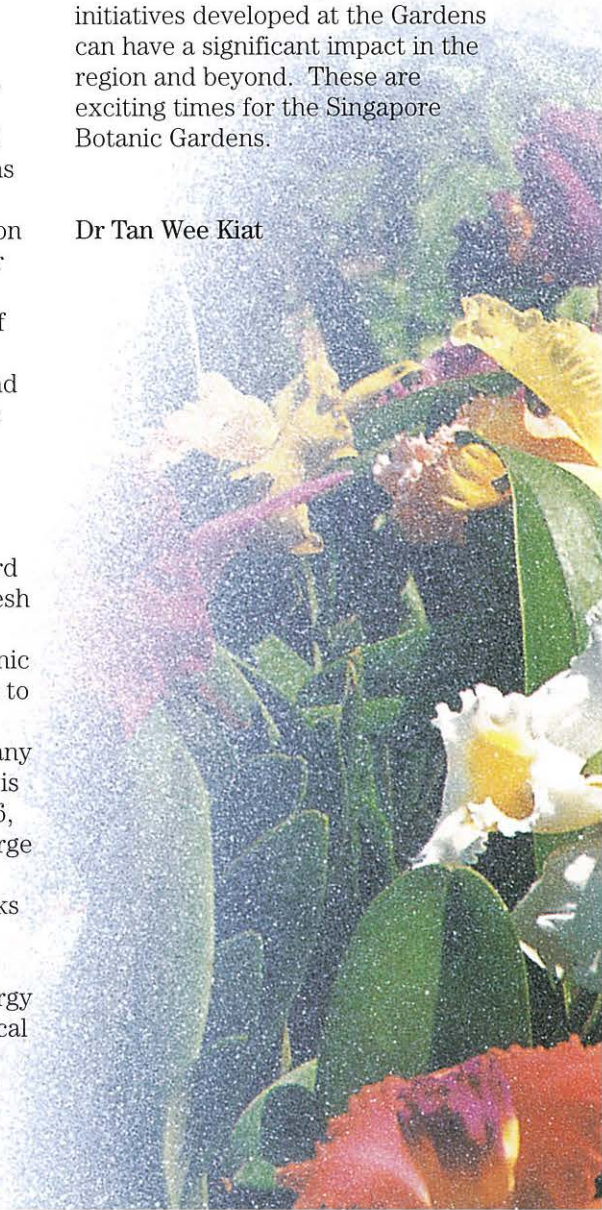
The parent ministry of the Parks and Recreation Department, the Ministry for National Development, formed the National Parks Board in 1990. The functions of the Research and Development Division of the Parks and Recreation Department were subsumed under this Board, along with the administration and development of the nature reserves and Fort Canning Park. The original role and functions of the Singapore Botanic Gardens were restored under the Executive Director of the Board.

In the six years since its formation, the National Parks Board forged a strong identity with its fresh initiatives and management programmes. The Singapore Botanic Gardens drafted a new Masterplan to take it into the 21st century as a leading institution for tropical botany and horticulture. Implementation is now under full steam. In July 1996, the parent ministry decided to merge the Parks and Recreation Department with the National Parks Board, with the former Executive Director at the helm as the Chief Executive Officer. Given the synergy of the merger, the increase in critical mass, resources and expanded portfolio, the newly re-constituted

National Parks Board will certainly thrive. Achievement of its mission to make "our nation our garden" will be facilitated by the loosening of constraints that hampered the former government department.

In the re-constituted National Parks Board, the Singapore Botanic Gardens will retain its divisional status under the new Director, Dr. Chin See Chung. Its role and status will be underlined as the flagship of the nation's fleet of parks and gardens. The Gardens will serve as the nerve centre for advancing the recreation, research, conservation and education programmes of the Board when the new headquarters of the National Parks Board move to the Gateway core of the Gardens. Increasingly, the Singapore Botanic Gardens will play a key part in defining the role and identity of new generation botanic gardens. Its unique value as an equatorial botanic and horticultural institution cannot be understated at a time when global biodiversity is under siege. The directions and management initiatives developed at the Gardens can have a significant impact in the region and beyond. These are exciting times for the Singapore Botanic Gardens.

Dr Tan Wee Kiat



We proudly present this first issue of Gardenwise of the post merger period. It represents a tangible expression of the commitment and effort of the Gardens' staff as they rally and adjust to the organisational changes.

The Singapore Botanic Gardens enters its 138th year with the confidence, courage and creativity to meet the new challenges ahead as Singapore's premier park and as an institution of international standing.

Today's botanic institutions must not only be repositories of botanic collections and sanctuaries for botanic and horticultural research, but they must also be resources for recreation and education. The Singapore Botanic Gardens, in particular, must embody these multiple roles because land is such a scarce resource. The Masterplan that has been drawn up for the Garden's development fully addresses these needs. Major developments are being implemented to create a critical mass of attractions that will make the gardens a more important tourist destination and a major location for recreation. Together with imaginatively designed, comfortable

From the Director...

areas for rest where food and beverages are served and an internal transport system, it is anticipated that visits will also lengthen. Needless to say the quality of our horticultural displays and landscapes must match that of the facilities planned.

To lay firm claim as a leading tropical botanic garden we will need to recapture the role of the Singapore Botanic Gardens as a centre of excellence for botanical and horticultural research and publication. Tropical horticulture and botany, in particular the taxonomy, breeding and micro propagation of orchids are our priority. To create a garden of greater botanical interest and value, efforts to increase our plant diversity will be intensified. As a responsible modern institution in an era when human impact on the environment threaten our quality of life, the Singapore Botanic Gardens will expand its role in conservation and

education. We will contribute towards ex-situ conservation to the extent that our limited land resources will permit, and we will propagate and make available in large numbers, selected rare and endangered species to relieve the pressure on the wild.

In formal horticultural education we aim to be a regional centre offering quality teaching and training to meet increasing demands for practitioners in this field. To help fulfil our roles and responsibilities in nurturing interests in recreational horticulture, developing nature awareness and appreciation, our activities in public education will be expanded.

Gardenwise is a supporting vehicle for education. It is also an outlet for our staff to communicate their horticultural and botanical experiences in the less esoteric themes to our friends here and overseas, and it will track major happenings in the gardens.

This 'new' Gardenwise, now the Newsletter of the Singapore Botanic Gardens, will be published biannually in January and July. The numbering of the volumes will continue from the last one published in December 1994.

Dr Chin See Chung

The Role Of Singapore Botanic Gardens In A City Economy

Singapore, with a total land area of 641 km², is home to a population of 3 million people, targeted to reach 4 million beyond the year 2000. With limited land and natural resources, trade and tourism are key factors contributing to a robust economy.

The Singapore Botanic Gardens has a long history of contribution to the country's economy starting from its role in the development of the rubber industry. In 1877 seedlings of the Brazilian Para Rubber Tree, reputedly smuggled to Kew Botanic Gardens, were sent to Singapore. A subsequent Director of the Gardens, Henry Ridley, successfully propagated more from the seeds of these first trees and later, devised a method of tapping the white latex from matured trees. This eventually led to the start of a massive growth industry in the Malayan region.

Over the years the Gardens has taken on a key role in the development of the commercially important cut-flower orchid trade in Singapore. The country exports about S\$20 million worth of fresh orchids a year, making it one of the top orchid exporters in the region.

Singapore's major breakthrough in commercial orchid growing was in 1929. Mr R E Holtum, then Director of the Gardens, successfully germinated and grew man-made hybrid seedlings in sterile media. His works encouraged an active breeding programme, which laid the foundation for Singapore to become a leader in commercial orchid growing and export of cut flowers.

With its strong emphasis on breeding and cultivating commercial tropical orchids, Singapore aims to remain a key player in the world's orchid trade. Today, the Singapore Botanic Gardens' role in promoting the country as a major source of orchids is to focus on developing new orchid hybrids, especially those with cut-flower potential, for the industry.

Another present day role of the Gardens in relation to the country's economy is in the promotion of Singapore's tourism trade. The Gardens received 2.4 million visitors in 1995. Foreign visitors made up 66% or 1.58 million of the total. This represented approximately 24% of Singapore's total international tourist traffic, an indication of the Gardens' popularity as an attraction to our visitors.

Among the new attractions in the Gardens is the National Orchid Garden which was opened in October 1995. This is one of the most comprehensive permanent exposition of orchid culture in Asia. The three-hectare display draws on the Singapore Botanic Gardens' longstanding, pioneering tradition of orchid breeding in creating a memorable recreational and educational experience for visitors.

Another attraction, soon to be completed in 1997, will further enhance the Gardens' value as a top tourist attraction. This is the S\$12.8 million Singapore Botanic Gardens Gateway/Visitor Centre complex. Comparable to a "village" centre, the Gardens Gateway will be bounded by a rainforest on one side and an arboretum on the other. With its ample car and coach parking facilities and visitor amenities such as an Interpretative Area, cafeteria and souvenir shop, the Gateway is poised to assume its role as the new Main Entrance to the Singapore Botanic Gardens.

While Singapore takes pride in being an economically successful nation, the Government is also concerned with the quality of life in Singapore. In this respect, the Singapore Botanic Gardens plays a very important role as a social and

recreational retreat and acts as a "green lung" only minutes away from the busy tourist belt downtown. A stroll through the tranquil, shaded lawns and lush tropical plantings of the Gardens offers respite from the city's hustle and bustle.

While the Gardens continues to make its contribution to the country's economy, it also includes conservation as a major component of its mission. The Nature Conservation Unit co-ordinates all conservation programmes and the National Parks Board is the scientific authority on conservation matters in Singapore.

The Gardens also contains a small but precious remnant of the rain forests of the region. The Singapore Botanic Gardens' four-hectare rain forest is one of a few remaining patches of primary forest in Singapore. It offers tremendous potential as a tangible, educational resource for students and researchers.

Although the findings of a 1990 survey show that the forest has done surprisingly well after 130 years of isolation, it does appear that remedial action is now necessary to maintain the primary forest character and its biodiversity. A major problem is the invasion of exotic species. We have in place a programme of selective weeding and reforestation involving public outreach and community support to try to address these issues.

In the next phase of the Gardens' redevelopment masterplan, the National Parks Board is augmenting the critical mass of attractions in the Gardens to improve its value as a key tourist destination as Singapore strives to achieve a tourism target of 10 million arrivals and \$16 billion in total spending by the year 2000 under the National Tourism 21 plan.

One of the proposed facilities will be a cloud forest conservatory. This will be the first attempt in the tropics to create on a large scale a conservatory with requirements contrary to those found in European and American gardens. The aim is to recreate environmental conditions of montane forests of the equatorial region. This cloud forest facility will

Visitors to the patch of rain forest in the Singapore Botanic Gardens frequently come across a vigorous climber, twining itself tightly to other plants. The distinctive, almost heart-shaped leaf with nine main veins radiating from the base and waxy-white fleshy stem that twines to the left, distinguish this plant readily from others. This climber, *Dioscorea sansibarens* or African Yam from Tropical West and Central Africa has firmly established itself in Singapore.

The species was introduced into the Gardens before 1928. A sample collected in the Gardens and made into a herbarium specimen by a former Director, Prof. R.E. Holttum, is dated 1928. According to him (*Plant Life in Malaya*, 2nd ed., 1973), this plant was introduced into the Singapore Botanic Gardens for experimental purposes.

Another former Director, Mr I.H. Burkill, who studied the genus *Dioscorea* in great detail wrote in the *Annual Report* of the Director of Gardens, Straits Settlements (1915), that African yams were received through the Royal Botanic Gardens, Kew from the Gold Coast and from southern Nigeria. *D. sansibarens* is one of the species of African Yams that could have been introduced into the Gardens during that time.

The proliferation of this plant in open, cleared areas such as forest fringes is due to its high degree of resilience and amazing ability to propagate vegetatively. Though it does not produce seeds in Singapore, it regularly propagates itself rapidly through the production of purplish brown bulbils from the leaf axils along the stem. After a leafy stem has been cut, bulbils would continue to develop from buds at the leaf-axils

make possible the maintenance and study of a distinctive group of plants with tremendous potential for horticultural application. As tropical cloud forests are increasingly subjected to land clearing activities, the successful development of this facility in the Gardens will provide an important learning resource.

The School of Horticulture, as part of the Singapore Botanic Gardens, in addition to formal courses also utilises outreach

AFRICAN YAM

(*DIOSCOREA
SANSIBARENSIS*)



1. *Dioscorea sansibarens* showing its distinctive leaves.
2. Uprooted tubers awaiting disposal sprouting readily.

even as the leaves and stem shrivel. By concentrating its food reserve into bulbils, the plant is able to regenerate itself after it has been cut. The bulbils sprout rapidly into new plants once shed from the shrivelled stem after about three weeks. Underground tubers will be formed and will increase in size year by year once the plant is established.

The toxicity of these bulbils and the tubers ensures their high survival rate. H.M. Burkill (*The Useful Plants of West Tropical Africa*, 1985, volume 1) mentioned that the bulbils are also adapted for water dispersal.

The tuber of *D. sansibarens* can grow to a massive 30 kg. The largest tuber excavated recently from the forest floor of the Gardens weighed 16 kg. Exposed tubers are able to sprout at several places due to their stored food supply. Though the wild form of this species is toxic and is known to contain alkaloids, the tubers are considered as famine or emergency food. Mr Maulud bin Elin, a gardener with the Singapore Botanic Gardens for 37 years, stated that the toxic tuber can be eaten after careful processing by cutting into smaller pieces and washing in water before boiling. Sometimes, these cut tubers are detoxified by leaving in running water for a few days. Other species of *Dioscorea* have long been cultivated in Africa, Asia and the New World for their edible tubers. Examples are *D. alata*, *D. batatas* and *D. trifida*.

While it looks like *Dioscorea sansibarens* will remain in the Gardens for quite some time, efforts are now underway to save some of our native forest species from being smothered by it. This is particularly true for those plants growing at the forest fringe. The Gardens' ground staff, including Mr Maulud, are constantly on the look-out for plants of this species. Tubers are being dug out and disposed of to prevent them from regenerating new plants and is one aspect of forest management in the Gardens to maintain the integrity of this patch of natural forest.

Tay Eng Pin
Curator/Horticulture

activities, such as public education courses, guided tours and publications as vehicles to promote understanding and appreciation for our natural heritage, and for imparting the urgency for the protection and conservation of biological diversity.

The Singapore Botanic Gardens is an important resource for the country's economy as well as an organisation dedicated to the conservation of Singapore's

biodiversity and natural areas. The Gardens aims to strike a balance between both roles through strategic planning, backed up by an enthusiastic staff and close liaison with private and public organisations.

Wong Wei Har
Assistant Director/Singapore Botanic Gardens Management

Pollination is a process whereby pollen is transferred from the anther to the stigma. Most orchids are cross-pollinated, requiring some pollinators to transfer the pollen from one plant to another. There are many extremely complex and ingenious mechanisms to ensure effective pollination. In this article, I will discuss how some of the species in our collection are pollinated in their natural habitats.

Besides providing food for the pollinators, the calli masses may provide certain visual effects to attract the insects. It is believed that the ultraviolet and visible light-reflecting patterns of the flower, provide such an attraction. Once a flower is pollinated, its colour and image change so that the flower is no longer attractive to the pollinator. These reflective patterns, especially those of the UV range, cannot be detected by the human eye.

example, the bee-pollinated *Dendrobium crumenatum* produces fragrance in the morning. *Angraecum sesquipedale* and *Brassavola nodosa*, both being moth-pollinated, produce their fragrances at night.

Once the pollinators are attracted to the flowers, many orchid species have other means to ensure successful pollination. One example is the ejection of pollinia by

Pollination Mechanisms of Orchids

Most orchids are cross-pollinated by animals such as ants, bees, beetles, wasps, moths, butterflies, flies, and birds.

One way in which a species attracts its pollinator is by the production of nectar. The sugary liquid may be produced in spurs as in species of *Angraecum* and *Aerides* or in nectar tubes as in *Cattleya*. The nectar produced by the host plant is food for the pollinator. While collecting nectar, the pollinator inadvertently transfers the pollen from one plant to another.

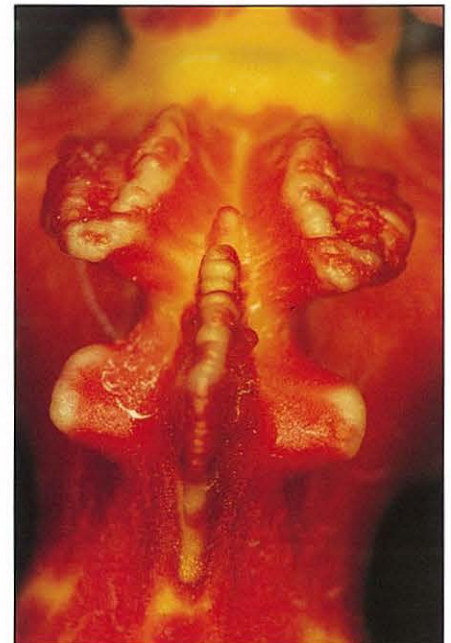
The lip of an orchid flower is often its most attractive part. It is adorned with decorative and sometimes stunning masses of calli. These calli and other floral parts may contain unicellular trichomes ("hairs"), papillae, and scales which produce starch, proteins, oil drops, fragrances, and other substances to attract the pollinators. Examples can be seen on flowers of *Cymbidium*, *Stanhopea*, *Oncidium*, *Dendrobium*, *Coelogyne*, *Vanilla*, and others. While feeding or scratching and gnawing at the calli, the pollinators may pollinate the plant.

Owing to the differences in colour vision among the different pollinators, orchid flowers pollinated by different groups of pollinators have different colours. For example, bee-pollinated flowers such as *Arundina graminifolia* and *Dendrobium crumenatum*, may be of several colours, but are seldom if ever red. Butterfly pollinated orchids such as *Disa uniflora* are mostly pink, red, and yellow. Those pollinated by moths such as *Angraecum eburneum* are cream, white, and pale green in colour. The colour of the flowers pollinated by flies such as *Bulbophyllum gusdorfii* is very variable. Orchids pollinated by birds, for example, *Dendrobium secundum* are bright yellow, red and pink, and are sometimes tubular in shape.

Certain orchid species possess some movable floral parts. The insect pollinator is attracted to the flower by the movement of such parts in an air current. An example is *Bulbophyllum barbigerum* from Africa. Its hairy lip is very sensitive to the slightest air movement.

To attract specific pollinators, orchid species produce a large number of compounds that generate odours and fragrances. For example, many of the fly-pollinated *Bulbophyllum* species smell like rotting meat, whereas the sweet smelling *Dendrobium crumenatum* is bee-pollinated. The odours and perfumes of these orchids are blended in such a way that each orchid species attracts only one or a few species of pollinators.

Depending on the activities of the pollinator, time of scent production varies among species. For



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Catasetum. *Catasetum* is one of those unusual orchid genera that has separate male and female flowers. When a euglossine bee visits a male flower of *Catasetum*, it touches the antenna of the column, triggering off the ejection of the pollinarium. The pollinarium sticks tightly to the back of the bee. If the flower the bee next visits is female, it will, on backing out of the flower, automatically cause the pollinarium to be inserted onto the stigma. Another interesting mechanism can also be seen in some *Cynoches* species (also with separate male and female flowers). As the flowers of this species do not resupinate, the lip is situated above the column. When the euglossine bee lands on the lip of a male flower, the lip is depressed. As the abdomen of the bee touches the tip of the column, it triggers off the ejection of



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the pollinarium. The ejected pollinarium sticks to the apex of the abdomen. When the bee visits a female flower, the pollinarium is placed on the stigma.

Flowers of the genus *Peristeria elata*, the national flower of Panama, have a hinged lip. When a euglossine bee lands on the lip of the flower, the hinged lip tends to counterbalance and throws the bee against the column. As a result, the pollinarium is attached to the thorax of the bee. The bee inserts the pollinarium in the stigma of another flower.

Only a small percentage of orchid species self-pollinate. Some orchids self-pollinate while the buds are still closed. An example in our collection is *Dendrobium mirbelianum*. Self-pollination is made possible by autolysis of the rostellum preceding pollination, thus allowing the pollinia to come into contact with the stigma. Although self-pollination results in reduced variability and genetic stability, it is a means of ensuring pollination when and/or where it may not take place. For example, when seeds of a species are being carried to a new

territory that has no natural pollinators, the ability to self-pollinate allows the plant to establish in the new territory.

Certain species have both cross-pollinated as well as self-pollinated varieties. Some examples that can be seen in our collection are *Spathoglottis plicata*, *Arundina graminifolia*, *Phaius tankervilleae*, and *Cattleya aurantiaca*.



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So, next time when you visit the Orchidarium (the part of the National Orchid Garden where our species collection is displayed), look out for some of the species mentioned in this article. Try and find out how these species are pollinated. It will add a new dimension to your understanding of this fascinating family of plants. And if you are lucky, you may even be able to spot some of the pollinators in action!

Dr Yam Tim Wing
Senior Research Officer/Orchidology

1. The calli on the lip of an *Oncidium* - the calli masses provide certain visual effects to attract its insect pollinator.
2. *Aerides lawrenceae* - nectar is produced in the spur of this beautiful species.
3. Male flower of *Cynoches pentadactylon* var. *peruvianum*.
4. *Angraecum leonis* - a species that is pollinated by moths.
5. Seed pods of *Dendrobium mirbelianum* formed by self-pollination.
6. A variety of *Spathoglottis plicata* that self-pollinates.

THE AROID HOUSE

Introduction

A new addition to the Gardens is the aroid collection which was put together for display in the recently opened Aroid House. The Gardens has, at the moment, a modest collection of 29 genera and some 160 species and cultivars. These plants were acquired either as gifts, exchanges or purchases through the years. Aroids belonging to the family Araceae are one of the distinctive and interesting groups of plants equivalent to the orchids and bromeliads. Unlike bromeliads which are found primarily in Central and South America, aroids like the orchids are cosmopolitan except in the arctic, high alpine regions and extreme desert areas. The majority occur in the tropics or sub-tropics.

An aroid is distinguished by the presence of a spadix (flower-bearing spike) surrounded by a spathe (large leafy bract) which is peculiar only to this family. What intrigues the grower is the bizarre leaf shapes and inflorescences found in this family. Aroids may be aquatic or terrestrial and can be herbs, climbers, creepers or tree-like plants. Generally, aroids prefer slightly moist and shady areas.

Low Herbs

Aglaonema, *Dieffenbachia* and *Homalomena* are herbaceous plants which can be rather attractive house plants. *Aglaonema* does well in deep shade whereas *Dieffenbachia* prefers more light. *Aglaonema commutatum*, has bright yellow to red, berry-like fruits which can be quite captivating. When handling *Dieffenbachia* (Dumb Cane), one must exercise caution. The tissue of this plant renders one temporarily dumb when consumed. The symptoms are a burning sensation and swelling of the tongue, mouth and throat. However, *Dieffenbachia* with lots of variations in the foliage is a great-looking house plant. A favourite of the Chinese in

Singapore is *Dieffenbachia paludicola* which is highly regarded as a "good luck" plant. The other genus that flourishes well in the shade is *Homalomena*. *Homalomena sulcata* and *H. wallisii* are two rather ornamental species that are easy to maintain and do well as house plants.

Creepers & Climbers

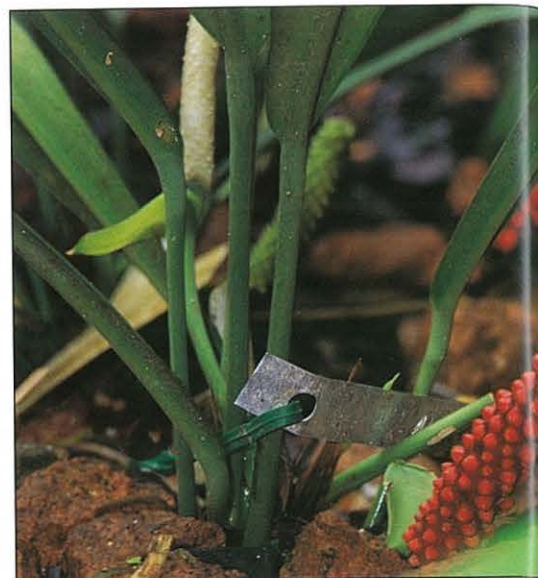
Most *Philodendron*, *Monstera*, *Epipremnum* and *Syngonium* are climbers and creepers which grow exceptionally well in diffused light. *Philodendron* means "tree loving." In nature, members of this genus creep on tall trees in search of light. They are best known for their diverse leaf shapes. In some species, the juvenile and mature leaves are completely dissimilar. Some *Philodendron* cultivars like *Philodendron* "Black Cardinal", *P.* "Moonlight" and *P.* "variegata" produce very lovely colours which enthrall many a gardener. One creeper that most of us are familiar with is *Epipremnum aureum* (locally known as "money plant"). This can be spotted in shady areas along some of the roads in Singapore. This species exhibits the phenomenon wherein as a creeping groundcover, the leaves are small but when allowed to climb on a tree or tall post, the leaves become gradually bigger, eventually exceeding half a metre in length.

Petite Foliage

The aroid that has the most exquisite and dainty foliage is indisputably the *Caladium*. This genus has numerous hybrids with very charming and delicate leaves. It can grow in bright areas but does better in slight shade. *Caladium lindenii* which has green leaves with prominent white veins is an ideal pot plant.

Dazzling spathes

Anthurium means "tail flower." It is the largest genus in the family with more than 700 species, and hundreds of cultivars and hybrids to its credit. They are either terrestrials or epiphytes. *Anthurium* is grown for its stunning spathe which is a very sought after "cut flower" in the floriculture



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industry. Its popularity in the recent years has further risen as many effulgently coloured spathes have been introduced into the market. While *Anthurium bakeri* has an spadix bearing interesting red berries, *A. scandens* has white ones. *Anthurium* thrives best in well drained soil mixes and in bright but not in too sunny areas.

"Keladi"

Colocasia, *Xanthosoma* and *Alocasia* are closely related; the first two especially are well known as root crops. They are known as taro or yam to some while the locals called them "keladi." The common *Colocasia esculenta* prefers to grow in damp areas or shallow water while *Alocasia macrorrhizos*, a species with inferior tubers, thrives on drier land. Yet as a specimen, *Alocasia macrorrhizos* can be quite imposing, growing to more than 3 metres even on poor soil. Other lovely species of *Alocasia* used for ornamentals include, *A. denudata*, *A. sanderiana*, *A. cuprea* and *A. lowii*. *A. denudata* is a native of Singapore and although fast disappearing can still be found in its natural habitat.

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1. *Anthurium bakeri*
2. *Homalomena sulcata*
3. *Anthurium andraeanum* "Rubrum"
4. *Philodendron* "Black Cardinal"
5. *Colocasia esculenta*
6. *Aglaonema commutatum*
7. *Caladium lindenii*
8. *Typhonodorum tinleyanum*



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To most people, pineapple is a familiar tropical fruit. Not many would associate it with the ornamental plants popularly called Air Plants, Spanish Moss, Earth Stars or Fingernail plants. These, just like the pineapple, belong to a plant family called Bromeliaceae and are commonly referred to as bromeliads.

They can often be spotted as vase-like or tank-like epiphytes, perched on branches of rain forest trees. They also inhabit rocky cliff faces while others grow on the ground in deserts or on mountain tops. One species, *Tillandsia recurvata*, has even been found growing happily on telephone wires.

Bromeliads are characterised by their bizarre forms. Their sizes may range from tiny moss-like plants as in some *Tillandsia* to gigantic forms as in *Puya*. When not in bloom, they often appear as a tuft of foliage or as a rosette of wiry, strap-like or sword-like leaves. The bases

Bromeliads



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Except for one species that is native to Africa, all wild bromeliads are restricted to the New World, extending from southern United States of America and Mexico down to the southern parts of Argentina and Chile. The main concentration of bromeliads is distributed in Mexico, the Antilles, Costa Rica, eastern and southern Brazil, the Andes of Colombia, Peru and Chile.

In the wild, members of bromeliads come from a wide range of habitats and climatic conditions - from the lowlands of the tropical rain forest, semi-deserts and deserts to the icy regions of high mountains.

of these leaves may overlap and be watertight, forming a tank or reservoir that collects water and detritus or they may be open, allowing free drainage of excess water. High up in the canopy of the tropical rain forest in the Amazon, many tank bromeliads actually provide the essential micro-habitats for frogs and other organisms that live off the ground.

The foliage of some bromeliads may be coloured green, yellow, brown, red or beautifully patterned with longitudinal stripes. In other instances, it may be mottled or spotted, cross-banded or



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reticulated. Some fine examples of coloured and patterned foliage are demonstrated by *Cryptanthus zonatus*, *Guzmania lindenii*, *G. musaica*, *G. vittata*, *Neoregelia carolinae* var *tricolor*, *N. marmorata*, *Vriesea fenestralis*, *V. gigantea* and *V. hieroglyphica*. Even in their non-blooming state, these bromeliads can be the pride of any grower. The inner leaves of many species (e.g. some *Neoregelia*, *Nidularium*) assume brilliant contrasting colours of different hues during flowering and gradually regain their normal, green colour after flowering. Other species, especially those found in very dry habitats, have thick leaves that are equipped with teeth and spines on their edges. Examples are found in many species of *Dyckia* and *Hechtia*.

Another outstanding feature of bromeliads is their prominent bracts and colourful flower spikes that frequently outshine the small flowers. The flowers of bromeliads are typical monocotyledon flowers with all parts in threes. There are three sepals, three petals and the stamens are arranged in two circles of three each. The ovary is formed of three fused carpels. In most bromeliads, a bloom often means the gradual death and the loss of the plant if offshoots are not produced from the base or from leaf-axils of the parent plant. Offshoots are an easier alternative of propagating bromeliads when seeds are not formed. For species that have successful fruit-set, the berries or capsules formed can be vividly coloured and remain so for several months. This is another unique feature that attracts bromeliad enthusiasts.

Care and Cultivation

With such a wide range of conditions under which bromeliads are found, it is a challenge for any grower to try and simulate the conditions of each species under his or her care. Part of the fun of growing bromeliads is to learn about the habitats of the species and to provide the required conditions if best results are to be obtained.

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1. Yuen-Peng McNeice Bromeliad House
2. A "water-tank" formed by overlapping rosette leaves
- 3, 4 & 5. Prominent bracts and colourful flower spikes

Bromeliads

The appearance and structure of bromeliads often give clues as to their cultural needs. Those with vividly coloured foliage usually need considerably more shade than those heavily furnished with grey or whitish scales. Such scales are a natural defense against intense light and drought and indicate that these grey and white plants grow in exposed areas of little rainfall but of high humidity. Many tillandsias, including Spanish Moss and the so-called Air Plants show this habit and they absorb moisture directly from the air. These plants under cultivation would enjoy daily misting with water on their foliage.

Bromeliads with thin textures and rather soft, green foliage would tend to have a preference for shade and high humidity and have a need for keeping the tank/reservoir formed by the bases of leaves filled with water all the time. These bromeliads are inhabitants of areas with high precipitation. However care must be taken however not to leave the water stagnant for too long, as mosquitoes might breed.

The absence of well-developed tanks/reservoirs and the presence of tough, succulent and spiny foliage suggests that the species in the wild probably grows under dry conditions. To avoid rotting, the roots of species of this description should not be kept constantly wet and watering should be sparingly carried out.

Potting mixes for bromeliads vary according to the needs of the various groups. In general, mixes must be acidic rather than alkaline, must drain freely, and for epiphytic kinds, they must contain a good amount of organic matter. Most bromeliads enjoy fairly dry, sunny and airy conditions. The cultural needs of bromeliads in many ways resemble those of epiphytic orchids. For those green-leafed bromeliads that can take to pot culture, e.g. *Aechmea*, *Billbergia*, *Guzmania* and *Vriesea*, an open-textured, lime-free mixture consisting of one part peat moss or shredded leaf mould, one part coarse sand or perlite plus some organic matter is ideal. Truly epiphytic bromeliads can be grown



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on cork bark, slabs of tree fern bark, drift wood or wooden frames. Besides judicious watering, small doses of a liquid fertilizer can be applied to the plants from time to time as a foliage spray.

More often than not, non-tank bromeliads perish due to root rot caused by over-watering. Many species are known to be sensitive to copper, iron and other metals. Do not use copper wires to attach labels to bromeliads. Alkaline soil and water should also be avoided. Over-exposure of shade-loving bromeliads to intense light would result in discoloration and leaf-scorch while not providing enough light for those grey and white bromeliads will result in unsatisfactory growth.

The Collection at the Singapore Botanic Gardens

A good way to trigger off an interest in Bromeliads is to visit the collection in the Gardens. This collection, located in and around the Yuen-Peng McNeice Bromeliad House in the National Orchid Garden consists of about 15,000 plants from 800 species and cultivars. A visit will inspire and give you an idea of the range of form and colour of these wonderful plants that have travelled half the world to be with us.

Tay Eng Pin
Curator/Horticulture

1. Coloured foliage
2. A flowering Painted-fingernail bromeliad
3. Inner leaves assuming brilliant colours close to flowering

THE AROID HOUSE

Aquatics and Semi-aquatics

There are a number of aroids that make rather majestic specimens in ponds while others are suitable for marshy areas or by the edge of ponds. *Typhonodorum lindleyanum*, a native of Madagascar resembles a banana tree and can grow to a height of more than 4 metres. *Philodendron bipinnatifidum*, a climber thrives well both on dry land or in water and is suitable for both sunny or semi-shaded areas.

Pistia stratiotes or water lettuce is the only floating and stemless aquatic aroid. This plant which can grow to a diameter of 20 cm is spongy in texture and bears small white hairy spathes in the centre of a light green rosette of leaves.

The genera, *Anubias* and *Cryptocoryne* are small plants, cultivated largely in aquariums although they can be planted in ponds, too.

The genus, *Spathiphyllum* favours wet grounds and does very well at pond margins. The inflorescence is quite similar in appearance to that of *Anthurium*, but the white spathe emits a strong and sweet fragrance.

Acorus calamus or Sweet Flag is an aromatic herb that originated from temperate Asia and India. Over the centuries, it has spread to most parts of the world and it is still highly regarded as a medicinal plant. It looks unlike a typical aroid looking more grass-like. When crushed, the leaves give a light and sweet aroma.

Bizzare Blooms

A very fascinating and unique aroid, *Amorphophallus*, can be found in the Aroid House. Members of this genus usually bear only one leaf at a time. The inflorescence is often massive and fleshy with a spreading spathe and a foetid appendix. *Amorphophallus*



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paeoniifolius or Elephant yam, a native of Southeast Asia is widely grown for its edible corm. *A. titanum*, reputed to have the tallest inflorescence of any herb, is also planted in the Aroid House.

Andrea Kee
Assistant Manager/Plant Resource Centre

1. *Pistia stratiotes*
2. *Spathiphyllum cannifolium*
3. *Acorus calamus*
4. *Amorphophallus paeoniifolius*



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Annuals in Your Garden

By definition annuals are plants that complete their life cycle within one year or less. They are fast growers and being heavy feeders and ephemeral are regarded as high maintenance plants. These plants normally lose their vigour after flowering and will have to be replaced by younger plants at this time. Flowering annuals nevertheless are popular among avid gardeners. They can be planted in beds and troughs, in pots, window boxes and hanging baskets. As they are short-lived, they can be planted as fillers, i.e. mixed among the more permanent plants in a planting bed.

Growing annuals may appear cumbersome and costly to some, however they yield quick dividends and the garden is always different with fresh flowers and new colours. It is obvious that annuals which are

the nurseries. (Locally grown or imported from Malaysia they are reasonably priced at between \$6 to \$15 per pot). However, you can grow a wide range, and all the year round too.

Selection

Annuals are usually grown from seeds which are sold in colourful packets in the gardening section of departmental stores or in plant nurseries. Few like the coleus, chrysanthemum, dahlia, petunia, salvia and busy lizzie, can be propagated from cuttings. While some annuals like the celosia and marigold take between 90 to 100 days to reach full flowering from seed, others like the chrysanthemum normally require between 120 to 180 days, depending on the cultivar.

Sowing and Seedling Care

There are several ways of starting plants from seeds. The conventional way is to sow seeds on a propagation tray of a suitable rooting medium like vermiculite, sand, or a mixture of sand and cocopeat.



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1. *Tithonia*
2. *Torrenia* (foreground) and *Coleus* in a garden setting.
3. Ornamental Chilli
4. Marigold

easily planted for a massed colour effect, bring life to shopping malls and meeting places. In the temperate countries they are predominantly displayed in parks and gardens during spring, summer and autumn. In Singapore they surface during the festive seasons like the Chinese New Year. Even then only a few popular types, like celosia, chrysanthemum, marigold and dahlia are available in

To prevent etiolation it is important to bring the seedlings out from the shaded propagation house to benches where there is sufficient sunlight. Ensure that watering is adequate and to boost growth, fertilise the seedlings with a dilute liquid fertiliser (check the instructions given on the fertiliser pack for the correct dosage for seedlings).

Another convenient way is to use netted Jiffy-7 peat pellets or 'pots'. Soak the compressed peat 'pots' in water and arrange them in the propagation tray. Plant two to three seeds to one peat 'pot'. The

advantage of using this method is that there is little disturbance to the roots as the seedlings are transplanted together with the peat to planting beds or pots.

When seedlings have developed two or more leaves they are ready to be transplanted or pricked on to individual pots containing a suitable potting mix for annuals. Imported potting mixes are generally light, consisting of sand, peat, and perlite. Burnt earth or sterilised topsoil can be incorporated to give the mix more weight, or used alone. The selected mix should be well-drained yet moisture-retentive.

Pinching and staking

Except for celosia, most annuals require pinching or the removing of terminal shoots or growing points to encourage branching and bushy growth. This is first carried out when seedlings are 8 cm to 10 cm tall, and regularly done for every branching until a suitable form is established and the plant is ready to flower.

Tall and bushy plants require supporting canes or stakes. Tie the stems loosely to the stakes. Continue supporting the stems as they grow.

Care

Most annuals require strong sunlight, adequate watering and regular fertilising. Use fertilisers high in nitrogen for initial leafy growth and high in phosphorus and potassium for flowering. Organic fertilisers like Hortimeal and Nitrosol and chemical fertilisers like Phostrogen, Gaviota, Hyponex, and Nitrophoska are some of the many suitable fertilisers available in the market.

Inspect the plants regularly for insect infestation and manually remove insects if present. If chemicals have to be used, apply the least toxic types like soap solution, white summer oil or plant-derived pyrethroids.

Jennifer Ng

Assistant Director, Education

JEWELS OF THE WATER

Introduction

The varied landscapes of the Gardens add to the joy and pleasure of visitors. A unique attraction is the waterscapes. These are graced by a fascinating group of plants, the aquatics.

Some aquatic plants grow rooted in the mud and are completely submerged. Others rooted at the bottom may produce floating leaves, with their flowers borne above the water. Yet others float on the surface with their dense tuft of fine roots trailing in the water. All these plants are completely dependent on the water and will not survive on land.

Other aquatic plants are happy in the border zone between water and land. They grow on wet soils or in shallow water and are often referred to as marsh plants. They have both shoots and flowers in the air, and some of them are able to withstand short periods of drought. It is often not possible to make a clear division between the plants of the water and marsh plants.

The plants

The waterlilies are the most common group of aquatic plants found in the Gardens. They are popular as they have strikingly beautiful flowers and because they are easy to grow. Their generic name *Nymphaea* is from the Greek word *nymphē*, meaning a water nymph. Water-lilies are propagated by seeds and rhizomes. Some species have viviparous ability with new plants sprouting from the leaf stalks. The rhizomes and seeds of some species are used as food locally.

Water-lilies need exposure to full sun and still or sluggish water. They do not prosper in streams with any appreciable flow or in pools with fountains splashing onto them. They are gross feeders, needing rich soil preferably on the clayey side. One good mix is fertile topsoil enriched with bonemeal and a slow release fertiliser. The Gardens showcases a collection of water-lilies with red, blue, yellow, white and pink flowers.

Nymphoides, due to their appearance, are often mistaken by many as belonging to the water-lily family Nymphaeaceae. Botanists recognised this similarity in overall appearance by bestowing the name *Nymphoides*, meaning, 'resembling the genus *Nymphaea*.' The similarity in the leaves and manner of growth is deceiving because careful examination of their blooms will quickly dispel any belief that *Nymphaea* and *Nymphoides* are kin. The latter belongs to the gentian family, Gentianaceae.

One species is *Nymphoides indica*, commonly known as 'snowflake'. From its underwater rhizomes, long leafstalk-like stems appear. Sterile stems bear a broad heart-shaped floating leaf at the top while the flowering stems bear one or more leaves and pure white blooms with yellowish centres. Individual blooms remain open only for one day.

Nymphoides are delightful for pools and other still waters. They give little trouble and produce long displays of blooms. They can either be grown in containers or directly in the soil bottom. They give their best in rich, rather heavy soil and thrive in full sun. Propagation is by division or by seeds.

There is probably no other plant held in such reverence in the East as the lotus, *Nelumbo nucifera*. This plant has thick rhizomes and large circular plate-like leaves with the stalks attached underneath at the centre of the blade. Both the leaves and flowers are normally raised high above the water on stout stalks, the flowers mostly overtopping the foliage. The usually white or pink flowers are very attractive and fragrant. The funnel-shaped 'seed-pods' are flat-topped with holes containing a large seed-like nut each. Frequently they are dried, bronzed or silvered and used as ornaments.

According to Hindu belief, valleys, hills and rivers were formed from the petals of a huge lotus flower by Brahma the creator of the Universe. An Indian fable holds that

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JEWELS OF THE WATER

the lotus flowers obtained their reddish colour by being dyed with the blood of Shiva, when Kamadeva, the god of love, wounded him with a love arrow. To the Buddhist the lotus flower symbolises Man with his head held high, pure and undefiled in the sun while his feet are rooted in a world of experience. It is a symbol of beauty and a sacred seat of Buddha. He was believed to have been born in the heart of a lotus flower. This could also be the sacred lotus of the Nile, which is no longer found there.

Lotus can be planted in mud bottoms or in containers of rich soil where their rhizomes are covered with 30 cm to 90 cm of quiet water. They need a sunny location and for their best development, ample space to spread. Propagation is best by seeds.

The water hyacinth, *Eichhornia crassipes*, is an aquatic herb native to South America. It is generally free floating but in shallow waters may root into mud bottoms. It forms broad, rosette-like clusters of leaves with much-swollen leafstalks and great masses of long, dangling, freely-branched roots. The flower spikes are erect and arise from the centre of the plant.

When first introduced to the USA from Venezuela in 1884, it was regarded as an innocent and most attractive water ornamental with its showy bluish flowers. But the plant soon became a menace reproducing remarkably fast choking waterway, affecting both transportation and fish population. On the other hand, it is considered useful because of its ability to absorb various elements from the water, hence functioning as a water purifier.

A Chinese resident brought the water hyacinth into Singapore from Hong Kong in 1903 and grew it in his garden at Balestier Road and from there it was later brought to the Botanic Gardens. Chinese villages at Bukit Timah Road later grew it for feeding pigs. In Java the young

leaves, petioles and inflorescence are cooked as food. Elsewhere it has been used for making paper and cardboard.

Water hyacinth grows best in nutrient rich waters. It requires sunny areas and a comparatively still environment. It is best grown in water not over 30 cm deep so that the soil that supplies needed nutrients is not far away. It increases rapidly by natural offsets.

Thalias, of the family Marantaceae, are confined to the tropics of the Americas and Africa and in nature chiefly inhabit swampy forests. The name commemorates the sixteenth-century German physician and naturalist Johann Thal. They are herbaceous perennials with long-stalked, calathea-like, all-basal leaves and purplish, violet or blue blooms. The stalks enfold each other toward their bases and function as pseudostems. The spikes bear flowers in two vertical rows and are with bracts that fall before the fruits mature.

Thalia dealbata, a native of swampy woods from South Carolina to Missouri, Florida and Texas, has purplish blooms that are attractively coated a powdery-white. *Thalia geniculata*, on the other hand, differs in having looser, pendulous spikes with markedly zigzagged stalks and blooms that are not coated a powdery-white.

Thalias are useful as graceful flowering decoratives for boggy places and shallow ponds and pools. They require lightly shaded or sunny locations and thrive in fertile soil that contains generous amounts of organic matter. They can be accommodated in large tubs or containers or can be planted directly into soil bottoms in up to 1 m of water. Propagation is by seeds or division.

Sagittaria sagittifolia, or better known as the arrowhead is a variable native of Europe and Asia. The name *Sagittaria*, from the Latin *sagittarius* (armed with arrows) alludes to the shape of the leaf blades. The bases of the arrowhead are under water with the roots anchoring them to the soil bottom. Arrowheads have milky sap and formed edible tubers which are much

used in the Orient. The flowers are about 2.5 cm in diameter and have petals blotched at their bases with purple.

Arrowheads are useful for permanent plantings at the margins of ponds, streams and other water bodies. They can also be grown in tubs and containers to complement water lilies and other lower-growing aquatics to provide a welcome variation in height, leaf-shape and flower pattern. They require fertile, loamy soil and succeed in sun or partial shade in water from 2 cm to about 45 cm deep. Propagation is usually by division.

In the Botanic Gardens there are a few areas where you will be able to see aquatic plants. These include the Aroid House, Marsh Garden, Sundial Garden, Symphony Lake and Eco-Lake. Take your time to enjoy the beauty of these plants.

Camelia Marican & Alan Tan
Assistant Managers,
Singapore Botanic Gardens Mgmt



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1. *Nymphaea cultivar*
2. *Nelumbo nucifera*
3. *Eichhornia crassipes*
4. *Thalia dealbata*, an inflorescence showing zigzag stalks