Gardenwise

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Gardenwise

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Articles

Regular Features

Cover
An inflorescence of *Dracaena surculosa*. This species joined *Dracaena* across Singapore in a rare mass flowering event earlier this year.
(Photo credit: Jana Leong-Škorničková)

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Group Direction

Let it never be said that the Singapore Botanic Gardens stands still! As in previous recent issues of *Gardenwise*, here we report another new development at the Gardens, the Ethnobotany Garden and Centre, opened on 30 June at the start of our annual Heritage Festival (see pages 2–5). A measure of how interesting this new feature is can be gauged by the fact that our ministerial Guest-of-Honour at the launch, Mr Desmond Lee, extended his planned visit by 90 minutes! As in other recent openings – namely the Learning Forest and Jacob Ballas Children's Garden extension – the Ethnobotany Garden is overtly educational in its purpose, thereby fulfilling the all-important 'E' for Educational in UNESCO, as part of our ongoing response to the World Heritage status conferred on us three years ago (see also pages 34–35). Elsewhere in this issue the human heritage of the Gardens is reflected in the extraordinary number of plant and fungal species named after our famous botanists down the years, from Murton, Cantley and Ridley (1875–1912), to Holttum, Corner and the Burkills (×3) during the 20th century (pages 25–27). And orchid shows are another key part of our history, the founding of what is now the Orchid Society of South East Asia (OSSEA) and the first laboratory breeding of orchid hybrids 90 years ago being celebrated in the largest ever local competitive show during April at the Gardens (page 36).

Plant and fungal diversity is addressed in a variety of contributions in this issue, be it as seen in nature, both here in Singapore and abroad, or in our parks and gardens, whether botanical, community or private, especially through the cultivation of vegetables and herbs to enrich our kitchens and dining tables. The ability of Singapore's hobbyist gardeners to produce extraordinarily large vegetables (see above) was amply demonstrated at this year's Singapore Garden Festival, where two of the exhibits in the Community Gardening tent were a winter melon weighing nearly 34 kg and a snake gourd approaching 2 metres in length!

Our networking with overseas partners brings many mutual benefits. Thus, link-ups with the historic Penang Botanic Gardens and with colleagues in Perth, Western Australia are enabling the sharing of expertise (pages 37–39), while our visiting fellows from around the world are helping deliver the much anticipated *Flora of Singapore* (page 28).

Nigel P. Taylor
Group Director
Singapore Botanic Gardens

The opening of the Ethnobotany Garden

The Botanic Gardens' newest feature, the Ethnobotany Garden, was officially opened on 30 June 2018 by Mr Desmond Lee, Singapore's Minister for Social and Family Development & Second Minister for National Development. It comprises a Centre for Ethnobotany and an outdoor garden showcasing over 300 species of plants used traditionally by indigenous people in the region, with a focus on the cultures of Peninsular Malaysia and Borneo. The aim of the Ethnobotany Garden is to be a hub for research in ethnobotany and to provide educational opportunities for visitors.

The outdoor garden is organised into four zones to reflect the traditional uses of plants by indigenous people in the region – the Living Zone which highlights plants used for sustenance, the Craft and Construction Zone, the Symbolism Zone focusing on the symbolic uses of plants, and the Medicinal Zone. The plant palette is mainly inspired by the tribal traditions of Indochina and based on notes from I.H. Burkill's *Dictionary of the Economic Products of the Malay Peninsula*. The outdoor landscape and shelters are decorated with artefacts sourced from Borneo. Boulders with murals depicting various scenes of domestic life are also displayed in each zone.

Living collections of the outdoor garden

Living Zone

The earliest tribes in the region were hunter-gatherers who foraged for sustenance and developed weapons for hunting from resources found in their forest environment. Framing the main entrance to the Ethnobotany Garden from the Eco-Lake is *Antiaris toxicaria*, a species important to many hunters from Peninsular Malaysia and Borneo as the latex is traditionally used as arrow poison. Also at the main entrance are species such as *Baccaurea parviflora*, *Durio oxleyanus* and *Diplazium esculentum* which provide some of the fruits and vegetables traditionally foraged from the wild. Plants with

A bird's-eye view of the Ethnobotany Garden, with the Centre for Ethnobotany shown at the top centre. *(Photo credit: Wong Tuan Wah)*

The Ethnobotany Garden is located in the Bukit Timah Core south of the Eco-Lake. It was designed around a waterbody and is organised into four zones which reflect the traditional use of plants in medicine, in craft and construction, for symbolic purposes and for food.

The Living Zone features a collection of plants with edible rhizomes and tubers, such as *Tacca leontopetaloides*.

edible rhizomes or tubers, like *Tacca leontopetaloides* and *Dioscorea hispida*, are also showcased.

Traditionally, the Dayak from Borneo would make the treacherous climb up *Koompassia excelsa* trees to harvest honey from honeybees nesting in the canopy. This tradition has evolved over time and today many Dayak prefer to collect honey from artificial hives located near the ground instead. Boxes for stingless bees have been installed at the base of a collection of *Koompassia excelsa* trees in the Living Zone. These boxes contain live colonies of the harmless stingless bee *Heterotrigona itama*, allowing visitors to safely observe bee activity up-close. This feature offers school groups and people of all ages an opportunity to learn about and appreciate the importance of bees and pollination.

Craft and Construction Zone

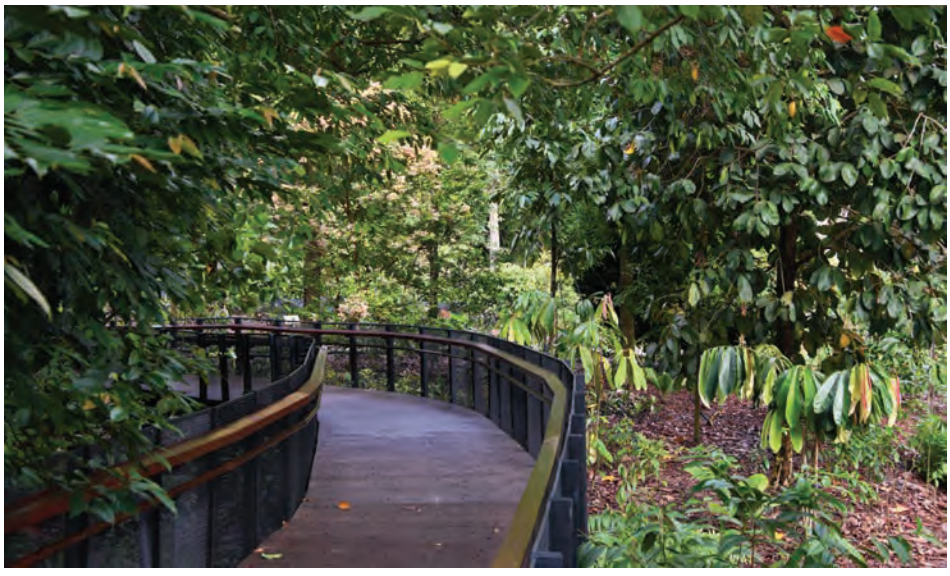
The plant collection in this zone consists of species which are used for timber, fibre and dye. One of the chief timber species that can be found here is *Eusideroxylon zwageri*. Commonly called Belian, it is used by the Dayak for crafting blowpipes, spears and religious totems. Various rattan and bamboo species commonly used in basketry are also on display in this zone. Also found here is *Artocarpus odoratissimus*, the bark of which is traditionally used to make cloth, or *terap*. This was the material of choice for clothing by many indigenous people before the introduction of cotton. Visitors can also see a variety of plants used as sources of traditional dyes in this zone.

Stingless bee hives and *Koompassia excelsa* trees in the Living Zone.

Symbolism Zone

Plants of symbolic value are showcased in this zone. There is a boardwalk through this area that takes visitors around an old *Cassia fistula* tree, which is enclosed by the roots of a Banyan tree (*Ficus microcarpa*). Along the boardwalk, species that produce an aromatic resin such as *Dryobalanops aromatica* and *Aquilaria malaccensis* can also be seen. Burning of their resins or bark is said to confer protection and heighten spiritual awareness in some religious ceremonies.

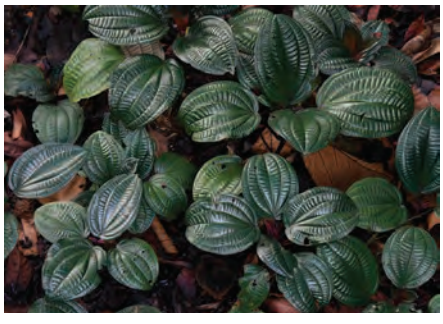
A stone mural by Mr Yip Yew Chong in the Living Zone depicting a scene in a Peranakan kitchen. There are three other murals featured in the Ethnobotany Garden; they show scenes of a Hindu wedding (in the Symbolism Zone), a *kampung* (in the Craft and Construction Zone) and a medicinal stall (in the Medicinal Zone). *(Photo credit: NParks)*



A boardwalk lined with forest species takes visitors through the Medicinal Zone.

Medicinal Zone

Many modern medicines are derived from plants, discovered through indigenous knowledge passed down for generations. In the Medicinal Zone, an elevated boardwalk takes visitors through a collection of forest plants with medicinal value, including orchids such as *Corymborkis veratrifolia* and *Bromheadia finlaysoniana*.



(Left to right) *Phyllagathis rotundifolia*, *Labisia pumila* and *Tacca integrifolia* are some of the medicinal plants featured in the Medicinal Zone.

Centre for Ethnobotany

The Centre for Ethnobotany is part of a cluster of five conserved houses which used to serve as staff housing for the principal and professors of Raffles College, the predecessor of NUS. Built around 1928, it overlooks the outdoor garden, and can be reached from the Medicinal Zone on an old brick staircase which is part of the original house, or from the building's main entrance near the Summit canteen at NUS.

The first floor of the Centre for Ethnobotany explores the relationship between plants and people. It features a room with the theme 'Plants Shaping the Region and Beyond', showcasing economic plants and their significance in shaping global history. An interactive rotoscope allows visitors to view the cross sections of plant parts, overlaid by a movable screen with an illustrated animation of how the plants are processed for use. Noteworthy species highlighted here are Gutta Percha (*Palaquium gutta*), Nutmeg (*Myristica fragrans*), Cacao (*Theobroma cacao*) and Pará Rubber (*Hevea brasiliensis*), the latter being of particular significance to the history of the Singapore Botanic Gardens.

View of the Centre for Ethnobotany from the outdoor garden.

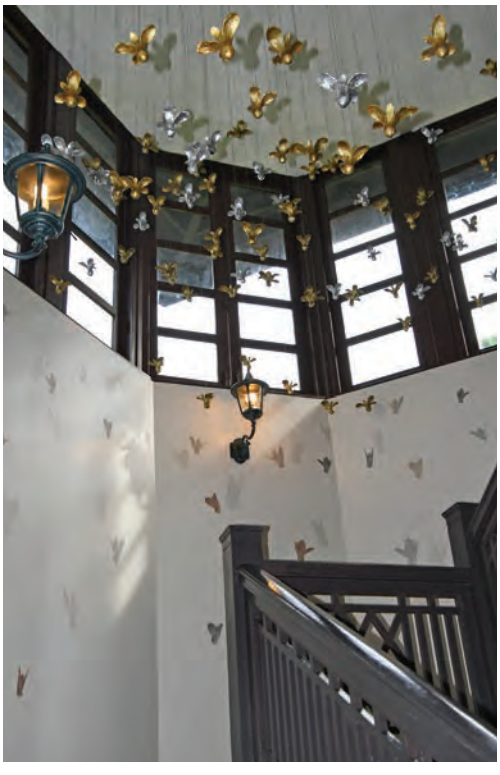
Also on the first floor is 'Cornucopia of the Botanical World', a gallery displaying artefacts collected from Peninsular Malaysia and Borneo. These are objects made from plants and previously used by indigenous people for domestic purposes, such as baskets, baby carriers, musical instruments and ceremonial totems. Through these artefacts, visitors can discover how indigenous knowledge of plants and botanical resources has shaped culture and identity.

Visitors can learn about the seven key species that shaped the region's history in this interactive showcase.

The artefacts in the 'Cornucopia of the Botanical World' are of plant origin and were sourced mainly from Sarawak.

This traditional Dayak baby carrier was carved from Belian (*Eusideroxylon zwageri*) and weighs more than 3 kg.

This interative feature allows visitors to view selected pages of Burkill's *Dictionary of the Economic Products of the Malay Peninsula.*



***Shorea macrophylla* fruits made from brass hang from the ceiling over the staircase to the second level.**

Underneath the staircase leading up to the second level is a cosy corner resembling a miniature library, complete with a desk where visitors can explore a digitised version of Burkill's *Dictionary*. Published in 1935, this book is a treasure trove of rare accounts of indigenous knowledge on plants. These were documented by I.H. Burkill based on field observations during his time as the Director of the Singapore Botanic Gardens from 1912 to 1925.

Known as the 'Shorea deck', the second level of the Centre for Ethnobotany is a flexible multipurpose space which allows for changing exhibitions and workshops to be held. A collection of 175 wooden printing blocks bearing botanical illustrations are currently on display in one room of this space. A number of these illustrations were created by Juraimi bin Samsuri, a Malayan artist employed by the Gardens in the 1940s, including when Singapore was under Japanese rule during WWII. During this period, Japanese botanists catalogued local uses of plants for a publication called *Illustrations of Useful Plants of the Southern Region* which was published by the Malaya Military Department. Their work highlights the unusual collaboration between the Japanese occupiers and Gardens staff during the war.

As forests and indigenous communities around the region disappear, the Ethnobotany Garden aims to collect and preserve traditional knowledge of plants, and provides an avenue to raise awareness about the field of ethnobotany.

Lai Simin
Horticulture and Operations

All photos by Lai Simin, unless otherwise indicated.

An introduction to traditional Japanese horticulture

Plants are a main component of the Japanese way of life. Many of us are familiar with the celebration of cherry blossoms in the spring and the strikingly colourful foliage of maples that characterise the autumn season in Japan. Chrysanthemums, lotuses, irises and peonies are also hugely celebrated elements of Japanese culture, as is the art of bonsai.

The development of traditional Japanese horticulture, known in Japan as *nihon no dento engei*, is closely associated with dramatic societal changes in Japanese history. In 1603, following years of civil unrest, Tokugawa Ieyasu was appointed shogun. He moved the capital city from Kyoto to Edo (today's Tokyo), diminishing the power of the imperial family. The shogunate spanned until 1868, and this era is known as the Edo period. During this time, contact between Japan and other countries was minimal and trade was tightly controlled. With little influx of exotic ornamental plants, native species were domesticated to become decorative garden features. Ieyasu himself was described as a lover of flowers. His son Hidetada collected many types of plants but had a special interest in primulas and camellias, and Hidetada's successor Iemitsu was apparently more interested in growing bonsai than spending time running the country.

During the Edo period, the local feudal lords resided every other year in Edo. There they created magnificent townhouses with large gardens and brought plants with them from their home provinces, fuelling Edo's crave for new plants. Horticultural novelties were exclusive, rare and expensive, and made great gifts for the shogun and other lords. The samurai also started growing traditional plants that could be sold to support their households.

Plants were exhibited, donated, exchanged and sold during this period, and the need to transport plants meant that potted specimens were most suitable. Bonsai were an obvious choice but also a myriad of other small plants became popular. Among the flowering plants, the already mentioned primulas were a favourite,

Omoto cultivars (*Rohdea japonica*) at Houmeien Nursery in Okazaki, Aichi Prefecture.

***Cymbidium kanran* on display at the Makino Botanic Garden in Kochi Prefecture.**

but more unusual perennial herbs such as *Adonis amurensis* and species of *Asarum*, and annuals such as *Ipomoea nil*, gained popularity as well. Orchids were also popular, in particular the native *Neofinetia* (now in *Vanda*) and *Cymbidium*. Variegated plants were particularly sought after and as early as 1829, Mizuno Chukyo published a seven-volume book dedicated to them, including hundreds of woodblock illustrations. One of the most iconic plants from this period is *Rohdea japonica*, commonly known as Omoto. It is still very popular in Japan, and numerous variegated forms with unusually shaped leaves have been developed.

Traditional Japanese plants that can be cultivated in Singapore

Psilotum nudum, or Matsubaran, is a fern that reproduces by spores and lacks roots and leaves. The above-ground stems are supported by a network of below-ground stems that absorb water and nutrients via many small hairs. Interestingly, *P. nudum* occurs in tropical and subtropical climates worldwide, including Singapore, but

Matsubaran or *Psilotum nudum* on display at the Makino Botanic Garden in Kochi Prefecture.

A Matsubaran cultivar with upright stems and yellow tips at the Ranmanen Nursery in Futtsu, Chiba Prefecture.

only in Japan has it become a sought after garden plant. Its popularity started about 400 years ago when specimens with unusually shaped stems were collected from the wild and cultivated. Up to 100 different varieties of *P. nudum* were known in the Edo period, many of which are still cultivated today. Some are dwarf with thick stems; others have yellowish, twisted or weeping stems. All can thrive in Singapore if potted in a well-drained medium and placed in moderate to deep shade and given ample water.

During the Edo period, *Rhapis* palms, which come mostly from mainland Asia, were introduced to Japan and

Kanonchiku and Shurochiku (*Rhapis*) cultivars at the collection of Kosuke Inukai in Osaka.

A selection of Kannonchiku and Shurochiku cultivated in Singapore.

gained popularity there. Variegated forms were known by the end of this period, and subsequently many more forms were selected and named. *Rhapis* cultivars are almost entirely derived from *Rhapis excelsa* (known as Kansochiku or Kannonchiku), but a few have been developed from *Rhapis humilis* or *R. laosensis* (named Shurochiku). New varieties can arise from seed but most commonly come about as mutations in new offshoots. Variegation can vary between individual offshoots of the same plant, with the leaves of some striped in white, yellow or pale green, while others may not be variegated at all. In today's Japanese markets plants are ranked on the quality of their stripe pattern, with those that have fine and evenly arranged stripes commanding higher prices. New or slow-growing varieties can command prices up to 1,200,000 ¥ (more than S$14,000!).

A few variegated forms are, however, rather stable, easy to grow and inexpensive. In Japan, it is common for *Rhapis* to be cultivated using a traditional method that keeps them dwarfed. They are grown in small containers which limit their root growth, and in a nutrient poor substrate made entirely of river sand. Japanese *Rhapis* varieties can be grown here in Singapore (*R. excelsa* is actually a locally common roadside plant and *R. humilis* is widely planted here), but the traditional Japanese method of cultivation is problematic. Due to our hot climate, plants tend to dry out quickly and should be planted in larger containers with some organic matter in the substrate to retain moisture. Some varieties can be grown here in the ground, but only in sheltered areas without direct sunlight. Specimens with large stripes of white variegation are particularly susceptible to direct sunlight and their leaves are easily scorched.

Michele Rodda
Herbarium

All photos by Dr Michele Rodda

Editorial note: This article is a summary of a talk given in February 2018 by Dr Michele Rodda through the Gardens' Speaker Series. Talks are open to the public and held once a month at the Singapore Botanic Gardens.

Botanising in the montane forests of Lanjak-Entimau Wildlife Sanctuary in Sarawak

Our third expedition to the Lanjak-Entimau Wildlife Sanctuary (LEWS) began at the Batang Ai jetty in Lubok Antu, Sarawak, on the 1st of March, 2018. The familiar sight of the longboats docking there was exciting, promising the joy of looking for unusual and rare plants in the forests, but also daunting, as we knew that an uncomfortable five-hour ride along a serpentine river with countless rapids lay ahead of us.

Our first two trips to the area focused on botanising the lowland and hill forests around Nanga Segerak and Nanga Bloh in LEWS, and in the Batang Ai National Park (see *Gardenwise* 48: 8–11, and 49: 4–7). As with the other trips, this expedition was organised by the Sarawak Forestry Corporation (SFC) as part of the RIMBA (Research for the Intensified Management of Bio-Rich Areas of Sarawak) project, with the joint participation of the Singapore Botanic Gardens. The purpose of this trip was to continue the botanical assessment of the forests in LEWS, focusing this time primarily on the montane forests of its highest peak, Bukit Lanjak.

The climb

The five-hour longboat ride was only the first part of our journey towards the summit of Bukit Lanjak. Our boat took us to Nanga Talong, where we stayed in a longhouse for the night, then spent the entire next day trekking to the Nanga Segerak field station. On the morning of the third day, we began our climb up the mountain. It was not straight-forward nor gradual; certain parts were steadily steep while others were undulating, and as it had been raining almost daily, the terrain was muddy and slippery. In steep areas, we had to grab on to whatever we could as we pulled ourselves up step by step, stopping occasionally to catch our breath. At one point, after ascending to an elevation of about 500 m, we had to make a steep descent in order to cross

The river with countless rapids that took us to Nanga Talong. *(Photo credit: Roslina Ragai)*

Members of the team: (back row from left) Roslina, Empading, Michele, Jantan, Kana and Paul; (front row from left) Mabong, Dellie, Sirukit and Bakar. *(Photo credit: Roslina Ragai)*

Our campsite at Kaki Peninjau. *(Photo credit: Michele Rodda)*

A misty morning at Kaki Peninjau. *(Photo credit: Paul Leong)*

the Jela River before climbing upwards again to reach the first campsite. Our full backpacks compounded the challenge as we had to carry supplies for the next seven days along with us. We reached the Ubah Ribu shelter at 704 m in elevation before 5 pm and spent the night there.

Our active botanising began the next morning with the hill forest vegetation around the Ubah Ribu shelter. The vegetation consisted of large trees such as *Koompassia* in the Fabaceae and various genera in the Dipterocarpaceae, Myristicaceae and Fagaceae, smaller trees from the Ebenaceae, Myrtaceae and Meliaceae, and shrubs and treelets from the Rubiaceae, Annonaceae and Melastomataceae. Herbs were mainly from the families Zingiberaceae, Begoniaceae, Gesneriaceae, Urticaceae and Araceae, while the main epiphytes and climbers were from the Orchidaceae, Araceae, Rubiaceae and various families of ferns. Worth special mention are two ground orchids, *Lecanorchis multiflora* and *Aphyllorchis pallida*: although non-spectacular looking, these are very unusual orchids that are leafless and lack chlorophyll. As myco-heterotrophs, they obtain their nutrients from fungi. Both individuals were less than 50 cm tall and only noticeable because they were in flower and fruit, in each case consisting of just a stem and an inflorescence bearing several flowers.

Montane forest

Above the Ubah Ribu shelter, the character of the vegetation gradually changed, transitioning from hill forest to lower montane forest. Our next campsite at Kaki Peninjau was our highest, at 1,003 m in elevation. We spent three nights there, making forays each day from this base – first to the peak of Bukit Lanjak, measured by our GPS at 1,285 m in elevation, and then to Bukit Sekajang, which is the second highest peak of Lanjak-Entimau. As it would be a long trek to that summit, we stopped at 1,122 m before returning back to camp.

In the montane forest, the diversity of the dipterocarps decreased, although one species of *Shorea, S. monticola*, was encountered flowering and fruiting near the summit of Bukit Lanjak. The size of the trees also appeared to diminish somewhat, reaching a maximum height of about 20 to 30 m. We noticed more trees from the Fagaceae, and collected specimens from three species of *Lithocarpus*, one with large acorns about 5 cm in diameter. Species of Lauraceae and Myrtaceae were also common. Perhaps the most distinct aspect of the transition from hill to montane forest was the increase in mosses, lichens and epiphytes. At elevations above 1,200 m, the mosses were so abundant that they covered the tree trunks and carpeted the ground, and occasionally we saw pads of sphagnum moss. Ferns were the most abundant of the epiphytes, and we encountered *Cheiropleuria bicuspis* growing on a vertical earthen bank in deep shade; a beautiful tree-climbing species of *Elaphoglossum*; a ubiquitious

The orchid *Coelogyne plicatissima*.
(Photo credits: Paul Leong)

The pitcher plant *Nepenthes tentaculata*.
(Photo credit: Michele Rodda)

The orchid *Eria* cf. *crassipes*.
(Photo credits: Michele Rodda)

***Rhododendron atrichum*.** *(Photo credit: Roslina Ragai)*

***Abrodictyum meifolium*, a filmy fern that looks like it would be happy in an aquarium.**
(Photo credit: Michele Rodda)

An interesting, yet-to-be identified *Bulbophyllum* species. *(Photo credits: Paul Leong; inset, Michele Rodda)*

View near the summit of Bukit Lanjak. *(Photo credit: Roslina Ragai)*

View of Bukit Sekajang, the second highest peak in LEWS. *(Photo credit: Roslina Ragai)*

scrambling climber, *Oleandra neriiformis*, with un-fern-like verticillate leaves; and a tree fern with moss-like hairs on the stem. At an elevation of around 1,150 m at the base of a tree, we encountered a feathery fern, *Abrodictyum meifolium*, that looked like it would happily grow submerged in an aquarium. The understorey was more open than in the hill forest, with several species of small palms from the genus *Pinanga*, and in sunny areas, species of *Vaccinium* and *Rhododendron* from the Ericaceae. Shrubs and climbers belonging to Melastomataceae and Rubiaceae were common in both the hill and montane forest. Two species of pitcher plants were encountered, *Nepenthes tentaculata* and *N. rafflesiana*, the latter of which was found at about 1,120 m in elevation but amazingly also occurs in lowland forests. Other epiphytes included the ginger *Amomum epiphyticum*, *Aeschynanthus pulcher* and *Agalmyla* from the Gesneriaceae, and of course orchids, such as *Coelogyne plicatissima*, *Eria* cf. *crassipes*, and several species of *Dendrochilum*, *Trichotosia* and *Bulbophyllum*, including an interesting specimen that the *Bulbophyllum* specialist with whom we consulted upon our return puzzled over.

After three days of camping at Kaki Peninjau, we returned to the Ubah Ribu shelter for a night and spent two nights further down the mountain in the valley of Nanga Gerungang, where we botanised the vegetation along the Jela River before returning to Nanga Segerak.

The team collected a total of 186 herbarium specimens, most with two or more sets of duplicates. The first set will be deposited in Sarawak, and duplicates will be sent to the Singapore Botanic Gardens' Herbarium and other herbaria. In addition, 40 living plants were collected to be cultivated by SFC. The families or group of plants most represented in our botanical collection, by percent of the total number of specimens collected, are the Urticaceae (11%), Orchidaceae (10.8%), Rubiaceae (10.8%), ferns (10.3%) and finally Melastomataceae (7.5%).

Paul Leong, Michele Rodda
Herbarium

Roslina Ragai
Sarawak Forestry Corporation

Our local *kampung* mango flowers

The flowering *Mangifera pentranda* near the Plant House, viewed from Cluny Road. This tree is very large – about 25 m tall, with a trunk around 90 cm in diameter.

In addition to the common Indian Mango (*Mangifera indica*), it would come as a surprise to some to know that there are about 70 species of *Mangifera* in total globally. Mangoes are distributed throughout tropical Asia, with the highest number of species found in the biogeographical area known as Sundaland. This area includes the Malay Peninsula, Borneo, Sumatra and Java, and Singapore is located at its geographical heart. Eleven species of mango are presently listed as native to Singapore and six of these can be found in the Gardens (*M. caesia*, *M. foetida*, *M. griffithii*, *M. magnifica*, *M. odorata* and *M. quadrifida*).

In February 2018, one of our large mango trees, located near the Plant House, flowered spectacularly. This provided an excellent opportunity to confirm its identity, as flowers are usually needed to distinguish mango species. Obtaining flowers from a mango tree can be challenging, however, as they are produced irregularly and usually after periods of drought. Also, there are collection difficulties as mature mango trees can often be more than 20 m in height, requiring special equipment to access the flowers. Fortunately, Dennis Sng from the Gardens' arboriculture team was able to help with obtaining the flowers from the 25 m-tall specimen near the Plant House. Examination of the fresh flowers enabled us to confirm its identity as one of the lesser known mangoes endemic to our region, *Mangifera pentandra*. Formerly planted in villages, this species is one of our local *kampung* mango trees. It is sometimes called *pauh asal* in Malay, which can be translated to 'native mango' in English. *M. pentandra* is known from the wild on the Malay Peninsula and in northern Borneo, where it is found in lowland forests. Other than the mature tree near the Plant House, there is a specimen Heritage Tree of this species located opposite the Sun Garden.

Mangifera pentandra very much resembles *M. indica*, which is considered naturalised in Singapore, and is often confused with that species. The key

The yellow-green inflorescence stalk of *Mangifera pentandra*.

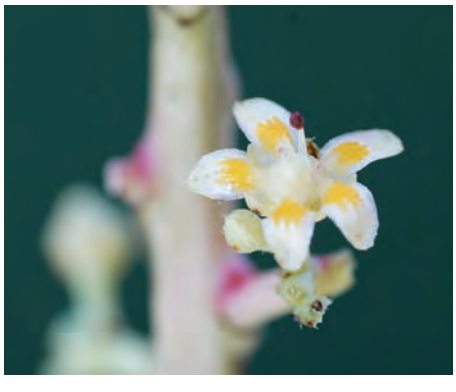
The pink-tinged inflorescence stalk of *Mangifera indica*.

Flowers of *Mangifera pentandra*, showing four fertile stamens.

differences between them are in their flowers and inflorescence stalks. The flowers of *M. pentandra* have three to five fertile stamens whereas the flowers of *M. indica* have only one or two. In addition, the inflorescence stalk is yellowish green in *M. pentandra* whereas it is tinged with pink in *M. indica*.

The flowers of *Mangifera pentandra* are very attractive when fresh, with purplish anthers and white, spreading, reflexed petals with yellow ridges. However, these colours are not long lasting. The anthers rapidly turn from purple to black and the ridges on the petals turn from yellow to brown as the flowers become older.

It is uncertain whether the *Mangifera pentandra* near the Plant House was planted or is a relic of the rainforest that once covered that part of the Gardens (a fragment of which still stands as the Rain Forest). At present, this species is not included as a native plant in the Singapore checklist. However, ongoing work on the family Anacardiaceae for the Flora of Singapore project has revealed a specimen of this species in the Singapore Herbarium collected by H.N. Ridley, dated 1899 from an unspecified location in Singapore. This suggests that *M. pentandra* should be added to the Singapore checklist, which would result in a total of 12 species of mangoes that are native to Singapore. Despite its small land area, the diversity of mangoes in Singapore remains surprisingly high!



A flower of *Mangifera indica*, with one fertile stamen.

S.K. Ganesan
Ali Ibrahim
Herbarium

All photos by S.K. Ganesan

Mass flowering of *Dracaena* in Singapore

In her stable and reliably hot climate, Singapore made headlines when daily minimum temperatures dropped to 21–22°C for five days in January 2018. This cool spell caused a rarely seen event in the city, and I don't refer to the sightings of winter coats on Orchard Road! One of the most spectacular effects of the cool spell was the flowering of *Dracaena* plants across the country.

Dracaena are common features of gardens and living rooms in Singapore and around the world. In fact, they are some of the most popular potted foliage plants in The Netherlands' famous international flower auctions, second only to species and varieties of *Ficus*. One of the most common of the ornamental species is *Dracaena fragrans*; also known as the Corn Plant, it has cane-like stems that bear long, often variegated leaves. Singapore's hot and humid climate suits this species well, and it is widely planted and also naturalised here. However, it hardly ever flowers in Singapore, and no mass flowering events have been recorded from the country before. There are only two flowering specimens of this species in the herbarium at the Gardens, one from the 1990s and the other from over a century ago.

In February 2018, there were sightings of emerging buds on *Dracaena* plants across Singapore. By the 20th of February or so, the branched inflorescences of *D. fragrans* could be seen everywhere, with their pinkish white balls of many flower buds. Flowering of this species was also recorded in Peninsular Malaysia, where it is equally rare. Many may have missed the main event though, as the flowers stayed tightly closed during the day and only opened at nightfall. Starting to close by sunrise, each flower lasted a single night, and the entire inflorescences were spent in about a week. Each night during that week, the Botanic Gardens was inundated

***Dracaena fragrans* at the Gardens, with flower buds (left), and fully open flowers after sunset (right).**
(Photo credits: Jana Leong-Škorničková)

The fruits of *Dracaena fragrans*.
(Photo credits: Jana Leong-Škorničková)

***Dracaena aubreayana* at the Gardens (left), and a close-up of the inflorescences with opened flowers (right).** *(Photo credits: Jana Leong-Škorničková)*

The fruits of *Dracaena aubreayana* are lopsided. This is the result of having a pistil with three locules, only one of which is fertile. *(Photo credit: Jana Leong-Škorničková)*

***Dracaena surculosa*, with a close-up of the inflorescence.** *(Photo credits: Jana Leong-Škorničková)*

with their sweet fragrance, which resembles the scent of *Gardenia* with hints of fruit, and explains the specific epithet for the species, '*fragrans*'.

The triggers of flowering in *Dracaena fragrans* have not been well studied. In tissue culture, it is known that cool temperatures of 15°C can initiate flower development. Outside of the laboratory, anecdotal evidence suggests that it flowers when temperatures drop close to 10°C, and in more seasonal climates, flowering often coincides with winter. Of course the temperatures here in Singapore don't get close to 15°C, so maybe it was the sudden drop from otherwise much higher temperatures that led to such a dramatic flowering event here – nearly all mature stems of this species at the Botanic Gardens bloomed!

Dracaena fragrans is native to tropical forests in mainland Africa, where it has a wide distribution. The genus has

***Dracaena surculosa* with ripening fruits.**
(Photo credits: Jana Leong-Škorničková)

several other widely admired species, most of which come from Africa. One of the most commonly known in Asia is the 'Lucky Bamboo', with spirally twisted bamboo-looking stems that are particularly popular around Chinese New Year. Not bamboo stems at all, they are cuttings from the culms of *D. braunii* (also called *D. sanderiana*), which is native to wet and tropical parts of Africa. *D. surculosa*, a shrubby climber that is well-loved for its spotted, ovate leaves, and *D. aubryana*, with its paddle-shaped and corrugated leaves, originate from the same areas, while the succulent Mother-in-law's Tongues (previously called *Sansevieria*, but recently transferred to *Dracaena*) are most diverse in dry regions of Africa. Forests of mushroom-shaped domes of *D. cinnabari* make the landscape of Socotra appear straight out of a Dr Seuss book, while on the islands off of the opposite coast of Africa, the iconic Dragon Tree, *D. draco*, has a similar growth habit.

One commonly cultivated species, *Dracaena reflexa* (the narrow-leaved variety is often sold as *D. marginata*)

Mother-in-law's Tongues blooming in the Sun Garden. From left to right: *Dracaena masoniana*, *D. angolensis*, *D.* sp.
(Photo credits: Jana Leong-Škorničková)

***Dracaena reflexa* on Île aux Aigrettes.**
(Photo credit: Matti Niissalo)

is widespread on islands in the western Indian Ocean, where I recently had a chance to visit. On Mauritius, the French island of Réunion, and the islands of Mahé and Praslin in the Seychelles, I witnessed a large amount of variability in this species. Also in the Seychelles, I observed it fruiting in the wild alongside the Coco de Mer or Double Coconut (*Lodoicea maldivica*) and *Vanilla phalaenopsis* orchids. I also had the chance to see the extremely rare *Dracaena concinna* in full bloom on Île aux Aigrettes, a protected islet off of Mauritius.

Dracaena surculosa and *D. aubreyana* are common plants in local gardens and can also be found naturalised in the forests here in Singapore. Both species joined the mass flowering event in February, initiating their blooming only a few days after *D. fragrans*. Unlike *D. fragrans* though, there have been other recent sightings and collections of flowering individuals of both of these species in Singapore, and they are probably more free-flowering in our climate. The flowers of each species have a unique fragrance: those of *D. surculosa* have a complex perfume-like quality, while the flowers of *D. aubreyana* have a strong similarity to Lily-of-the-valley. Many species of Mother-in-law's Tongues were also seen in bloom in the Gardens. While their fleshy leaves and underground stems make them look very distinct from other *Dracaena* species, their flowers are nearly identical.

Soon after the mass flowering event that started in February, fruits began to appear on *Dracaena* across Singapore. In the Gardens, we saw the first of the fruits starting to ripen on *D. fragrans*, turning yellow-orange around the end of May. Interestingly, even though we spotted many bees on the flowers late in the evening, only some of their inflorescences produced fruits. Our *D. surculosa* plants were more successful, with delicate red fruits seen on many individuals. We came across the fruits of *D. aubreyana* only once.

***Dracaena concinna* flowering on Île aux Aigrettes.**
(Photo credit: Matti Niissalo)

While some of the best-loved *Dracaena* species may be African, Asia also has its fair share that can easily compete with them in their ornamental value. In Singapore, probably the best known of these is *Dracaena cochinchinensis* (often called *D. loureiroi* in trade), which is sometimes planted as a feature plant in gardens for its pointy architectural leaves. This robust species is imported from Thailand around Chinese New Year and sold decorated with red ribbons. Its popularity could be due to its use as a source of 'dragon's blood', a strong red resin for which the genus is named.

Dracaena also has considerable native diversity in Singapore. If you are keen to learn more about our native species, watch out for the next issue of *Gardenwise*!

Matti Niissalo
Molecular Biology Laboratory

Death of a palm

The Oil Palm towering above the Fragrant Garden. *(Photo credit: Thaddaeus Cheng)*

The dying crown had about 16 leaves remaining by December 2016 (top), compared with triple that number in the healthy crown of an Oil Palm of similar age (bottom).

The Singapore Botanic Gardens received its first Oil Palms, *Elaeis guineensis*, in 1875 from Peradeniya, Sri Lanka, probably via Kew Gardens, with further supplies of seeds arriving from Kew in 1886 and 1887. By 1907 the tallest palm, reported to be about 30 years old and therefore from the initial 1875 import, was described as being 40 feet (12.2 m) high. By 1928 the tallest palm in the Gardens, possibly the same individual, was 45 feet (13.7 m) in trunk height excluding the crown. But there were many later plantings, and some of the oldest Oil Palms in the Gardens now may derive from the 1920s when an Oil Palm nursery was planned.

Several of these very old and historically important Oil Palms still survive. As of 2015 the Gardens had seven palms apparently of similar vintage: three on a grassy slope between the Fragrant Garden and the Evolution Garden, one just within the Fragrant Garden, and a tight cluster of three together in the Healing Garden, all of these within a span of 100 metres.

Before its death, the palm's trunk had decayed and fragmented patchily (left), while the inner layers of the decaying trunk began to smell and were soft enough to be pressed inwards with a fingertip (right).

One of these Oil Palms, the one in the Fragrant Garden, produced its last fruit crop in 2015. For several years it had been producing less than one fruit bunch per year and had few fruits per bunch. The fruits were viable on each occasion as seedlings repeatedly grew (and were removed by assiduous gardeners) beneath the parent. In 2015 the palm was approximately 13 m tall, with a girth of 172 cm at chest height (1.5 m) and a girth of 300 cm immediately above the root collar. The leaf-bases, that typically persist from top to bottom of the trunk on the palms seen in agricultural plantations, were on this palm confined to a couple of metres of trunk immediately below the crown; the rest of the trunk was smooth and grey to black.

The petiole bases on Oil Palms usually will persist if the fronds are cut before they expire as there is no gravity pull exerted on the base. If the fronds are allowed to stay (not managed for agricultural reasons) they will dry up and hang for months before naturally detaching from the trunk, giving the trunk a clean look. The Oil Palms in the Gardens were not managed for decades, and for most of their lives the fronds have fallen off due to their own weight, not human intervention. This reflects the fact that the Economic Garden, where the palms reside, was not open to the public before the 1990s. The vestigial frond stumps just below the crown are due to recent management, to avoid heavy fronds falling near visitors.

Fruits dropped by the palm no later than 2015 were still germinating one by one from the soil on site, up to a year after the palm's removal.

By mid-2016 the crown of the palm in the Fragrant Garden was visibly suffering: the fronds were slightly browned, bedraggled and thin. They were much fewer in number, about 20, than on the other six palms, each of which had from 25 to more than 50 leaves. The central spear (youngest leaf shoot) appeared to have died. Subsequently there was a spurt of growth from the central spear, but this died back again. One of the key reasons for later removal of the palm was the rotting smell emitted by the crown. Even in 2015 there were signs that bark had begun to flake off from the lower part of the trunk, less than 2 m from the ground. By November 2016 there were only 16 leaves left on the crown. By the middle of December 2016 the fronds had browned further, leaving no green leafy tissue visible anywhere in the crown. Beneath the hard outer cortex of the trunk, a finger could be pressed into the spongy decaying matter within.

On 26 April 2017, after it had been determined that the apical meristem was dead, the remaining trunk was felled to a point flush with the soil. The decaying trunk matter was pungent, the odour spreading beyond 50 metres. Fruiting bodies of fungi could be seen on the trunk. But all was not lost. Fruits of the palm were still newly germinating at the site in March 2018, long after the death of the parent and nearly three years after the last fruit crop had been produced. Palm life goes on.

Oil Palms in Bogor, Indonesia, have survived at least 120 years and some palms could be 200 years old or even older. Under heavy shade seedlings and young palms grow very slowly, so it is not possible to tell the age of individuals just from the size. The age of the Oil Palms at the Gardens is uncertain but not exceptional, and this has been a rare opportunity to document the slow senility and death of a palm.

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Thaddaeus Cheng
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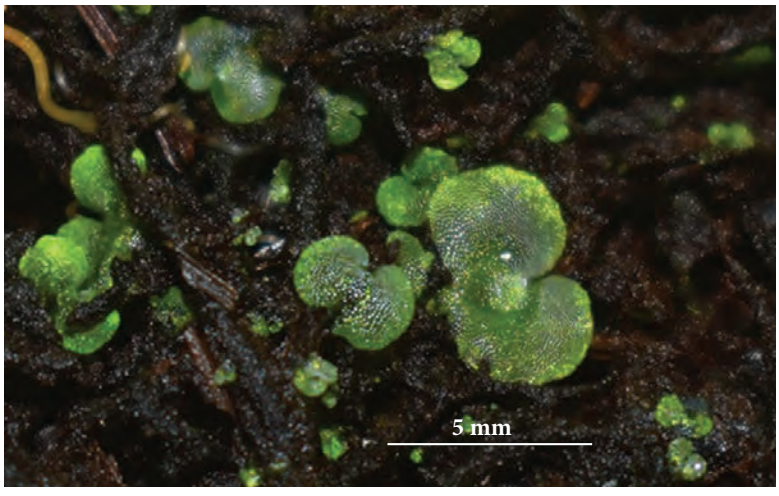
All photos by Dr Geoffrey Davison, unless otherwise indicated.

Bulbiferous ferns in the Gardens

Sexual reproduction is very different in ferns than in flowering plants. Most people are familiar with the reproductive parts of a flower – the stamens, comprising anthers attached to the filaments and where pollen is produced, and the female part known as the pistil, with the stigma and style at the top and ovary below. Following the transfer of pollen from the anther to the stigma, a pollen tube is sent down into the ovary, where the sperm are released to fertilise the ovules (eggs), which then develop into seeds.

In contrast, sexual reproduction in ferns happens within a tiny structure called a gametophyte, which contains both the male and female organs. The antheridia (singular = antheridium) produce sperm which are motile and swim through a thin film of water to reach the archegonia (singular = archegonium) and fertilise the eggs within. The fertilised eggs develop into embryos that grow into new fern plants. When mature, these plants will produce single-celled spores that are released into the environment, where they will germinate into gametophytes if and when conditions are right.

Because water is required for the sperm to swim over to the eggs within the gametophyte, dry conditions can limit or even prevent fertilisation in ferns. As a result, many species have also adapted various forms of asexual reproduction, one of these being bulbifery. This strategy involves the production of plantlets, or 'bulbils', directly on the plant (in fact, this also occurs in some flowering plants).



Gametophytes are extremely small and easily overlooked!

The Gardens has an extensive collection of ferns, with The Dell, Evolution Garden and Fernery being particularly good places to look for them. Highlighted here are some of the bulbiferous species that can be seen in the Gardens. Besides these, other species to look out for are *Asplenium longissimum*, *Asplenium prolongatum*, *Bolbitis appendiculata*, *Bolbitis sinuata*, *Diplazium accedens* and *Parahemionitis arifolia*.

Asplenium thunbergii

Distributed from Vietnam, Laos and Cambodia through Thailand to West Malesia, this fern is popular in the horticultural trade for its finely divided fronds arranged in a close rosette, giving it a feathery appearance. Near the tips of the fronds, it produces bulbils which develop into young plants upon contact with suitable media.

A bulbil that has formed on a frond of *Asplenium thunbergii*.

***Asplenium thunbergii* in the Evolution Garden. It does best in loose media with constant moisture. It prefers light shade but can be acclimatised to full sun.**

Asplenium ×kenzoi

First discovered on Yakushima Island, Japan in 1962, this interesting natural fern hybrid has been widely cultivated as an ornamental plant in Japan and beyond. It has rather thick fronds, with wedge-shaped pinnae arranged along a midrib. The midrib extends beyond the leaf-like portion, and a bulbil is produced at the very tip.

A frond of *Asplenium ×kenzoi* with a bulbil growing at the tip of the extended midrib.

***Asplenium ×kenzoi* in the Evolution Garden. It is occasionally sold in local nurseries. It does best in bright indirect light and if grown in a lightweight, porous mix.**

Tectaria nayarii

This very interesting fern, which has been growing in The Dell at the Gardens for more than 60 years, has two kinds of fronds, broad sterile fronds on which the bulbils develop, and narrower fertile (spore-producing) fronds, which stand erect above the sterile fronds.

More widely referred to under its old name *Heterogonium pinnatum*, *Tectaria nayarii* is native to Southern Thailand, Peninsular Malaysia, Borneo, Sumatra and the Philippines. In August 2017, a small population of this species was found growing on moss-covered calcareous boulders (possibly old concrete) near a stream in the Bukit Timah Nature Reserve. This is the first time that *Tectaria nayarii* has been found growing beyond the Botanic Gardens in Singapore.

A bulbil on a sterile frond of *Tectaria nayarii*. In this species, bulbils are produced near the bases of the laminae (not at or near the tips as in other species featured in this article).

***Tectaria nayarii* in The Dell. It occurs naturally in humid rainforests, and in cultivation grows well in partial shade and if the media is kept constantly moist.**

Asplenium tenerum

A rather widely distributed and variable species recorded from Sri Lanka to Polynesia, *Asplenium tenerum* is also native to Singapore. Individuals from different localities may be quite distinct from one another in terms of appearance and tendency to produce bulbils.

***Asplenium tenerum* in the Evolution Garden. It prefers lightweight, constantly moist media and lightly shaded areas.**

A bulbil on a frond of *Asplenium tenerum*.

Bolbitis heteroclita

This semi-aquatic fern can be found forming dense colonies along shaded streams and swampy forests in Singapore. Its wider distribution includes India, Myanmar, South China, Vietnam, Laos, Cambodia, Thailand and most of Malesia.

Mature plants produce fronds with terminal pinnae that end in long slender extensions, on which the bulbils develop. They also produce fertile (spore-bearing) fronds, which look very different to the sterile fronds.

***Bolbitis heteroclita* in the Evolution Garden. It is adapted to wet conditions and is sometimes sold as an aquarium plant. Its tolerance for wet conditions, along with its dense growth habit, suggest its suitability for planting to stabilise stream banks.**

A bulbil of *Bolbitis heteroclita* that has developed on the extension of the terminal pinna and rooted onto the stem of a tree fern (*Alsophila latebrosa*).

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Horticulture and Operations

The author would like to thank Dr Stuart Lindsay from NParks' Horticulture and Community Gardening division for his advice in the preparation of this article.

All photos by Jerome Koh

Ebonies of Singapore

Persimmons, the black keys of a piano and beedi cigarette wraps are more closely related items than most people might think – they all come from trees belonging to the genus *Diospyros*, in the Ebony family (Ebenaceae). The name *Diospyros* is of Greek origin and literally means 'the wheat of God', in reference to the sweet fruit.

There are several species of persimmon in the markets across the world. The most common in the USA is *Diospyros virginiana*, while in Europe and Asia consumers mostly eat the fruit of *Diospyros lotus* and *Diospyros kaki*. The latter, also known as Japanese persimmon, Chinese persimmon, or Sharon fruit, is the one we normally buy in Singapore in fresh or dry form. The dark, fine ebony wood is derived primarily from *Diospyros ebenum* and *Diospyros melanoxylon*, but several more species are used for timber. The leaves of *Diospyros melanoxylon* are used to wrap beedi cigarettes, and numerous other *Diospyros* are used by humans as medicine, fish poison and for ornamental purposes, making it one of the most useful and versatile genera in the whole Plant kingdom.

Overall, the genus consists of approximately 500–700+ species, distributed mainly across the world's tropics, with few species occurring in the temperate zones. Asia and the Pacific archipelagos host almost half of this vast diversity, about 200–300 species. Numbers are broadly approximate because the genus, despite having being known and used for millennia, is still poorly understood taxonomically, particularly in Southeast Asia and Madagascar.

There are 22 species of *Diospyros* in Singapore, more or less equally divided between native and introduced species. We are currently studying ebonies as part of the Flora of Singapore project. One of the most fascinating aspects of working with *Diospyros* is that the vast majority of the species are dioecious, meaning that each tree is either male or female, and therefore its flowers are either all staminate (with male organs) or all pistillate (with female organs). Male and female trees are identical in their

This *Diospyros brandisiana* flowered in April in the Gardens. The tree is very well protected by an army of weaver ants. This species exhibits cauliflory, the production of flowers from the main trunk. *(Photo credit: Jana Leong-Škorničková)*

***Diospyros argentea* takes its name from the soft, silver-coloured indumentum that covers most of the soft parts of the plant. This species is native to Singapore and Peninsular Malaysia.** *(Photo credit: Jana Leong-Škorničková)*

vegetative forms and they can be told apart only when in flower. In order to capture precious information for our ongoing and future research on *Diospyros*, we are making herbarium specimens from as many of the trees found in Singapore as possible.

Additionally, we are collecting leaf tissue that is processed and stored at -80°C in our laboratory, ready for DNA extraction. Over the next few years, this material will form the core of our research on the genus in Southeast Asia.

***Diospyros trengganuensis*. In many species the new leaves are strikingly different from the mature ones. This image shows, clockwise from the top left, how the newly formed leaves are brownish yellow, then become almost orange, terracotta, and finally turn green.**
(Photo credits: Jana Leong-Škorničková)

Unisexual flowers of two *Diospyros* species. (Left) Longitudinal and cross sections of a female flower of *Diospyros brandisiana*. The ovary is made of 10 locules, each with a single ovule. (Right) An entire and longitudinally dissected male flower of *Diospyros argentea*. In the dissected flower numerous stamens can be seen arising around an undeveloped ovary.
(Photo credit: Jana Leong-Škorničková)

Oddly, *Diospyros singaporensis* does not feature among the Singaporean species of *Diospyros*. This species was first described by Reinier Cornelis Bakhuizen van den Brink Sr., a Dutch botanist based at the Herbarium Bogoriense (Bogor, Indonesia), from a female tree cultivated at the Gardens. The epithet assigned to the new species, however, was found to be inappropriate, as the species is native to most parts of Peninsular Malaysia and Malaysian Borneo but not to Singapore.

A survey run by Botanic Gardens Conservation International (BGCI) on the *ex-situ* conservation of *Diospyros* (Beech *et al.* 2016) reported that less than a quarter of all the species of this genus are grown and propagated in botanic gardens, seed banks or arboreta across the world, and that only 25% of the species known to be under threat are part of *ex-situ* conservation programmes. Worryingly, this last figure is expected to be a significant underestimate, since the conservation status of many species is still unknown. There is certainly more that can be done to protect *Diospyros* around the world, and we are definitely taking action. The Singapore Botanic Gardens has one of the largest *Diospyros ex-situ* conservation programmes in the whole world. Scattered across our Gardens are well over 500 trees, including 43 known species and some unknown or undetermined ones, with a strong focus on Singapore and its immediate neighbours.

We hope that by increasing our understanding of the genus across Southeast Asia, we will enable conservationists in the region and beyond to rescue the most endangered species of *Diospyros*, thus preserving the biodiversity and traditional culture associated with ebonies.

Carmen Puglisi
Herbarium

Reference:
Beech, E., Shaw, K., Rivers, M. and Schatz, G.E. (2016) Global Survey of *Ex situ* Ebony Collections. BGCI. Richmond, UK.

Plants and fungi named after botanists of the Singapore Botanic Gardens

In 2017, the Singapore Botanic Gardens opened the Learning Forest, including the Keppel Discovery Wetlands, as an extension to the existing Gardens. The Wetlands include a feature called the 'Botanists' Boardwalk' where a number of species are showcased that are named after notable former staff of the Botanic Gardens. These include *Memecylon cantleyi*, named after Nathaniel Cantley who was the Superintendent of the Gardens from 1880 to 1888, *Platycerium ridleyi*, named after Henry Ridley, Director from 1888 to 1912, and *Freycinetia corneri*, named after E.J.H. Corner, Assistant Director from 1929 to 1945. Apart from these few on public display, there are very many more plants, and also fungi, named after former and current staff of the Botanic Gardens and this is the subject of this article.

One of the benefits of this age of online databases is that it has become possible to engage in all manner of searches on every subject imaginable. The early superintendents and directors of the Gardens could not possibly have imagined that we would be able to discover so much about them without leaving the comfort of our offices. One such online resource that we in the Herbarium access on an almost daily basis is the International Plant Names Index (IPNI). IPNI is a truly monumental undertaking and makes the process of conducting taxonomic research on vascular plants vastly more efficient than it would be if it were not available. There is a similar database for fungi called *Index Fungorum* and one for mosses called *Index Muscorum* which has been incorporated into

Beaumontia murtonii. *(Photo credit: David Middleton)*

Schoutenia corneri. *(Photo credit: S.K. Ganesan)*

Hoya ruthiae. *(Photo credit: Michele Rodda)*

Hoya benitotanii. *(Photo credit: Lily Chen)*

Entoloma burkilliae. *(Photo credit: Serena Lee)*

Haniffia albifora. *(Photo credit: Jana Leong-Škorničková)*

Fagraea ridleyi. *(Photo credit: Low Yee Wen)*

Corybas holttumii. *(Photo credit: Low Yee Wen)*

the database of the Missouri Botanical Garden. As well as allowing taxonomists to conduct their research, these databases enable us to interrogate the data in other more frivolous ways. One of the things we can do is search for species named after botanists associated with the Gardens.

Species named after people can be formed in a variety of different ways but are almost always formed from the stem of the person's name, along with various endings that conform to particular rules of Latin grammar. When conducting searches within IPNI we can replace these endings with a wildcard (%) so we can search on 'Ridley%' (for plants named after Henry Ridley) and thereby return species with specific epithets of *ridleyi*, *ridleyana*, *ridleyanum* and *ridleyanus*; for 'Corner%' (plants named after E.J.H. Corner) we find *corneri* and *corneriana*; and for 'Burkill%' (plants named after Henry Burkill and/or his son Humphrey Burkill, both former directors of the Gardens, or E.M. Burkill, the mycologist and wife and mother respectively of the two directors) we find *burkillii*, *burkilliae, burkilliana, burkillianum*, *burkillianus* and *burkillfilii*. There do not, however, appear to be any species called *burkilliorum*, which would be the form used when naming a species after any combination of two or more of the Burkills. This last search also shows up a weakness in the ability to search the data as we cannot easily distinguish between the three Burkills in our search, except that *burkillfilii* specifically indicates the son of the other two. Ridley, Corner and the three Burkills all had rather uncommon names such that it is reasonable to assume that most, possibly all, names in our searches above commemorate them. The same could also be said of Murton (Superintendent of the Gardens, 1875–1880), Cantley, Mohamed Haniff (who was a prolific collector and worked for both the Singapore and Penang Botanic Gardens in the late 19th and early 20th centuries) and Holttum (Director, 1925–1949). However, distinguishing just what plants were named after other Gardens' botanists such as Sinclair, Henderson, Tan and Chin, all of whom have much more common names, is very time consuming. Luckily, we know exactly which Tan *Hoya benitotanii* was named after, Benito Tan, the former Keeper of the Herbarium, as the author of the name helpfully added his given name too.

Alangium ridleyi. *(Photo credit: Koh Sin Lan)*

Memecylon cantleyi. *(Photo credit: Koh Sin Lan)*

With these caveats, a search of the data has uncovered more than 15 genera and over 400 species named after botanists of the Singapore Botanic Gardens. These include flowering plants, ferns, bryophytes and fungi. The most popular Gardens' botanist after whom plants and fungi have been named, by far, is Henry Ridley who has well over 200 different species named after him. It is commonly the case that a new species is named after the person who collected the specimens on which the description of the new species is based. It is also commonly the case that species are named after people who have made major contributions to botanical science. When a botanist has made major contributions in both fields, collecting and publishing, then this can lead to many taxa being named after them. Ridley collected around 50,000 specimens, far surpassing any of his contemporaries or those who followed after. He also published innumerable papers and several books. These accomplishments, coupled with the fact that he was active at a time when the plant and fungal diversity of Southeast Asia was only beginning to be thoroughly explored and large numbers of new species requiring names were being found, almost certainly means that no botanist in the Gardens now or in the future will ever surpass having 200 species named after them. Holttum has around 50 species named after him, Corner around 40 plants and another 20 fungi, Cantley around 17 species, and everybody else far fewer. Between them, the current staff of Singapore Botanic Gardens have one genus and around 13 species bearing their names.

Sometimes, several different botanists from the Gardens have been honoured in different species in the same genus. In the orchid genus *Bulbophyllum*, for example, there are the following species: *B. burkillii*, *B. corneri*, *B. holttumii*, *B. ridleyanum* and *B. ridleyi*. The genera *Alocasia*, *Alseodaphne*, *Amomum*, *Ardisia*, *Begonia*, *Calamus*, *Cinnamomum*, *Cyathea* and many more have species named after at least two botanists from the Gardens, reflecting both on the wealth of specimens collected during expeditions mounted by the Gardens and on the scientific legacy of the Gardens over its history.

As in all walks of life, the botanists of the Gardens have had quite differing personalities. This can sometimes manifest in preferring to use other methods of naming plants than after people. Corner very rarely named new species after people even though he had so many named after him. Ridley did so rather more frequently. As modern botanists mostly have a rather poorer grasp of classical Latin than our forebears, we often find it harder to coin names based on Latinisation of morphological features of the plants. Naming plants and fungi after people, particularly after the collectors of the specimens, is much easier (along with naming after geographical localities). Around a third of species described as new by staff in recent years are named after people. This is a much higher rate than in earlier eras.

Beauty is in the eye of the beholder but, even allowing for differing tastes, it is difficult to imagine that any species named after one of the Gardens' botanists is more beautiful than the quite spectacular *Beaumontia murtonii* in the Apocynaceae with flowers the size of a hand. Other contenders are *Hoya ruthiae* (named after Ruth Kiew, former Keeper of the Herbarium), also in the Apocynaceae, and *Haniffia albiflora*, a ginger with the genus named after Mohamed Haniff. No comment is offered here on whether the beauty of these plants is appropriately matched to their namesakes. But in this regard perhaps a quote from Linnaeus, the father of taxonomic botany, in comments on a genus named after him, is most apt (somewhat simplified): "It is commonly believed that the name of a plant which is derived from that of a botanist shows no connection between the two but *Linnaea* is lowly, insignificant, disregarded, flowering but for a brief space — after Linnaeus who resembles it".

David Middleton
Herbarium

International researchers on the Flora of Singapore project

(Photo courtesy of Hans-Joachim Esser)

Hans-Joachim ('Hajo') Esser was here from 26 August to 2 September 2017 to study our material of Araliaceae, Euphorbiaceae, Phyllanthaceae, Polyosmaceae and Rutaceae for the *Flora of Singapore*. Hajo is from Germany and has been the Curator of Vascular Plants at the Botanische Staatssammlung München since 2003.

(Photo credit: Serena Lee)

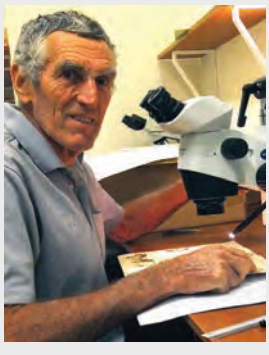
Henk Beentje is originally from The Netherlands. He is currently retired but working as an Honorary Research Associate at the Royal Botanic Gardens, Kew, where he previously worked as a researcher specialising in the Asteraceae. He gleefully tells us that he now gets to do the part of the job that he really loves (taxonomy) and not the administrative stuff he had to do in the past. He was with us for a month from 8 February to 8 March 2018 and worked hard on the families Aspleniaceae, Asteraceae and Pandanaceae.

(Photo credit: Serena Lee)

Peter Hovenkamp, from The Netherlands, is currently a researcher at the Naturalis Biodiversity Center. Since 2008, he has served as the Editor-in-Chief for the scientific journal *Blumea*. He also teaches phylogenetics skills to postgraduate students and courses on ferns. Peter was at the SING Herbarium from 28 May to 6 June 2017 to study the Athyriaceae and Polypodiaceae.

(Photo courtesy of Peter van Welzen)

Peter van Welzen is also from the Naturalis Biodiversity Center. Since 1990 he has been heavily involved in various Floras for the region, including *Flora Malesiana*, the *Tree Flora of Sabah and Sarawak*, the *Flora of Thailand* and the *Flora of Peninsular Malaysia*. He has contributed a number of plant families for one or more of these projects, including the Euphorbiaceae, Pandaceae, Peraceae, Phyllanthaceae, Sabiaceae, Sapindaceae and Trigoniaceae, and is now undertaking a number of families for the *Flora of Singapore*. Peter was here from 25 August to 1 September 2017.



(Photo credit: Serena Lee)

Robert Harwood was here from 30 October to 3 November 2017 working on a few genera in the Rubiaceae for the *Flora of Singapore*. Bob first got involved in taxonomy at the age of 45, when he began working as a research assistant at the Northern Territory Herbarium in Darwin, Australia. He was there for 10 years and developed his botanical skills to the stage where he revised the genus *Spermacoce* in the Northern Territory, including describing 39 new species. In 2005, he retired and moved to Thailand, where he still lives and spends a lot of time as a volunteer at the Forest Herbarium in Bangkok.

(Photo credit: Derek Liew)

Yong Kien Thai will be a familiar figure here at SING from now until December 2018, as he and our researcher Ho Boon Chuan work together to complete the 156 taxa in 25 families of mosses for the *Flora of Singapore*. Kien Thai is a Senior Lecturer at the University of Malaya and teaches Plant Diversity, Rainforest Ecology and Biogeography modules. He is also involved in the management of the University's botanical garden, Rimba Ilmu, as well as the KLU herbarium. He has three children, two named after mosses and one after a liverwort. Talk about love for this group of plants!

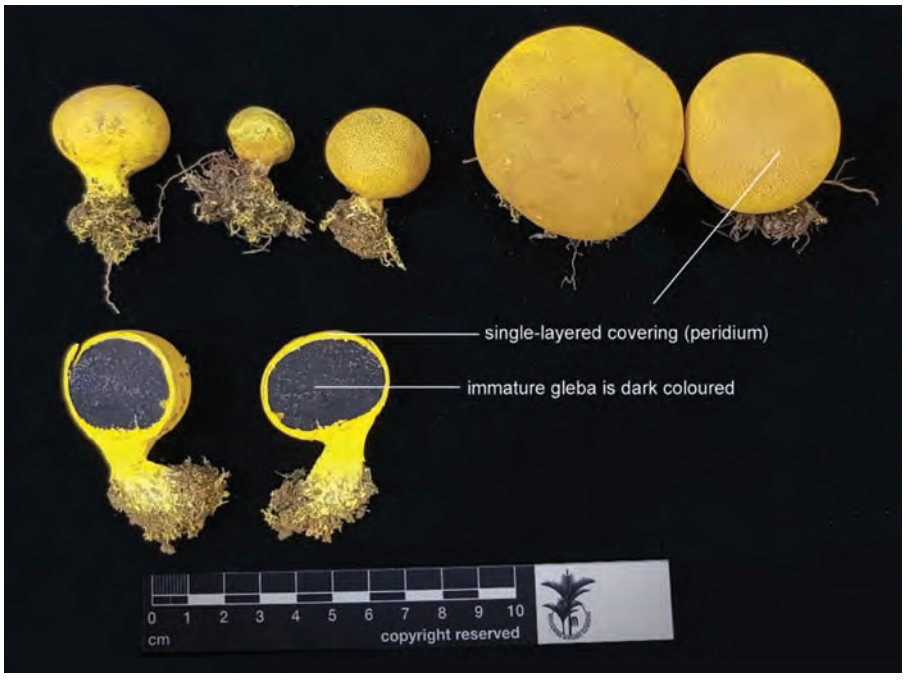
Serena Lee
Herbarium

Gardenwise • Volume 51 • August 2018

Puffballs, earthballs and earthstars, oh my!

Gasteromycetes (literally, 'stomach fungi') are fungi in which the hymenium is enclosed until after the spores have matured. While they have been grouped together based on this characteristic, molecular phylogenetic studies have revealed that this morphological similarity has arisen through convergent evolution rather than shared ancestry. The term 'gasteromycete' is still used informally however, and is applied to a variety of interesting fungi, including those generally known as puffballs, earthballs and earthstars. Featured here are some of the gasteromycetes that can be found in our native forests and a little beyond.

Scleroderma (earthballs), *Pisolithus* and *Calostoma* are genera found in the Boletales order. In *Scleroderma* and *Pisolithus*, the peridium is a single layer which degrades slowly upon maturity to reveal the gleba (mass of spores). The fruiting body of *Scleroderma sinnamariense* is a bright yellow ball commonly seen in Singapore's nature reserves. Also found in the reserves, *Pisolithus* species are not much to look at and may look very much like dog excrement. When young, their interior is filled with pea-sized spore packages (peridioles) somewhat like the Bird's Nest Fungi, *Cyathus striatus* (also a gastromycete; see *Gardenwise* 49: 29–30).

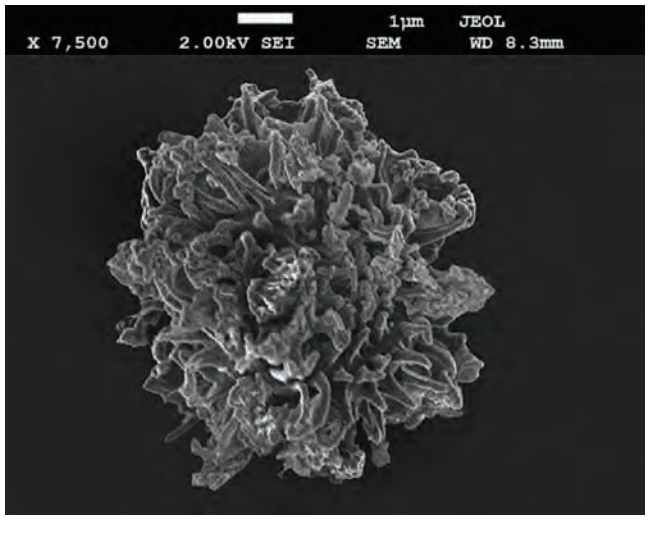


***Scleroderma sinnamariense* from the Upper Peirce area of the Central Catchment Nature Reserve.** *(Photo credit: Ho Boon Chuan)*

The Calostomas, however, have several layers of tissue and an evanescent and gelatinous exoperidium that, when mature, reveals a star-shaped pore by which the spores may escape. *Calostoma* cf. *pachystelis*, commonly known as *mata lembu* ('bull's eyes'), was spotted on one of our collection trips with collaborators in Brunei Darussalam.

From the order of Agaricales and in the family Agaricaceae, we have the puffballs – *Calvatia*, *Lycoperdon* and *Tulostoma*. They often have a sterile subgleba that gives the fruiting body a stalked appearance. The peridium consists of two to four layers, and the immature gleba is white and uniform while the mature gleba is dark and powdery. Representatives of

***Scleroderma* sp. from Bukit Batok Nature Park.** *(Photo credit: Ho Boon Chuan)*



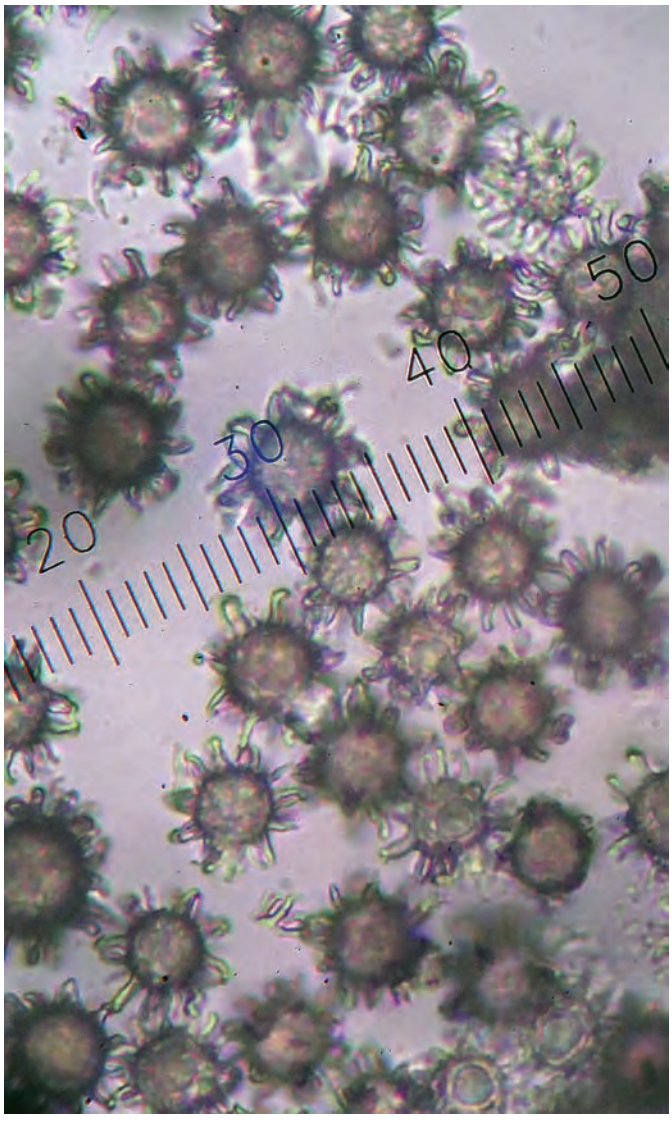
A typical *Scleroderma* spore at 7500× magnification under a scanning electron microscope (SEM). *(Photo credit: Serena Lee)*

***Pisolithus* sp. from the Bukit Timah Nature Reserve.**
(Photo credit: Hadzlinda Samri)

***Calostoma* cf. *pachystelis* from Brunei Darussalam.**
(Photo credit: Bazilah Ibrahim)

***Calostoma insigne* purchased from a market in Sibu, East Malaysia.**
(Photo credit: Serena Lee)

Fruiting bodies of *Calvatia* cf. *excipuliformis* from Labrador Park.
(Photo credit: Chung Yi Fei)

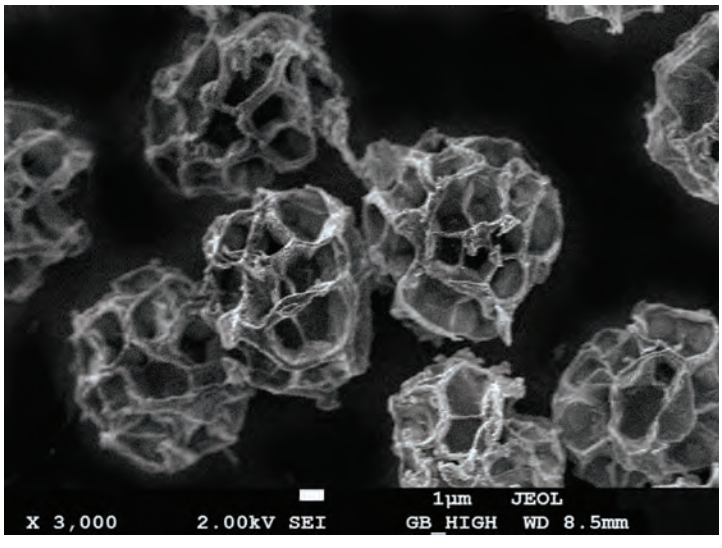


Spores of *Calostoma insigne* under the light microscope at 400× magnification. *(Photo credit: Serena Lee)*

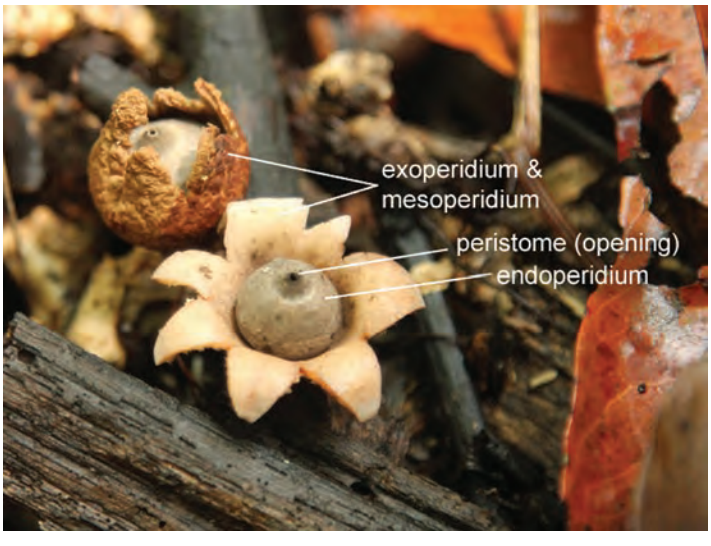
Cross section of an immature *Calvatia* cf. *excipuliformis* basidiome. *(Photo credit: Serena Lee)*

***Lycoperdon* cf. *pyriforme* on a tree trunk.** *(Photo credit: Serena Lee)*

***Tulostoma exasperatum* at various stages of maturity. In Singapore, this species has been found at Pulau Ubin, Bukit Timah and MacRitchie.** *(Photo credit: Wong Wei Hui)*



Alveolate ornamentation of *Tulostoma exasperatum* spores at 3000× magnification under the SEM. *(Photo credit: Serena Lee)*



***Geastrum subiculosum* growing on fallen twigs in the Gardens' Rain Forest. Each basidiome is less than an inch across.** *(Photo credit: Serena Lee)*

all three genera can be found in Singapore, with one particularly beautiful species being *Tulostoma exasperatum*. Its exoperidium is covered in conical, brown spines which fall of as it matures.

Earthstars are in the order Geastrales and they have an exoperidium and a mesoperidium that are tough and split in a stellate manner, and an endoperidium which is paper thin. *Geastrum subiculosum* has been found in the Gardens, growing in the Rain Forest.

Close to our hearts, the question would be, "Can we eat them?" Among the genera mentioned here, Calostomas are known to be edible by indigenous peoples from Borneo and the Indochina region. They can be found in desserts or even in stir-fried dishes. In the UK, Lycoperdons and Calvatias (which resemble a loaf of bread) are said to be edible only when the fruiting body is very immature. At any rate, when in doubt DO NOT consume mushrooms as they can be very toxic!

Serena Lee
Herbarium

Basil basics

Basils are culinary and medicinal herbs belonging to the Mint family (Lamiaceae) and classified in the genus *Ocimum*. Naturally distributed throughout the tropical and sub-tropical regions of the world, their diversity has been shaped by a long period of cultivation and breeding. This has resulted in great variation in leaf pigmentation, shape and size, as well as flavour and fragrance profiles. This article acquaints readers with some of the basils that can be found in local and community gardens, markets and commercial nurseries in Singapore.

Certain species of basil have seeds that produce a translucent, external gelatinous layer when they come into contact with water, giving them the appearance of frog eggs. These so-called 'tadpole eggs' are sometimes used in local desserts and beverages, like this coconut flavoured drink bought in Singapore.

Sweet Basil (*Ocimum basilicum*)

Most readers are probably familiar with Sweet Basil, as its tender leaves are used to flavour a number of dishes. It is reported to originate from Asia, although it is widely cultivated worldwide. A rather extensive range of cultivars has been created through extensive breeding and selection over many years. Generally grown as annual herbs, most of them grow up to around 50 cm in height, although some cultivars may reach 1 m or more. They generally feature green, serrated leaves that are smooth or slightly puckered. They produce white flowers and their foliage emits a rich, spicy and pungent aroma. In Singapore, sweet basil is sold in supermarkets as a packaged fresh-cut herb or as small potted plants.

Some of these cultivars produce leaves that are much larger than those of the species, such as 'Lettuce Leaf' and 'Mammoth'. Conversely, there are dwarf, bushy cultivars with much smaller leaves, such as 'Spicy Globe' and 'Boxwood'.

There are also popular purple-leaved cultivars of Sweet Basil, such as 'Purple Ruffles', 'Red Rubin' and 'Dark Opal'. These basils have been reported to be of hybrid origin. Their leaves are used to add colour to salads and herbal vinegars. For the same reason, they are often suggested for planting in otherwise green edible gardens, but unfortunately in Singapore's warm climate, purple-leaved cultivars may not be as intensely or evenly coloured as in other places.

Some Sweet Basil cultivars have leaves that emit a unique scent or flavour. Cinnamon Basil (*Ocimum basilicum* 'Cinnamon') is sold in some local gourmet supermarkets, and as its name implies, the leaves have a spicy aroma and flavour reminiscent of cinnamon. The licorice-scented Thai Basil (*Ocimum basilicum* var. *thyrsiflora*) is a common feature in Thai cuisine and 'Siam Queen' is a cultivar that produces very large and ornamental flower heads. Also in this group is Lemon Basil (*Ocimum ×citriodorum*), a hybrid between Sweet Basil (*Ocimum basilicum*) and Hoary Basil (*Ocimum americanum*) with leaves that have a citrus-like scent.

Holy Basil (*Ocimum tenuiflorum*)

Ocimum tenuiflorum, often called by the English names of Holy Basil or Sacred Basil, or by its Hindi name, Tulsi, is a highly regarded plant in India. The entire plant as well as its dried leaves and seeds are used in traditional medicine. Holy Basil is sanctified in Hinduism, and the plant is commonplace in the gardens of Hindu households. A visitor to Singapore's Little India district would likely see two different types of Holy Basil being sold as potted plants – a green-leaved version called Rama Tulsi, and one with purple leaves known as Krishna Tulsi. Holy Basil, also referred to as Kaphrao in Thai, is a culinary herb in Thai cuisine.

Thai basil is commonly used in Thai cuisine. The plant is heat tolerant and thrives in Singapore's tropical climate. It is shown here in the Jacob Ballas Children's Garden.

There are two types of Holy Basil grown locally, Rama Tulsi (left) and Krishna Tulsi (right).

Ocimum tenuiflorum grows as a long-lived annual. As it does not tolerate 'wet feet', it needs to be kept in a sunny spot with well-drained soil. Container cultivation is a good way to grow this plant in Singapore, as it can be moved under shelter during the rainy season. Plants self-sow in the garden readily.

Tree Basil (*Ocimum gratissimum*)

Ocimum gratissimum is known by a range of common names including Tree Basil, African Basil, Clove Basil and Ram Tulsi. It is a perennial that becomes woody with age and can reach a height of 1.2 m or more. Its leaves are rather broad, slightly hairy, and used in traditional medicine and religious ceremonies. In Thai cooking, the leaves are fried together with chili, garlic and meat to impart flavour.

Tree Basil is not a common sight in Singapore. I have seen it for sale only in the Thai supermarket at the Golden Mile Complex, in bundles of fresh cut material.

Green Pepper Basil (*Ocimum selloi*)

Ocimum selloi is an uncommon species with leathery, shiny dark green leaves that have the scent and flavour of a green bell pepper. Compared to other basils, the leaves are reported to retain their colour and flavour much better after drying. This plant can take full sun, but will produce more tender leaves which are better for cooking if grown in shadier conditions.

Green Pepper Basil in the Healing Garden.

Green Pepper Basil produces abundant lavender flowers which makes it rather ornamental. In Singapore, it is grown as a perennial and reaches about 30 cm in height.

Growing basils in Singapore

To grow basils successfully in Singapore, plants should be exposed to at least six hours of direct sunlight. This will help to achieve a robust but compact growth habit and the production of flavourful foliage. They can also be grown indoors under artificial lighting.

Basils are not drought tolerant and must not be allowed to dry out. They are best grown in a slightly acidic, friable, fertile soil that retains moisture but drains well. To improve the drainage and aeration of the soil mix, a good quality compost and fine grade lightweight expanded clay pellets (LECA) can be added in equal parts.

Plants need to be adequately spaced apart to ensure air circulation and the penetration of sunlight to the lower leaves, thereby reducing the likelihood of foliar fungal diseases. If grown in apartments that receive sunlight from a single direction only, they should be kept in containers that can be rotated periodically.

Common pests that affect basils often appear due to sub-optimal growing conditions, such as overfeeding with fertilisers, insufficient sunlight or low humidity. Small infestations of sucking pests like aphids, mealybugs and spider mites can be washed off with a blast of water. Heavier infestations may warrant some pruning followed by a regular application of a dilute castile soap solution, neem oil or summer oil. In the case of leaf-rolling caterpillars, which stitch the two halves of the leaves together to make a curry puff-like hideout, affected leaves are best removed by hand.

The foliage at the stem tips should be pinched off regularly to encourage a bushy growth habit, and if the plant is being grown for culinary purposes, the flower buds should be removed as soon as they appear. As basils age, their vigour tends to decline. When this happens, inflorescences can be allowed to develop on the plant so that fresh seeds can be collected. New plants can also be propagated from cuttings of the stem tips. These will root within a week or so in a container with clean water.

Wilson Wong
Horticulture and Operations

All photos by Dr Wilson Wong

Training and development workshops for the Gardens' Education Branch

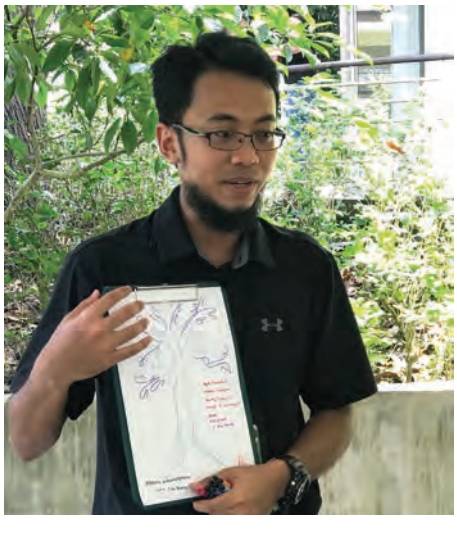
On a quest to inspire and motivate our educational staff while upgrading our knowledge and skills, we recently invited specialists from various fields to conduct a series of mini-workshops for us. The sessions focused on connecting our staff with nature and learning new and creative ways to engage the youth in our programmes.

Learning the 'web of life' game that will help us to facilitate children's understanding of food webs and plant-animal interconnectivity. *(Photo credit: Janice Yau)*

One-ness with nature

"The beauty of the trees, the softness of the air, the fragrance of the grass, speaks to me … And my heart soars." This quote by Chief Dan George, printed on the card of Dr Claire Elouard, gives a strong indication of where she finds her inspiration. Claire is a nature educator and environmental consultant who taught three mini-workshops for us, and her love for nature came across clearly during these sessions.

At the start of each workshop, Claire softly 'talked' us into a relaxed and focused state. During one session, we sought out a tree, drew and documented our impressions of it, and later shared our feelings and observations with the rest of the group. This exercise led us to a greater appreciation for the majestic giants in our Gardens. In another session, Claire led us on a 'fox walk' – a silent walk aimed at reaching a meditative state to better connect with our surroundings. Claire also taught us a game called the 'web of life', which was aimed at helping us teach children about how the plants and animals around us are all interconnected.



Our colleague Taufiq sharing his drawing of a Marsh Pulai tree (*Alstonia pneumatophora*). *(Photo credit: Janice Yau)*

Connecting with and engaging the youth

Our most frequent visitors to the Jacob Ballas Children's Garden are children aged six and below. On weekdays, they come in droves with their teachers for field trips, and on weekends, for playtime with their families. It is impossible for a day to pass by without a young child visiting the Children's Garden!

In April this year, the Gardens' educational team came together for a sharing session led by early childhood expert Beth Fredericks. Beth is the Executive Director at Wheelock College Singapore and she has spent the past few years training early childhood educators. She has also collaborated extensively with our local museums and libraries to introduce more early childhood programmes into Singapore.

With learning opportunities hidden at every turn of our Gardens' paths, the team set out to discover ways to make learning more fun and interactive for children and their families. Beth expounded on the development of a child's brain and how children learn, touching on how to promote cognitive development through educational programmes and activities. She also discussed how concepts from STEM (Science, Technology, Engineering and Mathematics) subjects can be incorporated into the Children's Garden using its plant collections and the natural environment.

In addition, we were introduced to a survey tool to help us reflect on how we can personally contribute to active learning in a child, and a programme audit tool to help us ensure that our programmes are appropriate for early childhood ages.

“If you are planning for a year, sow rice; if you are planning for a decade, plant trees; if you are planning for a lifetime, educate people.”

– Chinese Proverb

Students from Wheelock College conducting a ‘storywalk’ for families at the Jacob Ballas Children’s Garden. *(Photo credit: Cyrena Lin)*

Waking up and smelling the coffee

The pleasant and familiar aroma of mornings, alfresco cafes and soporific afternoons signalled the start of our coffee painting class. Using a medium that is traditionally used for making beverages, our colleague Lai Simin from the Gardens’ Horticulture and Operations team patiently taught us to paint plants and animals.

Simin has always had an innate interest in art and nature. She was inspired to paint with coffee after joining a special interest group on the subject. Her very first painting was of a Spotted Wood Owl (*Strix seloputo*), the largest owl species in Singapore, and which is considered Critically Endangered here. She has continued to hone her skills by creating many different paintings of our local flora and fauna. Through her guidance, we were able to exercise our creativity and display hitherto undiscovered artistic talents during this class.

Completed paintings created with coffee. *(Photo credit: Cyrena Lin)*

A Crested Goshawk (*Accipiter trivirgatus*) painted by Lai Simin. One of the things we learnt during our session with Simin is how to mix different amounts of coffee and water to create various shades of paint. *(Photo credit: Steffi Loe)*

Feeling inspired and fuelled by the new skills and knowledge gleaned from these recent workshops, the Education Branch has started revising our existing programmes to make them more interaction based, and we have plans to create more child-directed activities to engage our young participants. After all, our role as nature educators is to encourage a sense of curiosity in children. It is also our dearest wish for all visitors to delve into the amazing world of plants, and all the wonders that nature has in store for them.

“What we learn with pleasure we never forget.”

– Alfred Mercier

Janice Yau
Cyrena Lin
Steffi Loe
Education Branch

The Singapore Garden Festival Orchid Show 2018

The inaugural Singapore Garden Festival (SGF) Orchid Show was held from 21 to 29 April in and around the National Orchid Garden. An offshoot of the flagship SGF, the SGF Orchid Show is a partnership between NParks and the Orchid Society of South East Asia (OSSEA). The show was officially launched at a ceremony graced by Mdm Halimah Yacob, President of the Republic of Singapore, who was hosted by Mr Lawrence Wong, Minister for National Development and Second Minister for Finance.

As would be expected of an orchid show, there were an array of orchids on display. More than 700 individual plants from around the region competed for a total of 38 heritage awards, or 'challenge cups', and the winning plants bore their ribbons with pride. The Singapore Botanic Gardens won a total of 11 Challenge Cups across various classes, including the award for the Grand Champion Plant. Non-winning orchids were also on display during the show, both outside of historic Burkill Hall and amongst the landscape of the National Orchid Garden. Many of the seasonal orchids that flowered profusely were from intermediate and cooler climates.

At Orchid Plaza, landscape displays incorporating orchids were put up by local and international exhibitors. Thirteen of these were competitive displays by growers in Singapore and around the region. There were also four non-competitive displays – one from OSSEA to mark their 90th anniversary, another from the Singapore Orchid Growers' Association (SOGA), and two by the staff of the Singapore Botanic Gardens, including a special display of orchids native to ASEAN countries to mark Singapore's chairmanship of ASEAN this year.

The show also included an educational exhibition at Burkill Hall chronicling Singapore's history and achievements as a centre of orchid breeding, and

The Indonesia Orchid Community's display came in runner-up for the Tan Jiew Hoe Grand Champion Landscape Cup and won the Straits Times Challenge Cup for the Best 15 sqm Landscape. *(Photo credit: Syed Yusof Alsagoff)*

The winner of the President's Challenge Cup for the Grand Champion Plant, the Penang Gardening Society Challenge Cup for Best Species, and the Quek Kiah Huat Challenge Cup for Best Dendrobium Species was this *Dendrobium lineale* by the Singapore Botanic Gardens. *(Photo credit: Syed Yusof Alsagoff)*

eight floral arrangements specially created by Keith Lin, SOGA member and Chelsea Flower Show Gold Medal Winner, to celebrate the beauty of Singapore's cut-flower orchids. The cut orchids were generously donated by SOGA. Besides admiring the beautiful orchids on display, visitors were able to purchase their own plants from vendors and attend talks and educational activities that were arranged throughout the nine-day show.

Whang Lay Keng
National Orchid Garden

A historical link revived

On 22 January 2018, a significant event took place at the Penang Botanic Gardens. The day marked a renewal of ties that had long lapsed between the Singapore Botanic Gardens and the Penang Botanic Gardens (PBG). The two institutions entered into a Memorandum-of-Understanding (MoU) that was officially signed by the Group Director of our Gardens, Dr Nigel Taylor, and the Director of the PBG Department, Mr Mohd Azwa Shah Ahmad. The simple ceremony was witnessed by Dr Saw Leng Guan, Curator of PBG; Mr Lim Guan Eng, Chief Minister of Penang; Mr Jagdeep Singh Deo, Penang State EXCO for Housing, Town & Country Planning; and Dato' Seri Haji Farizan Bin Darus, Penang State Secretary. Various other Penang government officials and staff and friends of the Penang Botanic Gardens also attended.

The MoU signing ceremony was held in the administrative complex of the Penang Botanic Gardens on 22 January 2018. Front row, from left to right: Dr Saw Leng Guan, Mr Mohd Azwa Shah Ahmad, Dr Nigel Taylor and Dr Nura Abdul Karim. Back row, from left to right: Mr Jagdeep Singh Deo, Mr Lim Guan Eng and Dato' Seri Haji Farizan Bin Darus.
(Photo credit: Penang Botanic Gardens)

PBG was established in 1884 by Nathaniel Cantley, the Superintendent of the Singapore Botanic Gardens at the time. It was founded on an old granite quarry site that lies deep in a valley at the base of a tall hill covered by tropical evergreen forest. The valley is divided by a cascading stream that meanders through PBG's sprawling 29-ha grounds. The care of both the botanic gardens and the 3,575 ha or so of surrounding forest was assigned to Charles Curtis, who was appointed by Cantley to be the Assistant Superintendent.

At its inception, PBG was administered by the Gardens and Forest Department of the Straits Settlements, and in its early years was engaged in the cultivation of commercial plants, inspecting crops and advising the agricultural and forestry communities. Later, when the work connected with economic crops and forest management was taken over by the Agriculture and Forestry Departments, Curtis assumed full responsibility as PBG's Superintendent. He is credited with laying out the grounds and transforming them into a lush green repository of flora unique to the region, and was instrumental in advancing the botanical and horticultural aspects of PBG.

Under the auspices of the Straits Settlements Gardens Department, a notable line of colonial directors and curators were later appointed to manage both the Singapore and Penang Botanic Gardens, including R.E. Holttum and I.H. Burkill. Unlike our Gardens, PBG took a heavy toll during WWII as the Japanese occupiers used part of the grounds as an ammunition works and storage facility and torpedo assembly station. When the British reoccupied Malaya in 1945, much restoration work was needed. As part of the post-war reorganisation, PBG was separated from its relationship with our Gardens and in 1946, its administration was passed to the Federated Malay States. After this handover, PBG's research and botanical activities gradually decreased. Most of the herbarium collections made by Curtis and successive superintendents were transferred to our Herbarium, and from then until recently, PBG has mostly functioned as a public park.

Today, under the administration of the Penang State Government, PBG is conducting research in earnest again and collaborating with other botanical institutions on research programmes both nationally and internationally. It aims to provide visitors with programmes that focus on its heritage, plant collections, natural landscape, and the rich diversity of flora and fauna that can be found in the region.

By entering into this MoU, the Singapore and Penang Botanic Gardens hope for a revival of old ties between the two institutions. We look forward to sharing our knowledge in horticulture, garden management, conservation, research and education outreach.

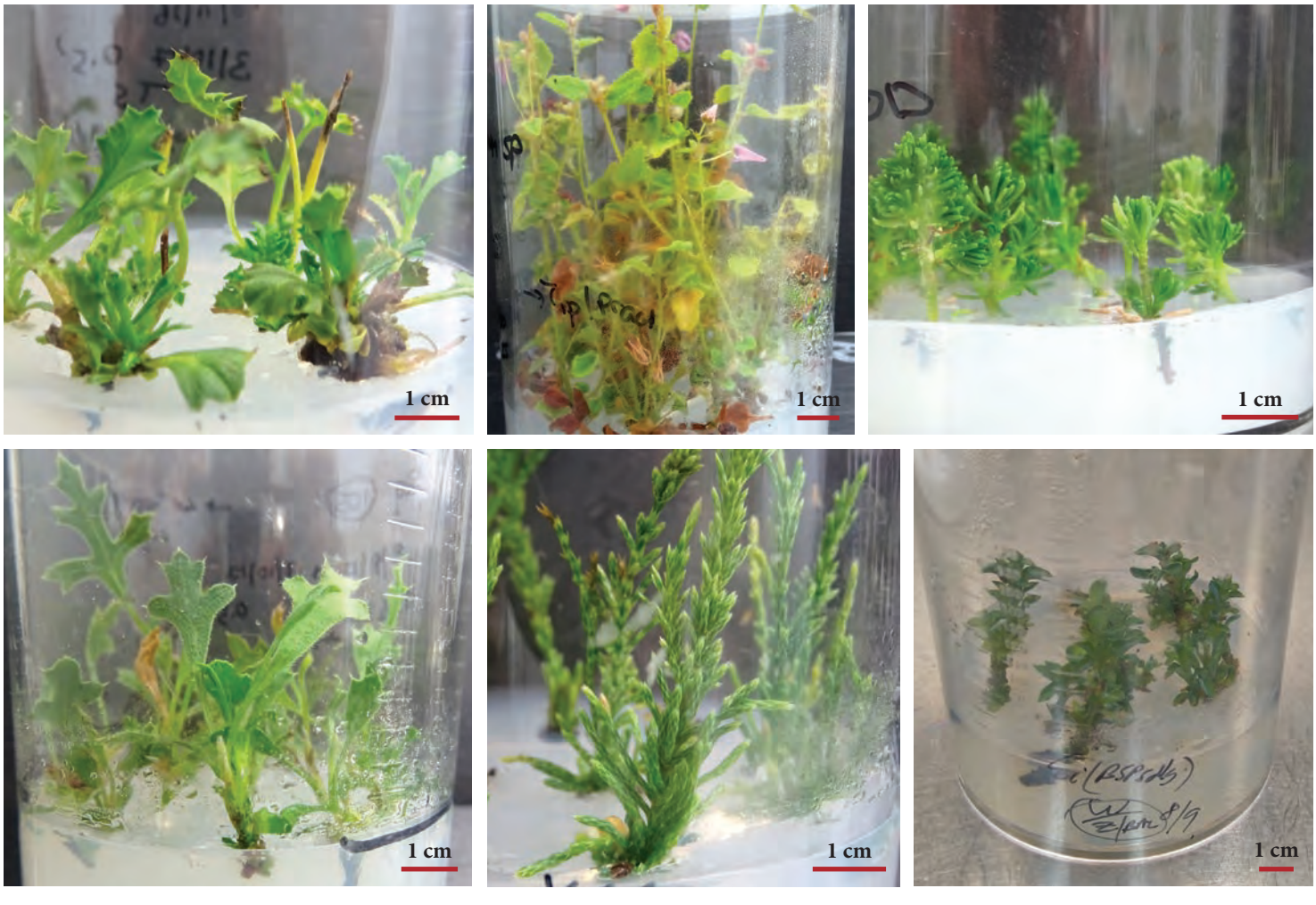
Nura Abdul Karim
Library, Training and External Relations

Professional exchange programme with Kings Park and Botanic Garden

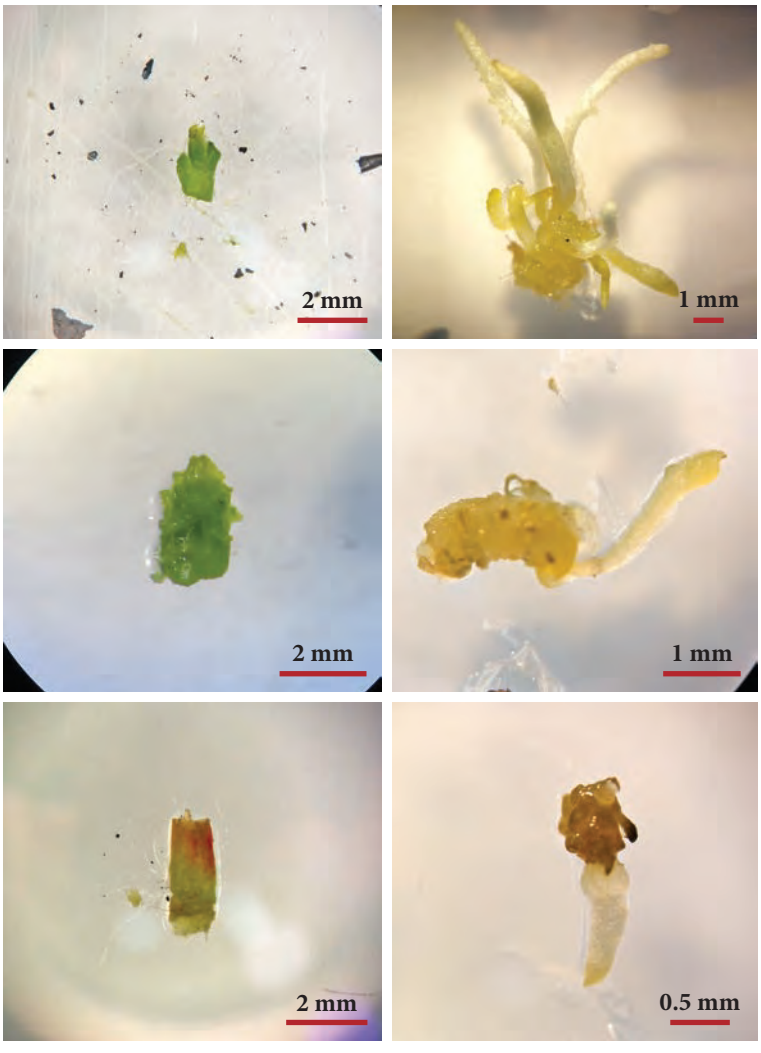
A golden opportunity was bestowed upon me when I received news that I would be going for a professional exchange programme to Kings Park and Botanic Garden (KPBG) in Western Australia. KPBG is well-known internationally for its excellent scientific research programmes and conservation practices. The Kings Park Science programme is led by Dr Jason Stevens and has a long history of successful research projects in collaboration with many universities, government organisations and private sector companies.

The Kings Park Science team has developed expertise in woody plant tissue culture, plant tissue cryopreservation and protoplast fusion techniques over many years and has published numerous scientific papers on these topics. During my short stint with KPBG from 18 September to 27 October 2017, I had the opportunity to work with Dr Eric Bunn, Ms Keran Keys, Dr Bryn Funnekotter and Dr Tony Scalzo from the Science team. The goals of my study programme were to pick up new techniques in the areas of woody plant tissue culture and cryopreservation, and to strengthen the connection between the Gardens and KPBG.

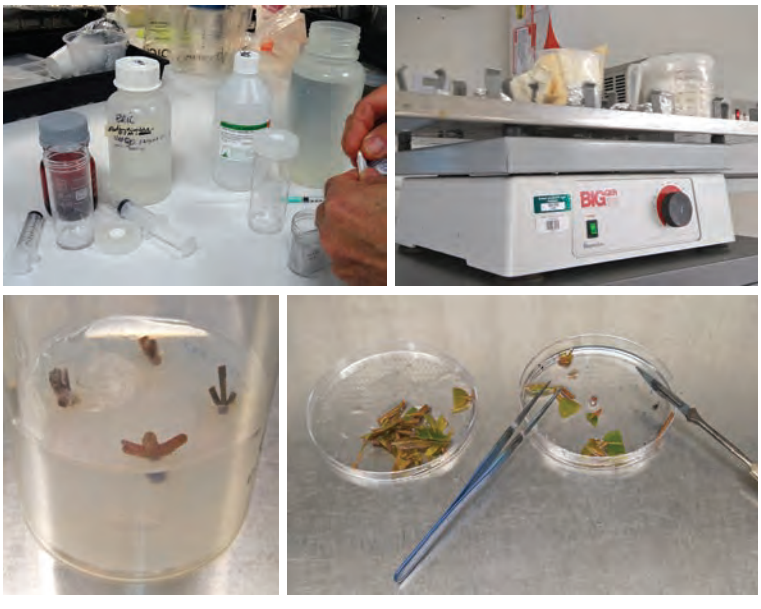
I was kept busy every day with hands-on sessions in various cryopreservation procedures and tissue culture techniques for woody plants. There was no time to waste, for the clock was ticking for me to quickly hone my skills and ensure that I acquired sufficient knowledge to bring back to the Gardens. Cryopreservation techniques are of particular interest to me and highly relevant for the Gardens' Orchid Breeding and Micropropagation Laboratory. Culturing native plants is part of our conservation plan, and cryopreservation could be one way for us to store living material from large numbers of nationally important plants that could be used for reintroduction in the future. It could also be used to preserve genetic material from our VIP orchids. Cryopreservation allows us



Different plant species that are cultured at KPBG using cryopreservation techniques. Top row, from left to right: *Grevillea scapigera*, *Lasiopetalum* sp., *Philotheca basistyla*. Bottom row, from left to right: *Synaphea quartzitica*, *Allocasuarina fibrosa*, *Eucalyptus impensa*.



Shoot tips from three different species before and after cryopreservation. On the left, they are shown freshly isolated, and on the right, after freezing in liquid nitrogen for one day and incubation in a recovery medium for two weeks. (Top) *Grevillea scapigera*, (centre) *Philotheca basistyla*, (bottom) *Synaphea quartzitica*.



The process of woody plant tissue culture involves: (clockwise from top left) preparation of solution for collection of field samples; initial sterilisation of explants; cutting sterilised samples in a solution comprising antioxidants and an extra sterilant; and the culture of sterilised explants on a specific medium.

to freeze plant tissue with regenerative potential (such as stem tips) until we are ready to propagate it again *in-vitro*. In comparison, the preservation of genetic material through traditional *in-vitro* cloning requires the transfer of tissue onto fresh media when the nutrients are depleted. Because genetic variations can occur during this process, which freezing avoids, cryopreservation has the important advantage of reducing soma-clonal variations. The protocol of this method is indeed intricate, and I would not have grasped the techniques if not for the patient guidance of my mentors.

Being an inscribed UNESCO World Heritage Site, the Gardens strives to conserve the mature trees that make up its precious natural heritage. Tissue culture of woody plants, which is generally more challenging compared to herbaceous plants, would enable us to conserve the germplasm of our Heritage Trees as well as threatened native tree species across Singapore. During my time at KPBG, I was honoured to be able to pick up not just a skill or two, but several techniques from Dr Bunn that could increase the Gardens' success rate of culturing different woody plant species.

Dr Scalzo demonstrated to me the protoplast fusion process using native Australian plants. This technique has the potential to be used for the production of novel orchid hybrids which cannot be produced by conventional breeding methods, such as inter-generic hybrids (for instance, a hybrid created by crossing a *Cattleya* orchid with a *Dendrobium*).

While I was at KPBG, Ms Keran kindly guided me around the grounds, giving me insight into the operation of the garden and familiarising me with its facilities. She also showed me around Perth and introduced me to places to get nice Asian food on the weekends. It was truly a fruitful trip, and I hope to find time to visit KPBG again.

Koh Teng Seah
Orchid Breeding and Conservation Biotechnology Laboratory

The author would like to thank Dr Eric Bunn from Kings Park and Botanic Garden for his advice in the preparation of this article.

Nature's offering fit for a god …

Ixora are some of the most ubiquitous flowering shrubs that have graced Singapore's gardens and streets since the early days of our greening movement. This genus of flowering plants is in the Coffee family (Rubiaceae) and consists of around 563 species of mainly evergreen shrubs and small trees that come from the tropical and subtropical regions of the world. Red and orange flowered ixoras have symbolic importance to Hindus, and their flowers are traditionally offered to deities during prayers. In fact, the generic epithet *Ixora* is derived from the Sanskrit 'Ishwara', a name synonymous with Lord Shiva, a leading Hindu deity.

From March to April this year, a period which saw extreme hot spells in the afternoons followed by heavy rains, flowers burst from *Ixora* shrubs all over Singapore. This colourful spectacle was especially observable in the Gardens where various species and cultivars of *Ixora* showed off their beauty with flowers in colours of intense red, orange, yellow or white. One species that stood out is *Ixora finlaysoniana*. With its sweetly scented flowers, visitors walking past this plant in full bloom would have had their olfactory senses come alive!

Ixora finlaysoniana is a handsome, large growing shrub with lush, dark green leaves. This species has a wide distribution range and can be found growing from Assam and Bangladesh to southern China, through Indochina and to the Philippines, and thrives at the edges of humid forests up to about 1,000 m in elevation. It has a number of common names, including Fragrant Ixora, White Ixora and Siamese White Ixora, and in Malay it is called Jejarum Putih and Bunga Siantan Putih.

When in full bloom, *Ixora finlaysoniana* is covered in numerous corymbs carrying multitudes of white, four-petalled, tubular flowers. The flowers are protrandrous, meaning that the male reproductive organs mature before the female organs, a mechanism to prevent self-pollination. The flowers are highly scented and attract butterflies, and the fruit is a drupe that ripens from green to a deep blackish red.

A close-up view of the highly perfumed flowers of *Ixora finlaysoniana*. *(Photo credit: Koh Sin Lan)*

***Ixora finlaysoniana* used as a hedge planting.** *(Photo credit: Nura Abdul Karim)*

Ixora finlaysoniana can be propagated from seeds, by semi-woody cuttings or even air layering. It is a popularly cultivated species due to its ornamental foliage and showy, perfumed flowers which bloom almost continuously in tropical gardens. It is not susceptible to disease and thrives in full sun. It is highly recommended for mass plantings and hedges. Periodic pruning is encouraged to keep the plant compact and to stimulate flowering.

In the Gardens, *Ixora finlaysoniana* and other flowering Ixoras can be found near the Sundial Garden and in the Learning Forest. On your next visit, why not stroll past for a glimpse (and whiff!) of the flowers that have proven a worthy offering to the gods!

Nura Abdul Karim
Library, Training and External Relations

January–June 2018

From left to right: Her Excellency Tao Thi Thanh Huong, Ambassador of Vietnam to Singapore; His Excellency Mai Tien Dung, Chairman of the Government Office, Vietnam; Mr Lawrence Wong, Minister for National Development and Second Minister for Finance, Singapore; Mdm Tran Nguyet Thu and His Excellency Nguyen Xuan Phuc, Prime Minister of Vietnam, in the National Orchid Garden on 27 April 2018.

His Excellency Narendra Modi, Prime Minister of India, with Mr Ong Ye Kung, Minister for Education, Singapore, and Dr Nigel Taylor, Group Director of the Singapore Botanic Gardens, in the National Orchid Garden on 2 June 2018.

Ms Agate Leung and **Mr Thomas H.W. Shiu**, Hong Kong International Airport Market and Connectivity Development Division

Dr Axel Dalberg Poulsen, Royal Botanic Garden Edinburgh, United Kingdom

Mr Barton J. Putney, Acting Deputy Assistant Secretary for Environment, Bureau of Oceans, Environment and Science, United States of America

Dr Bill McDonald, Queensland Herbarium, Australia

Mr Bruce Greer, Fairchild Tropical Botanic Garden, and **Mrs Evelyn Greer**, United States of America

Dr Bui Hong Quang, The Institute of Ecology and Biological Resources, Vietnam

Dr David Johnson, Ohio Wesleyan University, United States of America

Mr David Sole, Wellington Botanic Gardens, New Zealand

Delegation from the Seoul Metropolitan Council, South Korea

Delegation from the Southern Osaka Assembly Federation, Japan

Delegation from the Tatarstan Investment Development Agency, Russia

Dr Dian Latifah and **Mdm. D.M. Puspitaningtyas**, Bogor Botanic Gardens, Indonesia

Mr Ed Ikin, Royal Botanic Gardens, Kew (Wakehurst), United Kingdom

Dr Ed de Vogel, Naturalis Biodiversity Center, Leiden, The Netherlands

Dr Elliot Gardner, The Morton Arboretum, United States of America

Dr Henk Beentje, London, United Kingdom

Prof. Indy Burke and **Prof. William Lauenroth**, Yale School of Forestry & Environmental Studies, United States of America

Ms Isna Arofatun Nikmah, Bogor Agricultural University, Indonesia

Dr Kate Armstrong, New York Botanical Garden, United States of America

Mr Konstantin Shulz, Herrenhausen Gardens, Hannover, Germany

Prof. K.P. Rama Prasanna, formerly from Lalbagh Botanical Garden, Bangalore, India

Dr Lawrence Liao, Hiroshima University, Japan

Ms Lee Won-Young, **Mr Rhee Jung-Chul**, and **Ms Choi Woo-Kyung** of Seoul Botanic Park, South Korea

Ms Nadhanielle Simonsson, National Research Institute of Papua New Guinea

Dr Nancy Murray, Ohio Wesleyan University, United States of America

H.E. Narendra Modi, Prime Minister of the Republic of India

Dr Nguyen Van Du, The Institute of Ecology and Biological Resources, Vietnam

H.E. Nguyen Xuan Phuc, Prime Minister of Vietnam, and **Mdm Tran Nguyet Thu**

Mr Nutdanai Putthisawong, Prince of Songkla University, Thailand

Participants of the Study Space XI: Singapore workshop co-organised by the International Council on Monuments and Sites (ICOMOS) Singapore and Georgia State University, United States of America

Mr Peter O'Byrne, Sabah, Malaysia

H.E. Prof. Piotr Glinski, Deputy Prime Minister and Minister of Culture and National Heritage of Poland

Dr Rogier de Kok, London, United Kingdom

Dr Sahut Chantanaorrapint, Prince of Songkla University, Thailand

Dr Sajeewanie Jayapala, Ocean University of Sri Lanka

Ms Sakuntala Ninkaew, Khon Kaen University, Thailand

Dr Tracy Ireland and students from the University of Canberra, Australia

Mr Tran Huu Dang, Southern Institute of Ecology, Vietnam

Mr Witsanu Saisorn, Khon Kaen University, Thailand

Dr Wolfgang Stuppy and **Mr Lukasz E. Wisniewski**, Botanical Garden of Ruhr University Bochum, Germany

Dr Yong Kien Thai, University of Malaya, Malaysia

Dr Zhang Li and staff from Fairy Lake Botanical Garden, China

The Japanese Garden

The Japanese Garden in the 1980s.

Japanese gardens are characterised by their simplicity and designed to inspire reflection and bring people closer to nature. They often incorporate elements such as stones, water features, mosses and carefully chosen plants, and like all gardens, they are an expression of human imagination and craftsmanship.

There used to be a small Japanese Garden in the Singapore Botanic Gardens. It was created in 1972 on Lawn M near Lower Ring Road, and was landscaped with Japanese natives such as *Juniperus conferta*, *Ophiopogon japonicus*, *Cycas revoluta* and *Rhododendron indicum*. Other species featured in the garden included *Baeckea frutescens*, a small tree with needle-like leaves; the African sedge *Cyperus flabelliformus*; and *Wrightia religiosa*, a shrub that produces pretty white flowers and is often used in bonsai.

In Japanese culture, water represents renewal. Two waterlily ponds were incorporated to make the garden a soothing and relaxing space, and they were filled with Japanese guppies and carp. Boulders, Japanese style stone 'lanterns', and a simple bamboo fence were added for harmony. There was also a white wall which interestingly attracted the rare arboreal snail *Amphidromus inversus*. Known to occur only in the Singapore Botanic Gardens, this snail would feed on the algae and lime that it scraped off the wall.

In 1986, the Japanese Garden was improved by Mr Jun-ichi Inada, the Senior Landscape Architect at the Parks and Recreation Department (the predecessor of the National Parks Board) at the time. He laid a stone path, instructed workers to water the boulders to promote the growth of moss, and made improvements to the wall and the garden's water features. The Japanese Garden was eventually removed for the creation of a new Aroid Garden, which is still there today.

Christina Soh
Library

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