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# The Singapore Botanic Gardens Palm Collection – Historical Perspective, Representation, Conservation and Direction

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1. The avenue of Royal Palms planted in 1950 along office gate road.



A specialized plant collection within a botanic garden often carries a complex historical legacy. At the same time, it can help to shape the future direction of the institution. The palms at the Singapore Botanic Gardens (SBG) constitute a very good example of such a collection, because they have been augmented over many decades, and each major phase of augmentation has left its distinctive mark; furthermore, the collection as a whole has absorbed more than the entire history of the gardens and is still continuing to influence it today.

The development of such a palm collection invokes many dimensions, from planning to collection, from horticulture to arrangement, but three very interesting perspectives ought to be recounted. Firstly, the natural abundance of palms in the Asia-Pacific region, a center of diversity for palms, is impressive. The family has an astonishing diversity of more than 1200 species here. In the botanical region of Malesia alone 50 genera and almost 1000 species of palms have been recorded (e.g., Dransfield et al. 2008, Baker & Couvreur 2012, Heatubun et al. 2014). The hot-wet equatorial climate in Singapore, of course, favors the cultivation of myriad representatives of this essentially tropical plant family. Situated just slightly north of the equator (1°17'N, 103°50'E), Singapore enjoys conditions that promote plant growth: high humidity, a mean average temperature of 28°C all year round, and average rainfall of around 2300 mm annually. How numerous the cultivated palms are in Singapore can be realized from a short bus ride along upper Bukit Timah road from the Botanic Gardens MRT station to the Bukit Timah entrance: as many as 30 genera can be seen!

A second perspective relates to the historical development of the Gardens. Brought to life by an Agri-Horticultural Society with the idea of creating an ornamental pleasure-garden that at the same time should serve local agriculture, the SBG realized that palms had both an ornamental as well as a functional role. Palms even preceded the establishment of the botanic gardens in the form of remnant, cultivated individuals from former days when part of the area served as a plantation. When the Gardens became integrated into the network of British colonial botanic gardens, the exchange of plant material intensified, and more palms were sourced from other parts of the colonies.

The third interesting aspect regards the innovators of the collection, or in this case a series of superintendents, directors and botanists, each contributing to the extension and curation of the collection according to his own interests, personal links, professional enthusiasm or, simply, his general love for plants. I hope to show, over the following pages, how these three areas continue to shape one of the great palm collections of the tropical world.

### Singapore botanic gardens in history

The birth of the SBG was in 1859, when a number of wealthy Singaporean residents

founded the Agri-Horticultural Society. There had been several attempts previously to establish a garden, though mostly driven by the interest in commercial plantations such as nutmeg cultivation. But as the value of such crops declined, so did the interest in establishing botanic gardens. The name Agri-Horticultural Society suggests a somewhat mixed agenda. Its objectives may be summarized as the development of an experimental garden for the trial of economic crops, while at the same time creating an ornamental pleasure park for the important and wealthy. Its founders were influential business people, and initially the gardens were open only to certain subscribers; this soon changed, however, and all members of society gained access.

The Agri-Horticultural Society acquired the land at the current site and employed Lawrence Niven as its manager on a part-time basis to conceptualize and develop the garden. Niven, from a family of nurserymen, was also managing a local nutmeg plantation. It appears the nutmeg crop had been in decline because of disease, and this may have been Niven's reason for seeking alternative employment (Taylor 2013). Niven started clearing much of what was then secondary growth (previously part of the area had been a gambier plantation – gambier, *Uncaria gambir*, was an important agent for tanning), and the site began to take shape. Soon the space had been neatly laid out with flowerbeds, consciously or not, in a style influenced by the 18<sup>th</sup> century English Landscape movement, manifesting itself in gently rolling hills and a lake (Taylor 2013). Much of the initial flower cultivation served to provide cut flowers for the garden's subscribers. There was also a patch of natural rain forest, which is still in existence today.

As the garden's developments and expenditures increased, the Agri-Horticultural Society made a proposal in 1874 to hand over the garden to the government. It was argued that by becoming a governmental institution, it could be placed on a "proper scientific footing" (Fox 1889) and be backed up with the necessary financial means.

The government accepted the proposal and what had so far been a nicely laid out park became another link in the network of British colonial botanic gardens. The British had set up botanic gardens in the West Indies (St Vincent) in 1765, Jamaica (1779), Trinidad





2. The male reproductive plant of *Lodoicea maldivica* is growing in the Palm Valley. Its pollen is transferred manually to the female plant in the original Palmetum behind Holttum Hall.





3. Palm Valley with a view toward Burkill Hall 1917.

(1818), and later in the East Indies (with the British East India Company), at Calcutta (1787) and Peradeniya (Sri Lanka) in 1821. By 1837, Queen Victoria's ascension, there were eight such gardens, but at the end of her reign in 1901, this number had grown to more than 100 and included sites in Africa, Australasia, Canada and the Indian Ocean, Hong Kong and the Pacific (McCracken 1997). Regionally two other botanic gardens were of significance: Buitenzorg (today Bogor, Indonesia) founded in 1817 by the Dutch, and Penang (Malaysia) founded in 1884. At the center of this network remained the Royal Botanic Gardens, Kew, training and supplying garden directors, head gardeners and scientists. It was Sir Joseph Hooker, then director at Kew, who recommended the superintendents and directors for the gardens in Singapore.

### The first accumulation of palms

From 1875 until 1880, Henry James Murton served as first superintendent of the SBG. Son of a Cornish nurseryman and trained at Kew, Murton arrived in Singapore via Ceylon, from where he already acquired "liberal donations" of plants (Burkill 1918a). Throughout his five years of service in Singapore he maintained regular correspondence with many other colonial gardens as well as Kew, and frequent plant exchanges ensued. It was he who started

to turn the well-kept park into a working botanic garden and who first began to accumulate a palm collection. Under him, a herbarium and a library were constructed, and the number of known plant species in the gardens was raised from about 500 to over 1300 (Fox 1889).

In the annual report for the SBG from 1876, all plants under cultivation in the gardens by November 1875 are listed, including some 25 genera and 49 species of palms (Murton 1876). This number will vary slightly if we consider current taxonomy, and the list does not include some of the native palms existing on site, such as *Oncosperma*. By the end of his first year of service, however, he already appeared to grow the Double Coconut (*Lodoicea maldivica*) (Fig. 2) and *Stevensonia* palms (*Phoenicophorium borsigianum*), both Seychelles endemics; *Seaforthia elegans* (*Ptychosperma elegans*, N. Australia) and *Kentia* (*Howea*, Lord Howe Island), to name a few. In the annual report for the year 1879, Murton wrote, "The collection of palms has increased by 14 genera and 46 species during the year and some other place must soon be selected for them" (Murton 1880).

The idea of a space dedicated to palms was becoming clearer. By 1879, about 40 genera of palms were cultivated in the gardens. Initially



the palms were planted behind what is today Holttum Hall and referred to as the "Palmetum." This was not the only space devoted to palms; Murton also began to plant

palms at the head of a valley, later to become "Palm Valley" (Fig. 3). However, the concentration of palms into "Palm Valley" would come at a later stage.

4. Several specimens of *Attalea* appear to be some of the oldest remaining palms in the Palm Valley.



In 1880, Nathaniel Cantley was appointed superintendent of the SBG. Like Murton, he was recommended by Sir Joseph Hooker and had been trained at Kew before serving as the assistant director of Gardens and Forests in Mauritius. Some of the first changes that Cantley made to the gardens in Singapore included the arrangement of plants into systematic order according to the taxonomic system of Bentham and Hooker. The palm collection established under Murton, partly growing in the Palmetum but increasingly populating the future Palm Valley, was rearranged to reflect the latest taxonomic understanding as outlined in *Genera Plantarum* (Bentham & Hooker 1883). In 1892, James Herbert Veitch learned on a visit to the SBG that the newly established Palmetum was only about six years old (Veitch 1896). This statement confirms that it was Cantley who rearranged the palms accumulated since Murton's time into a space dedicated to palms and the future Palm Valley. Ridley extended the collection of palms commenced by Murton at the head of the valley down into the valley from 1891 onwards (Burkill 1918b).

Cantley spent much time identifying and correctly naming the plants in the collection. He also employed a printer to produce labels for the living collection. The herbarium and the library, which Murton had started, were expanded. These systematic changes to the hitherto rather eccentric collection of plants consolidated the "scientific footing" of the SBG as initially proposed to the government by the Agri-Horticultural Society. Having served within a forestry department before, Cantley was able to increase substantially the number of economically important plants and related trials. He also deserves credit for the establishment of a nursery facility predominantly for ornamental plants, which meant that there was now a dedicated space for plant propagation within the gardens. Unfortunately, Cantley's service was interrupted several times by illness, and he died while on leave in Australia.

### The 'finest palm collection in the world'

Henry N. Ridley was appointed as first director of the SBG in 1888. To date, he is still the most famous personality of this garden, not only because of his persistence in promoting *Hevea brasiliensis*, Pará Rubber, as an economically viable crop, bringing him the nickname "Rubber Ridley" among others, but also because he embodied the indefatigable

botanist. He collected many thousands of specimens throughout the region and was extremely productive in generating scientific publications. His works included the description of new plant species and writing an entire flora of Malaya, among other classic books about seed dispersal and spices. He also conducted an enormous range of trials with economic plants.

Ridley's interest relating to palms was not only scientific but one centered very much on their usefulness. One of his earliest achievements was the Coconut Tree Preservation Ordinance, an Act that was passed as early as 1890, following his recommendations as outlined in a report to the Royal Asiatic Society (Ridley 1889). Its objective was to control the Rhinoceros beetle, *Oryctes rhinoceros*, in coconut plantations and to prevent its spread to other healthy palms, including those at the SBG, where these insects regularly inflicted damage. A coconut tree inspector was employed to frequent the plantations and fine the owners for not clearing any debris that provided a breeding ground for the larvae of this insect. Ridley wrote in the annual report for 1890, "In the Botanic Gardens, notably at one spot near the office, it was almost impossible to grow any palms at all. Those liable to attack were destroyed often within a day or two of their being planted; a small avenue of the rare and beautiful *Verschoffeltia splendida* by the aviary was perishing tree by tree, till the Act came into force" (Ridley 1891).

Ridley soon started to publish an agricultural bulletin (later to become the *Gardens Bulletin*, see Wong 2012), in which he documented economic plant trials such as his rubber experiments or notes on the cultivation of sago (*Metroxylon sagu*). His article on the oil palm (Ridley 1907), which discussed effective methods of extracting oil from oil palm fruits, undoubtedly intensified the already growing interest in a crop that would become the most important agricultural product of the region, next to rubber. This review of *Elaeis* was based on trees that were planted at the SBG in 1875. Although it appears to be the first introduction of oil palm to Malaya (Anonymous 1958), this planting occurred almost 30 years later than the introduction of oil palm to the Buitenzorg Botanic Gardens (Bogor, Indonesia). Ridley (and subsequent directors) provided oil palm seeds to interested plantation owners in the region, so aiding the establishment of the palm as a major crop, but the origin of many commercial oil palms in Malaya can actually



be traced back to four trees at Bogor that were introduced as early as 1848. The potential of oil palm as a crop was realized very early, but palm oil was imported directly from Africa. There was a growing need for the oil and its derivative glycerine. It was used in soaps and candles (used for heating and light), photography (to preserve film), manufacturing of colors, as a cosmetic and in perfumery (Henderson & Osborne 2000). Commercial explorations by a Belgian company soon started plantations in Sumatra, supplied with seeds from these four trees grown in Bogor. Seed from Sumatran plantations then began to spread to Malaya in 1917 (Henderson & Osborne 2000).

The growing interest in palm oil also led to the exploration of other potential palms yielding oil. For some time around the turn of the 19<sup>th</sup> century, *Attalea* from tropical America was promoted as an oilseed crop; however, the long time needed by the plants to start fruiting was not anticipated, and plantations of this palm were not deemed economically viable (Burkill 1921). These palms have another interesting connection to the SBG; they were used by the

rubber collectors in the Amazon to coagulate and sterilize the rubber by burning the seeds and letting the greasy smoke pass over the rubber (Burkill 1966). Some of the largest palms at the SBG today belong to the genus *Attalea* (Fig. 4).

For the year 1891, Ridley reported the planting of additional palms into the Palmetum, which now comprised 102 genera and 160 species (Ridley 1892). Several species of rattan were introduced into the gardens around the same time, probably in view of the economic value of rattan cane. Ridley also maintained a column in the annual reports where he listed the phenology of rare or particularly interesting plants, such as the flowering of *Korthalsia rostrata* (1900), *Wallichia disticha* (1907) and *Prestoea montana* (1909). Ridley was the first to publish two notes on the palms at the SBG. The first one is an extensive description of palms, a general introduction and horticultural challenges (Ridley 1904). The second is a short list of newly acquired palms (Ridley 1906). In the annual report for the year 1909 Ridley wrote, "Over 200 palms were planted in the Palm Valley. The collection of

5. *Hyphaene dichotoma* in the National Orchid Garden. This plant was already there in the 1920s as part of the Sun Rockery.





palms now is probably one of the largest in number of species of any garden in the world" (Ridley 1910).

In 1910, *Raphia* palms were planted in the economic garden with the intention to use them for fiber production. The same year saw the first recorded flowering of *Licuala grandis* introduced from the island of New Britain, today one of the most commonly used garden palms throughout Singapore. The year 1911 saw the introduction of *Latania commersonii* (*L. lontaroides*), which flowered for the first time in 1920 (Burkill 1921).

While Ridley evidently kept himself occupied, he still exchanged plants and seeds and continued to source plants from overseas, be it through his correspondence with other botanic institutions and growers or from his frequent collecting expeditions throughout Southeast Asia. The herbarium grew to such an extent that it had to be expanded, soon containing a good collection of dried specimens from the entire region.

In 1912, the first *Index of Plants* of the SBG was published (Anderson 1912), containing some 93 genera of palms. The discrepancy between the 102 genera recorded by Ridley a few years earlier and the 93 recorded by Anderson can be explained by the fact that Anderson's catalogue was intended to advertise seed exchange of certain plants, so some immature palms may have been omitted intentionally.

### Maintaining and promoting a world class collection

Isaac Henry Burkill succeeded Ridley as director and served from 1912 until 1926. By this time, palm genera from all over the world had found their home in Singapore, and the SBG collection was providing an excellent basis for their study, both botanically and horticulturally. And the acquisition of palms continued. In the annual report dating 1920, Burkill wrote that 27 palms new to the collection had been introduced, while others were starting to flower and fruit, such as *Latania* and *Attalea*.

Frederick Flippance, the assistant curator during 1919–1921, published a guide to the palm collection. This was the first guide to appear since 1906. "In the fourteen years since the last article was written many additions, and it is feared several losses, have to be recorded and accordingly it seemed desirable thoroughly to investigate the collection again"

(Flippance 1920a). Surprisingly, in this guide, merely 60 genera of palms are mentioned to be in cultivation. This is in strong contrast to the 102 genera written about by Ridley in 1891, and the 93 genera counted in Anderson's *Index of Plants* (1912). While there is mention of pests such as the Rhinoceros Beetle and the Red Palm Weevil destroying palms (Ridley 1889, 1904; Flippance 1920b), this discrepancy may also be the result of changing palm taxonomy over time, or simply newly introduced palms failing to establish.

In 1923, Caetano Xavier Furtado joined the SBG as assistant botanist, chiefly in charge of naming the living collections and cultivated plants (Kiew 1999). He previously had published studies of an agricultural nature on coconut palms, and soon after arriving in Singapore, he began to study Malayan palms. Four new genera were erected by Furtado: *Cornera*, *Liberbaileya*, *Schizospatha* and *Maxburretia* (*Cornera* and *Schizospatha* were subsequently reduced to *Calamus*, and *Liberbaileya* sunk into *Maxburretia*). During several expeditions, including to Kinabalu and Peninsular Malaysia, he studied and collected palms in the field. He also travelled to Europe, where he carried out research in major herbaria in Berlin and London. Furtado studied the extensive living collections at the Bogor Botanic Garden and deposited herbarium vouchers at the SBG herbarium. In order to study the taxonomic accounts, which were often in foreign languages, he learned Italian, Spanish, French and German. He described over 100 species of Malayan palms, mostly in the genera *Licuala*, *Pinanga*, *Daemonorops* and *Calamus* (Johnson & Tay 1999). His numerous publications on Malayan palms appeared in the *Gardens' Bulletin Singapore* between 1934 and 1960. During WWII, Furtado continued to work at the SBG along with Edred John Henry Corner and Richard Eric Holttum. After his retirement, Furtado continued to work in the herbarium and studied, among others, the genus *Hyphaene*. Several publications on this genus appeared in the *Gardens' Bulletin*, including a treatment of the Asian species of *Hyphaene* and the publication of *H. dichotoma* from India (Furtado 1970), the only species in cultivation at the SBG (Fig. 5). Furtado's impact on palm taxonomy has not always been realized to the extent it deserved, while personalities like Corner, primarily a fungus specialist, earned a lot of recognition for his inspiring work *The Natural History of Palms* (Corner 1966).



6. The first *Lodoicea maldivica* to reach the fruiting stage was planted in 1961.

Other eminent palm scientists have had an association with the SBG over the years. Odoardo Beccari, for example, regularly corresponded with Ridley discussing information on palms. In honor of Beccari's

contribution to our understanding of palms, an avenue of palms described by him was intended to be planted at the SBG (Burkill & Moulton 1921). This intention was realized and "Beccari's palms" were planted below the





7. *Oenocarpus bataua* is producing inflorescences throughout the year.

Sun Rockery (Burkill 1927), which during the 1920s was situated where today the entrance to the National Orchid Garden lies. However, none of these palms exists at this site today. In 1897, David Fairchild was received by Ridley during his travels through the region (Fairchild

1938). Although not primarily a palm scientist, Fairchild left his legacy at the Fairchild Tropical Botanic Garden, Miami, Florida, USA; anyone interested in palms knows the magnificent collection there. Recent years have seen repeated visits by John Dransfield, who has





8. Murton's *Oncosperma tigillarium* planted in 1878.

given much effort to assist palm identification at the SBG. The latest such visit was in October 2014, when two specimens of *Tahina spectabilis* were specially planted by him in a commemorative act. SBG's botanists recently honored Dransfield in *Adonidia dransfieldii*

(Wong et al. 2015), a rare Bornean palm with straighter trunks than those of the more commonly planted *Adonidia merrillii*, which usually shows some sinuous trunk development. The SBG will soon plant out the first batch of *Adonidia dransfieldii*.





9 (top). The *Johannesteijsmannia* collection along Maranta Avenue contains some splendid specimens. 10 (bottom). *Sommieria leucophylla* along the Maranta Avenue.





11. *Johannesteijsmannia perakensis*.

### Representation

Today the SBG has the largest collection of palms in Singapore besides the recently established Gardens by the Bay and possibly one of the largest collections in the world. There are about 800 individual palms (accessions) in Palm Valley alone. Following the taxonomy as outlined in *Genera Palmarum* (Dransfield et al. 2008), the SBG has 112 genera and 260–300 species, including several yet to be determined. The combination of natural palm diversity in the region, historical acquisition of species through a colonial network of gardens and repeated collecting expeditions throughout SE Asia makes the collections at the SBG world class.

There is a heavy representation of Asia-Pacific palms with 52 genera. Second are palms from the Americas with 32 genera. All six endemic Seychelles palms are in the collection, as well as several genera from Australia, Lord Howe Island, New Caledonia, Madagascar and mainland Africa. Some palms from higher elevations or a more moderate island climates, such as *Howea* or *Rhopalostylis*, can be grown only with great difficulty and usually do not live for very long. Hence the focus has been on

Asian, American and African tropical and subtropical species.

Palm Valley is the principal location for palms at the SBG. The arrangement of palms in Palm Valley follows an overall taxonomic arrangement; there are eight clusters (or “islands”) of palms, arranged into four subfamilies: along the National Orchid Garden side are two clusters of Arecoideae (characterized by the large clumps of *Oncosperma tigillarum*), one cluster of Coryphoideae (mostly *Arenga*, *Caryota*, *Corypha* and *Wallichia*) and Calamoideae with some adult *Mauritia*, *Mauritiella* and *Metroxylon*. Along the rainforest side are two more Coryphoid clusters with *Copernicia*, *Livistona*, large *Corypha* and a male reproductive *Lodoicea* (Fig. 6) among others. There is also one more Arecoid cluster and the Ceroxyloid cluster, the latter being under development, currently with a mix of species including *Borassodendron machadonis*, *Calyptronoma occidentalis* and a frequently flowering *Oenocarpus bataua* (Fig. 7). Only recently, young plants of *Ravenea* have been added in an attempt to establish a Ceroxyloideae cluster, reflecting the currently accepted subfamilies (Dransfield et al. 2008). More Ceroxyloid palms are targeted for





12. *Lodoicea maldivica* in 1947.

inclusion in the future, especially the Ivory Nut palms such as *Phytelephas*, a palm that used to be grown at some point in the past. In the center of Palm Valley is a large *Attalea* species (Fig. 4) as well as a mature *Coryph utan*. These are remnant plantings from a time before the Symphony Stage was built, as now they are in the sight line of the stage. The addition of Symphony Stage in the year 2000 has meant that Palm Valley has additionally evolved into an event space. This of course, has considerable implications for the continued management of palms. To maintain this remarkable landscape feature, successional planting is done where possible. This helps to rejuvenate and maintain the palms here, many of which are quite old. Palm Valley is, as such, a major showcase of the SBG grounds, where carefully maintained palm specimens and exhibits, as well as special visitor congregations, will be managed as key aspects. At the same time, important or rare collections are also being planted in different parts of the garden.

In other areas of the gardens, palms are also plentiful, and indeed the huge diversity can

only benefit by adopting more than a single concentration at the Palm Valley. The lawn behind Holttum Hall, for example, the original starting point of the Palmetum, is still home to several species including the female *Lodoicea maldivica* (Fig. 6) and a large *Oncosperma tigillarium* (Fig. 8), the latter supposedly established by Murton in 1878. From here, an avenue of *Roystonea* palms planted in 1950, leads toward Maranta Avenue and the Ginger Garden (Fig. 1). Along Maranta Avenue, a significant collection of mostly understory species is cultivated, most remarkably the *Johannesteijsmannia* collection and the New Guinean *Sommieria leucophylla* with its lychee-like fruits (Figs. 9 & 10). Many palms can be seen in the Ginger Garden, including *Drymophloeus*, *Calypstrocalyx*, *Dypsis*, *Areca*, *Pinanga* and *Roystonea*. *Johannesteijsmannia* palms have also been planted along the drive to the back of Burkill Hall, behind the entrance to the NOG. These may well be the largest cultivated specimens found in any garden; one individual *Johannesteijsmannia perakensis* has a considerable stem attaining an overall height of about 3 m (Fig. 11)!

*Lodoicea maldivica*, the Coco de Mer or Double Coconut, appears to have been introduced to the SBG on several occasions. It was first mentioned in the Annual Report for the year 1875, where Murton listed it as one of the plants cultivated at the SBG. It is uncertain, however, for how long this plant lived. It also appears that this species was cultivated at various locations throughout the years; a tree planted behind Holttum Hall (possibly the specimen pictured in 1947, Fig. 12) is mentioned in the annual report from 1956 as having been destroyed by the Red Palm Weevil, and another specimen near the Cluny Road entrance was killed by falling branches of another tree (Purseglove 1956). Fortunately, four more seeds were obtained from the Seychelles and were planted in the Palm Valley. In the *Illustrated Guide to the SBG* by Burkill (1927) there is a picture of *Lodoicea* growing on the banks of the [Swan] lake. It seems to be growing well in this habitat although its actual habitat is on the Seychelles on granite bedrock in monodominant stands. In the annual report for 1963 it was stated that "The gardens have for many years been trying to establish plants of the Seychelles Double Coconut (*L. seychellarum*) but have been unsuccessful, the plants succumbing to attack by the Red Stripe Weevil" (Burkill 1964).

The large *Oncosperma tigillarium*, or *Nibung*, growing behind Holttum Hall and supposedly planted by Murton, is one of the largest clumps of this palm at the SBG. However, recent surveys at the bottom of Palm Valley uncovered another specimen, at least three times the size of Murton's. *Oncosperma tigillarium* is native to SE Asia and is found at the inland side of mangrove estuaries. Furtado wrote, "Others like the *Nibung* made the Malayan civilization possible since its timber was needed not only for the boats but also for the houses, for no other cheap timber was available that could stand salt water and also resist the attack of termites and other destructive organisms" (Furtado 1959).

More palms are found scattered throughout the other parts of the gardens, usually as individual, yet often noteworthy, specimens. A clump of the Sago palm (*Metroxylon sagu*) near the Tanglin Gate is of significant size and predates the establishment of the gardens, presumably started when the area was a plantation. Another such leftover from cultivation is the betel nut palm (*Areca catechu*, Fig. 13). Betel nut palms have been cultivated throughout large parts of Asia for centuries,



13. *Areca catechu*, the betel nut palm.

owing to their seeds used as a stimulant (e.g., Flippance 1920c). Used by Niven as an avenue palm in the bandstand hill area, it was later replaced by *Seaforthis elegans* (*Ptychosperma elegans*) by his successor. Today this species can be seen at various places in the gardens, including Heliconia Walk, the Healing Garden and Palm Valley itself. The Healing Garden also contains a number of oil palms, which were planted around the turn of the century. The fringes of the Eco Lake in the Bukit Timah core are occupied by *Metroxylon sagu*, *Maurita flexuosa* and a large cluster of *Nypa fruticans* (Fig. 14), the last completing the representation of all five subfamilies of palms at the SBG.

The rain forest is home to several rattan species as well as two *Orania sylvicola*, which could have always been there. Undoubtedly the Bayas palms (*Oncosperma horridum*) occurred in the rain forest then, as they do today. Ubiquitous is *Caryota mitis*. Also a number of rattans, notably the large *Plectocomia elongata* as well as *Daemonorops grandis*, have always lived here. These species are equally abundant at the Bukit Timah and the Central Catchment Nature Reserves. *Korthalsia rostrata* has been recorded for the rain forest by Turner (2000);





14. *Nypa fruticans* at the Eco Lake. Ridley stated in 1904 that *Nypa fruticans* would not grow well away from salt mud, however, it grows fine today at the SBG and sets fruit regularly.

however, this species is now difficult to find. General concerns with small fragments of rain forest include the decrease of humidity, possibly affected by increased developments in the surrounding area, and a resulting loss of buffering vegetation. Another issue is the reduction of canopy cover as trees fall and fail to reproduce. The increase in light also favors

the establishment of more weedy species in the understory of forest fragments.

#### Challenges in palm cultivation

Some of the challenges faced in the cultivation of palms at the SBG may briefly be mentioned. The shade requirements, which many species rely upon, cannot always be guaranteed at

Palm Valley or other open sites, thus those species have been given a home in the more wooded environment of the Ginger Garden or along Maranta Avenue, as well as the new Tyersall Learning Forest being established. Successive planting inside the Palm Valley has to be done very selectively, leaving enough room for palm specimens to grow to their full potential so they can be appreciated as landscape features. There are some species that were already mature and flowering at the turn of the century (e.g., *Wallichia* in 1907) but are now represented as very young individuals. Others, such as the *Attalea*, are mature and new recruits have been planted only recently. Hence allowance needs to be made for the large age gap between individual plants, and it will take quite some time for younger palms to catch up. Replacements are carefully chosen and limited to those plants that are going to make a visual impact on the landscape.

The increase in area of the SBG in 1985, when Tan Wee Kiat was the Director, has meant that even more opportunities became available for palms. A good example can be seen at the northern end, where the establishment of *Nypa fruticans* along the edge of the freshwater Eco-Lake has been successful.

Throughout the annual reports, references were made to the various pests that attack the palms at the SBG. Ridley's Coconut Tree Preservation Ordinance was to deal with the Rhinoceros Beetle, but in his preceding reports he also discussed the Red Palm Weevil. Ridley's cure was to locate the beetles by visual inspection and then use barbed wire to impale the insects inside their holes in the palm, at least when dealing with the more obvious Rhino Beetle. During the 1950s, *para*-dichlorobenzene crystals were put into the holes left by the beetles, and the holes then plugged with mud. Preventative measures – collecting the grubs out of compost – were the best control (Burkill 1958). The adult beetles will lay eggs in rotting plant material and dead wood, hence compost heaps represent the ideal food source for the developing larvae. Chemicals were also applied to defend palms against the Red Palm Weevil but to no avail, since “the symptoms of attack are revealed too late to save the plant” (Burkill 1958). Both pests are present today and can cause considerable damage to palms. Pheromone traps are currently employed for monitoring and control of both species at the SBG. Interestingly, the annual reports mentioned palms that were apparently affected by Red

Palm Weevil and Rhino Beetle, such as “the avenue of *Verschaffeltia splendida*” mentioned by Ridley, which perished “tree by tree.” Today we have several specimens of this palm in the gardens, yet no observation of it being attacked by the insects has so far been made. Equally, the coconut palms have never been observed to be attacked by either Rhino Beetle or Red Palm Weevil. That they do get attacked in other regions of the world has been shown by Hoddle (2015), so possibly the lower density of coconut trees in Singapore today may have drawn the insects instead to other palms, such as *Bismarckia nobilis*, *Lodoicea maldivica* or *Latania verschaffeltii*, suggesting a hierarchy in the insects' preference that could be density dependent.

The worst pest of palms at the SBG, however, and one for which we do not yet have a cure, are squirrels. These ravenous creatures attack all kinds of palms, especially those with a crownshaft, which they bite through to get to the juicy palm “cabbage.” Certain species, *Roscheria melanochaetes* for example, despite being covered in spines, have been difficult to establish outside of the security of the nursery. Constant vigilance and adaptive measures to protect such species are necessary if they are to be included in the collection. We are exploring various methods of such protection including wire mesh cages around small palms. New plantings are usually done at some distance from other palms, reducing “springboard” possibilities for squirrels, but other measures may need to be developed.

### Conservation and direction

In the case of the SBG, as for many other gardens, the aspect of a pleasure garden also featured in the reasoning for their establishment. Over the years pleasure merged with economic plant exploration and botanical research as primary objectives. Ridley and others led the SBG toward playing a major role in advancing the region's agriculture, as had been the original objective by the Agri-Horticultural Society. Staff at the SBG advanced the botanical study of palms and made the information available to a wider audience, culminating in Furtado's numerous palm papers in the *Gardens' Bulletin Singapore* and influencing Corner's *The Natural History of Palms* (1966).

In a speech by Holtum in 1984, subsequently published in the *Gardens' Bulletin*, the role of a botanic garden was summarized: “A botanic garden is essentially a museum of living plants.



The word 'museum' is derived from the name of the Greek goddesses of learning and the arts; thus a museum is a place devoted to the pursuit of such studies. A botanic garden is primarily a place where plants are grown for scientific study. But a garden differs from a museum in the fact that the objects in it are living and growing, and thus need the attention of horticulturists. Horticulture is in part applied botanical science: but it is also in part an art, and the aesthetic aspects of horticulture therefore find expression in any garden..." (Holttum 1999).

Over the last three decades, forest cover in large parts of Southeast Asia has disappeared dramatically. Ironically one of the major drivers of deforestation and loss of palm diversity is the exploitation of another palm for commercial use, the oil palm. Since the 1980s the total area of land allocated to oil palm has more than tripled globally, exceeding 14 million hectares in 2007 (Sheil et al. 2009). The understanding of palms, both horticultural and scientific, is thus more important than ever, if this family of plants is to remain as diverse in the region in the future as it is today. The traditional purpose of education and display in botanic gardens has increased once more, to focus on sustainable land use, climate change, public engagement and most importantly, *ex situ* plant conservation and public education. Where horticulture was once evolving around the "aesthetic aspects" of a garden, it must now focus on the applied botanical science – working out practical methodologies such as propagation protocols to facilitate plant cultivation outside their natural habitat, thus preventing them from becoming extinct. Studies have shown that temperate botanic garden collections do not adequately reflect palm conservation priorities because of the lack of genetic diversity represented in their collections, or simply the inability to house such large plants inside a glass house (Maunder et al. 2001). Space constraints are much less a problem in the tropics, where palms can be grown outdoors. In order to encourage the ultimate recovery of threatened palms by means of reintroduction of garden-grown stock, the most effective form of *ex situ* conservation programs have been identified as those that happen in-country (or at least within a region) and are linked with habitat conservation (Maunder et al. 2001). Thus the palm collection at the SBG has a function that far exceeds its mere grandeur; it is a

fundamental starting point for *ex situ* conservation.

One priority of the SBG should be the conservation of those palms of the region, which are threatened with extinction, and to build a genetically diverse collection within the gardens. Equally important is the recording of horticultural methods and ecological data such as phenology or pollination behavior. These data could be effectively linked into living collections research and be made available to a wider audience or the scientific community. Such efforts must then be interpreted for the education of the public. Possibilities include, for example, the parallel use of Palm Valley as an event space, where also exists the potential to capture a wide audience, and educate and inspire them about our rich plant life. Our collection strategy now emphasizes assessing and evaluating the current collection in view of conservation purposes, and leading on from this, the planning of a coordinated collecting program, together with regional partners, to continue to study and conserve SE Asian palms. We have now arrived at a point in history, where the repertoire of expertise and intellectual property accumulated over the more than 150 years of SBG's history must be used to lead plant conservation activities more strongly and, at the same time, raise public awareness in our support. And what would lend itself better for such activities than one of the greatest palm collections in the world?

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