

THE GARDENS OF SINGAPORE – ENTHUSING AND EDUCATING
THE PUBLIC IN THE WORLD OF PLANTS*Stuart Lindsay¹ & David Middleton²*

ABSTRACT

Singapore has several public gardens of which two, Singapore Botanic Gardens and Gardens by the Bay, are of particular national and international renown. These two gardens have contrasting but complementary ways of enthusing and educating the public about plants and of gaining their support for horticultural excellence, botanical research and conservation. Founded in 1859, Singapore Botanic Gardens is an old and established garden with a long history of horticultural and botanical research, plant exploration and conservation. It became a UNESCO World Heritage Site in July 2015, the world's first tropical botanic garden to receive this accolade. Gardens by the Bay opened in 2012 and its focus is on large-scale displays in spectacular settings, thereby attracting huge numbers of visitors since its opening. In their contrasting ways, both gardens enthuse and educate the public about plants and the natural world. This work lays the foundations for public advocacy of conservation efforts in Singapore, resulting in a very high level of public support for greening efforts and the protection of natural areas in land-scarce Singapore.

INTRODUCTION

Singapore is the second most densely populated country in the world (United Nations, Department of Economic and Social Affairs, Population Division, 2013) with a population of over 5.6 million in a land area of only around 720 km². Conservation of biological diversity in a country with such a high population density inevitably poses many challenges. The original vegetation cover of the island would primarily have consisted of dipterocarp forest, mangrove forest and freshwater swamp forest but shortly after the arrival of British and Chinese colonisers in the early 19th century most of the forest was cleared for plantations (Wee & Corlett, 1986; Chong *et al.*, 2009). Today, primary forest covers less than 1% of Singapore's land area although vegetation covers about half of the country. About half of this green cover is spontaneous secondary vegetation, with some areas of mature secondary forest, but the rest is a planned network of parks and gardens, mostly under the management of Singapore's National Parks Board (NParks). NParks manages over 300 regional and neighbourhood parks, many of which are connected to each other by a network of over 60 'park

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connectors', strips of vegetated land, often along paths and roads. Singapore also boasts two world-renowned gardens: the Singapore Botanic Gardens and Gardens by the Bay. Singapore Botanic Gardens comes under the umbrella of NParks whilst Gardens by the Bay is independent. In this paper we shall examine how these two gardens contribute to enthusing and educating the public in the world of plants in Singapore and the wider SE Asian region.

Singapore Botanic Gardens was established in 1859, originally as a private, 23-ha garden of an Agri-horticultural Society. The members were leading figures in Singaporean society, including landowners, traders and colonial officials. The Gardens were designed by Lawrence Niven in the English Landscape Movement style which emphasised a landscape design that reflected nature rather than having a formal symmetrical layout (Fig. 1). By 1874 the Society was having financial problems and the government stepped in to take ownership and management of the Gardens. In 1875 Henry Murton was transferred from the Royal Botanic Gardens, Kew to Singapore Botanic Gardens and started a herbarium and library. It was from this point that the Singapore Botanic Gardens began horticultural and botanical research, including on potentially economically important plants. Since 1875 Singapore Botanic Gardens has had several Superintendents and, later, Directors, of which arguably the most famous



Fig. 1 Singapore Botanic Gardens taken some time between 1870 and 1875. © National Library Board Singapore.

was Henry Ridley. Ridley was the Director of the Gardens from 1888 to 1912 and then had a long ‘retirement’ at the Royal Botanic Gardens, Kew (he died in 1956 at the age of 100). As Director he extensively explored the region, particularly Singapore and Peninsular Malaysia, collecting many thousands of specimens and describing thousands of new species (Van Steenis-Kruseman, 1950; IPNI, 2016). But he is most famous in Singapore for his role in the birth of the rubber industry, which he researched and championed, and which brought great prosperity to the region. Later directors and researchers were noted authorities on ethnobotany, the vegetation of the region, orchid breeding, and taxonomic research on many and varied plant families. From the 1960s Singapore Botanic Gardens was the lead organisation in the greening movement that is manifested in Singapore’s extensive network of parks and tree-lined streets. Nowadays this role is performed by NParks, of which Singapore Botanic Gardens are a part. After recent expansion the Singapore Botanic Gardens have grown to 82 ha, contain a number of heritage buildings, have many and varied specialist gardens on the site, have major *ex situ* conservation collections and continue botanical research in Singapore and the wider SE Asian region. In July 2015 the Singapore Botanic Gardens were inscribed as a UNESCO World Heritage Site, only the third botanic garden to have this accolade and the first in the tropics.

Gardens by the Bay, by contrast, is a rather new garden, having opened only in 2012 with a remit to reinvent the garden to appeal to 21st-century Singaporeans. It is designed to instil awe in visitors due to the spectacular and award-winning architecture of its two enormous conservatories and its grove of ‘Supertrees’ (Fig. 2). These Supertrees are tree-shaped structures, planted as vertical gardens, but which also perform a number of other functions, such as lighting, exhausts for the conservatories, collection of rainwater and energy generation. There are a number of themed gardens including ‘Plants and People’ that contain plants of cultural importance to the major ethnic groups in Singapore. One conservatory, the Flower Dome, showcases plants from Mediterranean and semi-arid areas of the world alongside a ‘flower field’ with changing exhibitions; the other, the Cloud Forest, showcases plants from the cool and moist vegetation of tropical mountains on an internal ‘mountain’ of 42 m which includes a waterfall 35 m tall (Fig. 3). In 2014 and 2016 the Singapore Garden Festival was staged by NParks at Gardens by the Bay.

ENTHUSING THE PUBLIC

Conservation of biodiversity is most effective when backed by action from national governments; governments are most likely to back conservation programmes and legislation when there is large public support for such actions. National and non-governmental bodies, including botanic gardens, have roles to play in generating this support through creating an appreciation and enthusiasm for nature, as well as in educating the public about biodiversity and conservation. Singapore Botanic Gardens and Gardens by the Bay have both similar and contrasting ways



Fig. 2 The Supertrees at Gardens by the Bay. Photo: Gardens by the Bay.



Fig. 3 The Cloud Forest conservatory at Gardens by the Bay. Photo: Gardens by the Bay.

of enthusing the general public about plants. Singapore has long valued the simple appeal of greenery in the environment, which led to the greening movement that began in the 1960s. The extensive network of nature reserves, parks, other green places and roadside plantings is the result of this movement. The two gardens are part of this network and appeal to the public through the beauty of their managed landscapes, the diversity of their plantings and a perception that they bring citizens and visitors closer to nature. They differ but complement each other in their approach to enthusing the public in the scale of event and exhibition programming. Singapore Botanic Gardens has a plant collection that, as a botanic garden, is largely geared towards collections of species of known wild origin. It does also have significant collections of cultivars, particular in its National Orchid Garden, but the bulk of the collection is of species. Gardens by the Bay, in contrast, emphasises that it is

a visitor attraction first and foremost and that the plantings, largely of cultivars obtained from specialist nurseries, are planned to enthuse and delight visitors. Its changing displays encourage repeat visits. These approaches are not contradictory: indeed, many visitors go to both Gardens, or one or other of them will appeal to particular sensibilities. That huge numbers of visitors go to one or both of the Gardens is something to celebrate and their popularity is beyond dispute. In 2015 Singapore Botanic Gardens had 4.73 million visits and Gardens by the Bay had 8.5 million visits.

EDUCATING THE PUBLIC

Both Singapore Botanic Gardens and Gardens by the Bay educate the public with schools programmes to teach about biodiversity and conservation; with interpretation on the landscapes and plants; and with exhibitions on biodiversity, conservation, climate change, sustainability, horticulture and so on. The education is both formal and informal (Fig. 4). The formal education is in the form of schools programmes whereby the two Gardens work with the Ministry of Education to provide learning materials for school groups who visit them. In 2015 Singapore Botanic Gardens welcomed 26,455 children to its formal schools programme; Gardens by the Bay similarly had 32,000 children in its schools programme. In addition, many school groups come to the Gardens and conduct their own programmes. Informal and adult education is provided in the form of interpretive panels, mobile apps and audio commentary. Singapore Botanic Gardens is expanding its educational reach through the opening of an extension to the Botanic Gardens called the Tyersall Learning Forest with a specific remit to educate the public on forest ecology and biodiversity (Fig. 5). Singapore Botanic Gardens also has a museum that showcases the history and work of the Gardens, a gallery that has changing exhibitions on themes related to the Gardens, and it organises public talks and lectures on botanical, horticultural, ecological and conservation subjects. The 'Domes' in Gardens by the Bay also have extensive exhibitions on biodiversity, conservation, climate change and sustainability through interpretive panels, film and interactive exhibitions.

The result desired from these attempts to both enthuse and educate the public about plants, biodiversity, and the need for sustainability and conservation, is to cultivate future generations to become advocates for these ideals, both in Singapore and abroad. Time will tell if this is successful but current indications would already suggest it is working. A recent survey by NParks indicated that 90% of the population agreed that greenery contributes strongly to Singapore's identity and 95% agreed that the natural areas in Singapore should be conserved for future generations (Victor Tan/NParks Users Survey, pers. comm.).



Fig. 4 *Rafflesia* made of Lego in the Cloud Forest conservatory at Gardens by the Bay. Photo: Stuart Lindsay.



Fig. 5 Singapore Botanic Gardens' Tyersall Learning Forest, opened in 2017, showing recreated wetlands. © National Parks Board Singapore.

RESEARCH

Singapore Botanic Gardens has a history of research on Asian plant diversity, ecology, plant breeding and economic botany whereas the research at Gardens by the Bay focuses more on understanding and controlling phenology for display purposes, plant health, plant trials, plant breeding and wildlife monitoring. Here we shall discuss the research of Singapore Botanic Gardens as it relates to conservation. Specifically we shall briefly outline the Gardens' work in basic biodiversity research, IUCN conservation assessments, conservation genetics and the reintroduction of rare or nationally extinct plant species.

Plant taxonomic research at Singapore Botanic Gardens began with the establishment of a herbarium in 1875 but took off when Ridley became Director in 1888. Ridley collected many thousands of plant specimens from which he described over 4,000 new species, mostly from Singapore and Peninsular Malaysia (IPNI, 2016). Many of these were described after his 'retirement' but were still largely based on collections he made whilst Director of the Gardens. The management and staff of Singapore Botanic Gardens have maintained this commitment to taxonomic research in the SE Asian region to the present day through monographic work (e.g. Middleton, 2016; Wong, 2016), descriptions of new taxa (e.g. Rodda & Simonsson Juhonewe, 2016; Leong-Škorničková & Kiew, 2016) and phylogenetic studies (e.g. Puglisi *et al.*, 2016). In the years 2015/2016 the staff of Singapore Botanic Gardens described more than 100 species new to science. These works provide the foundations upon which all other areas of biological science depend. Singapore Botanic Gardens have recently begun a new *Flora of Singapore* with the first volumes expected to be published in 2019.

The system set up by the IUCN to assess the likelihood of a species becoming extinct (IUCN, 2016) relies first and foremost on a clear understanding of taxon concepts. It also relies on an understanding of the distributions of species and possibly also of population size, growth or decrease, and any fluctuations. Population studies, along with assessments of current threats to populations, rely on field studies but the work of a taxonomist to delimit taxa and to assess their distributions provides much of the raw data for IUCN conservation assessments. In 2015/2016 the staff of Singapore Botanic Gardens assessed and published the conservation status of around 150 species.

Assessments of populations and an understanding of breeding mechanisms also provide valuable data for the formulation of conservation policy. In Singapore the remaining very small area of primary forest is severely fragmented and resulting extinctions of native species have been assessed as being high (Chong *et al.*, 2009). Studies on Zingiberales in Singapore have found that concerted efforts to locate particular taxa reveal that extinction is not as high as previously thought but that many populations are extremely small and possibly too small to be viable in the long term without intervention (Niissalo *et al.*, 2017). Many plants are long-lived and the effects of habitat fragmentation leading to non-viable populations could, therefore, take a long time to manifest in extinction. The genetic variability in populations of Singapore's Zingiberales is also

being studied in order to assess their health or viability (Niissalo, pers. comm.). These conservation genetics studies can then be used to formulate specific conservation actions for each species.

Some of the plants considered to be nationally extinct in Singapore (Davison *et al.*, 2008; Chong *et al.*, 2009) have since been rediscovered (Chong *et al.*, 2012). Often these rediscovered species, along with species not considered to have ever become nationally extinct, occur in extremely small population sizes. *Ex situ* propagation of threatened species, including through tissue culture and cloning, is being conducted at Singapore Botanic Gardens and more widely within NParks. More than 75% of Singapore's 226 native orchids have been assessed as nationally extinct and of those that remain 40 species are considered to be Critically Endangered (Yam, 2013). They have, therefore, been the focus of much conservation attention. By growing these plants from seed in controlled conditions and/or by bulking up numbers through cloning, along with tissue culture, propagation and reintroduction to habitats where they were previously known to occur, mean that immediate threats of extinction through stochastic events can be avoided. For some of these species there may be a problem of a lack of genetic variability potentially leading to inbreeding, but this process can conserve local germplasm and can buy time while the wisdom and feasibility of reintroductions from other populations, possibly from other countries, of nationally but not globally extinct species is investigated. For species which have truly become nationally extinct, reintroductions, particularly from Malaysia, are being conducted.

CONCLUSION

Conservation of biological diversity throughout SE Asia requires protection and management of remaining forest and other habitats and specific conservation actions on many and varied species. This requires political will which largely requires public support. Singapore Botanic Gardens and Gardens by the Bay aim to enthuse and educate the general public about plants and the environment and thereby create advocates for the natural world and its conservation. Botanic gardens can, in addition, provide the taxonomic and other biodiversity research that underpins our understanding of plant species, provide information on the threats to them, and guide any conservation actions and policies that are required. Both public engagement and research are needed if conservation efforts are to be effective.

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