

Flowering of *Carpoxylon* *macrospermum*, a Critically Endangered Palm, in the Townsville Palmetum, Australia

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In October 2014, the critically endangered palm *Carpoxylon macrospermum* growing in the Townsville Palmetum, Queensland, Australia, flowered for the first time, an event that had been much anticipated since the species first entered the collection in 1989. We provide a broad outline of the botanical history, cultivation and conservation of this species, as well as details about its occurrence in the Palmetum collection.

The Townsville Palmetum, in Queensland, Australia (latitude 19°S; elevation 25 m above sea level; seasonally dry tropical environment), has one of the largest and most diverse public collections of palms in the world (Dowe 2005, 2011). One of the design criteria for the collection is to display individual palm species in groups or avenues, demonstrating the

inherent variability of the species and its landscape/ecological function. Among the many palm avenues in the Palmetum is one composed of the critically endangered species *Carpoxylon macrospermum* H. Wendl. & Drude (Fig. 1). The definition of a critically endangered species is described in the International Union for the Conservation of

Nature and Natural Resources' *Red List* as: *A taxon that is facing an extremely high risk of extinction in the wild in the immediate future* (IUCN 2014). The Palmetum collection holds a large number of threatened, rare or endangered palm species. The value of *ex situ* conservation of such palm species, in particular those species that are threatened through habitat loss, has been examined in regards to public collections, and it has been found that the best outcomes involve a combination of habitat protection and *ex situ* projects (Maunder et al. 2001).

Carpoxylon macrospermum is endemic to Vanuatu, an archipelago of over 80 islands in the southwest Pacific Ocean lying northeast of New Caledonia and west of Fiji. The southern islands of Vanuatu, where *C. macrospermum* occurs naturally, have some of the most altered habitats in the archipelago and have experienced significant forest loss in recent times. Regrettably, there is a local, pervasive attitude that habitat protection is not a viable option in Vanuatu because of the implications of traditional land ownership, and that *ex situ* conservation, such as in the

Palmetum and other botanic gardens, may be the only practicable, long-term option for preserving endangered species. Presently, the species is not being actively protected in Vanuatu, and the initial enthusiasm of the 1990s for local conservation has waned (Palm Specialist Group 2015). Therefore *ex situ* conservation of this species has become increasingly important.

As a result of thorough field-work undertaken in 1994 throughout Vanuatu, the known population of *C. macrospermum* at that time was estimated to consist of fewer than 200 mature individuals of which only about 30 mature individuals occurred in undisturbed rainforest in Vanuatu's southern islands of Tanna, Aneityum and Futuna, the majority as cultivated individuals or small groups in villages throughout the whole of Vanuatu (Dowe et al. 1997). The palm is cultivated as it has a number of local uses, though primarily in the fabrication of durable brooms from the dried leaves (Dowe 1996). At one time the species was thought to be extinct (Hodel 1982), but was serendipitously rediscovered whilst one of the authors (JLD) was preparing an

1. The avenue of *Carpoxylon macrospermum* lining the Carl von Martius Way in the Townsville Palmetum, Australia, April 2015. Photo by J.L. Dowe.



account of the palm flora of Vanuatu (Dowe 1989). Because of the palm's rarity it became the subject of a number of conservation projects in Vanuatu (Devoe 1994, Fry et al. 1998), and a program of seed collection and global distribution was established, based at a "village economy" level (Fry et al. 1997). Through those efforts, the species is now relatively frequent in cultivation, in both public and private collections, and has proved amenable to horticulture in tropical climates. It has been flowering and fruiting for a number of years in many locations including Thailand, Hawaii, Florida and Australia.

The habit and flowers of *C. macrospermum* remained unknown to botanists until 1987,

2 (top). Males flowers of *Carpoxylon macrospermum*.
3 (bottom). Female flower of *C. macrospermum*.
Photos by J.L. Dowe.



as the species was known only by illustrations of fruits and seeds that were collected on the island of Aneityum (also known as Anatom) by the naturalist John MacGillivray in the 1850s. The original diagnosis of the species consisted only of a brief description of the fruit and seed, with an accompanying illustration (Wendland & Drude 1875). The MacGillivray fruits and seeds were later found in the British Museum herbarium (Zona 1995), somewhat as serendipitously as the palm was rediscovered in the wild, when research for a revision of the genus *Veitchia* was being conducted. The fruits and seeds had been incorrectly placed among the *Veitchia* specimens. Based on wild collected specimens, the flowers were first diagnostically described and illustrated in 1989 (Dowe & Uhl 1989), allowing the affinities and relationships of the taxon to be established: *Carpoxylon* is a monotypic genus and its closest relatives are *Neoveitchia* and *Satakentia* (Dransfield et al. 2008). Flowers and fruits of the Palmetum palms are presented here in Figures 2–4.

Carpoxylon macrospermum is the second palm species to grace the long curving pathway in

4. Full-size but immature fruit of *Carpoxylon macrospermum*. Photo by J.L. Dowe.





5 (above). Avenue of *Caryota no* in about 1997, the original palm avenue along Carl von Martius Way. 6 (below). The *Caryota no* avenue after Cyclone Tessi (Category 2) in April 2000. Photos by J.L. Dowe.

the Townsville Palmetum that is part of the Carl von Martius Way since its opening in 1988. The first was an avenue of *Caryota no* Becc., one of the largest solitary-stemmed representatives of that genus. They were planted in 1987, and by 1999 had begun to reach maturity (Fig. 5). Being monocarpic, the flowering palms began to draw on the carbohydrate reserves in their stem for flower and fruit production, slowly weakening the structural integrity of the stems. Consequently, a number of the weakened palms were toppled during Tropical Cyclone Tessi in 2000 (Fig. 6). As the remaining *Caryotas* in the avenue were showing signs of collapse and deterioration, they were all removed soon after, and the avenue remained palm-less for a number of years.

The first accession of *C. macrospermum* into the Palmetum collection occurred in 1989, with later accessions in 1990, 1992, 1994, all as ungerminated seeds that were collected from cultivated palms in Vanuatu, and in 2006 as established seedlings from a commercial palm business. All individuals from these accessions were correspondingly nurtured as pot plants in the Anderson Gardens Conservatory nursery until large enough to be planted in the ground. The first in-ground plantings occurred in





7 (left). *Carpoxylon macrospermum* in the Palmetum Rainforest section, February 2005. Photo by J.L. Dowe. 8 (right). Same plant of as in figure 7, May 2015. Photo by Nadia Snajder.

February 1995, when four individuals were planted within the Tropical Rainforest Section in the vicinity of the Carl von Martius Way bridge (Fig. 7, Fig. 9, palms 38–41). Although now 25 years old, as of August 2015 (Fig. 8), none of these four individuals has yet to flower. We presuppose that *C. macrospermum* requires exposure to strong sunlight to initiate flowering regardless of age.

The *C. macrospermum* avenue was established in two phases, with 24 individuals planted in 2004, and another ten individuals in 2006 (Fig. 9, palms 1–34). The substrate conditions along the length of the avenue are variable with regard to soil compaction, irrigation reach and water penetration into the soil. Accordingly, there has been considerable variation in growth rates and robustness of individuals in the avenue (Fig. 1). Two individuals were replaced in 2006/07 after they perished of an unknown cause. In 2014, another two were replaced when they succumbed to what was diagnosed at the time as palm weevil infestation and fungal attack respectively. In addition, another three individuals were planted in the nearby “Pandan Wangi Gully,” thus bringing the total of individuals in the Palmetum to 41 (Fig. 9, palms 35–37).

An examination of Table 1 indicates that the palms in the shaded Tropical Rainforest Section (Fig. 9, palms 38–41), planted in 1995, had considerably less biomass than those in the open environment of the avenue, planted in 2004/2006, despite being in the ground for about nine years longer. The average height of the four *Carpoxylons* in the Tropical Rainforest Section is 595.5 cm (the avenue is 664.5 cm); the average DBH of the group is 44.5 cm (the avenue is 64.7 cm) and the average basal diameter of the group is 131 cm (the avenue is 170.4). This extrapolates to a comparative biomass increase of about 21% in the avenue individuals compared to those in the shaded Tropical Rainforest Section. Horticulturally, this suggests that optimal growth for the species is best achieved in open sunny environments.

As of May 2015, five individuals in the avenue had flowered, and two of these had produced mature fruits. An examination of the data in Table 1 indicates that the flowering individuals had all reached a height of at least 700 cm and the tallest to 852 cm. The average height of the avenue palms is 664.5 cm. It appears that there is an optimum height at which *Carpoxylons* begin to flower, this being about 700 cm or



9. Aerial view showing the locations of *Carpoxylon macrospermum* in the Townsville Palmetum. Numbers refer to 'Individual' column in Table 1. Map prepared by R. Lovatt and Asset Management Services, Townsville City Council.

Table 1. Dimensions, planting history and flowering/fruiting of *Carpoxyton macrospermum* in the Townsville Palmetum, recorded May 2015. See Figure 9 for locations of individual palms.

Individual	Clear trunk [cm] ¹	Crownshaft + leaves[cm] ²	DBH ³	Basal diam. [cm] ⁴	Year planted ⁵	Flowered/ fruited ⁶
1	107	337	>DBH: 53	131	2004	
2	335	500	67	184	2004	
3	180	422	70	179	2004	
4	392	458	71	185	2004	Fl/Fr
5	177	383	60	171	2004	
6	310	477	76	174	2004	Fl
7	158	345	56	147	2004	
8	140	414	66	169	2004	
9	102	331	44	144	2004	
10	0	240	0	49	2014	
11	136	354	80	186	2004	
12	293	427	64	184	2004	
13	171	380	79	185	2004	
14	247	522	67	183	2004	
15	149	332	52	152	2004	
16	218	477	64	172	2004	Fl
17	180	441	62	164	2004	
18	310	542	71	184	2004	Fl
19	218	486	66	178	2004	
20	327	569	70	184	2004	Fl/Fr
21	256	404	63	171	2004	
22	422	570	71	177	2004	
23	245	492	64	171	2004	
24	88	460	>DBH: 53	150	2004	
25	245	392	65	170	2006	

greater. It is also evident that those individuals that have flowered are growing on the more exposed side of the avenue, in locations where overhead shading, cast by *Samanea saman* (raintrees), is less than in other locations along the avenue (Fig 9, *S. saman* indicated).

The *Carpoxytons* in the Palmetum have proven hardy to moderate drought and temperatures occasionally dropping to 10°C, although better suited to an increased watering regime and quarterly applications of fertilizer. The species displays no major nutrient deficiencies or tendency for any pest problems. As with the entire palm collection, the *Carpoxyton* avenue receives an annual application of palm weevil borer spray.

Ideally, *ex situ* conservation programs should attempt to include as broad as possible sampling of genetic diversity of the subject species. It is known that all the plants of *C.*

macrospermum in the Palmetum were collected from cultivated specimens, though from a number of parent palms in different localities. The origin of the parent palms of the cultivated individuals is not known, but it is highly suspected to be from nearby cultivated palms, thus suggesting that genetic diversity may be limited. This proposal was confirmed by Dowe et al. (1997), who examined the genetic diversity within 19 collections of both cultivated (n=15) and naturally occurring individuals (n=4) and concluded that diversity was extremely low within the cultivated samples but higher in the natural samples. It would be advantageous to collect representatives from the entire known range of *C. macrospermum*, both natural and cultivated individuals, to have a truly representative *ex situ* collection.

The flowering and fruiting of *C. macrospermum* in the Townsville Palmetum represents a

Table 1. continued.

Individual	Clear trunk [cm] ¹	Crownshaft + leaves[cm] ²	DBH ³	Basal diam. [cm] ⁴	Year planted ⁵	Flowered/fruited ⁶
26	134	450	56	163	2006	
27	147	394	52	153	2006	
28	211	476	64	179	2006	
29	93	443	>DBH: 48	140	2006	
30	99	443	59	146	2006	
31	0	213	n/a	46	2014	
32	50	427	>DBH: 45	121	2006	
33	36	368	n/a	120	2006	
34	82	367	42	127	2006	
35	0	190	n/a	34	2014	
36	0	287	n/a	51	2014	
37	0	189	n/a	51	2014	
38	62	423	>DBH: 38	105	1995	
39	158	382	43	128	1995	
40	190	470	48	145	1995	
41	243	454	49	146	1995	

¹ From ground-level to the attachment of the crownshaft.

² From base of the crownshaft to the highest vertical extent of the leaves.

³ DBH = diameter at breast height; >DBH being that the measurements were taken below breast height, which in this case was set at 137 cm.

⁴ Basal diameter was measured 2–4 cm above ground-level.

⁵ Does not indicate age; it is the year in which the individual was planted in the ground.

⁶ These individuals first flowered in October/November 2014.

significant milestone in the history of the collection and is a demonstration of the relative ease with which this species can be grown in botanic gardens and induced to flower and fruit in a moderate time frame with normal levels of maintenance and care. Under the Palmetum conditions, flowering has occurred within ten years of planting. The other *Carpoxylons* known to have flowered and fruited in other areas of the world also occur in tropical climates, in Hawaii, Thailand and southern Florida. Growth rates and horticultural adaptation to sub-tropical or warm temperate climates is presently not known.

If the shortcomings in genetic representation are considered, the collection of *C. macrospermum* in the Palmetum represents an integral part of the *ex situ* conservation of the species, as records have been kept related to collection, propagation and cultivation. The

value of the Palmetum collection is inherently important for conservation of the species, considering the current situation in Vanuatu.

Acknowledgments

We would like to thank Paul Craft, Mike Dahme, Arden Dearden, Don Hodel, Anders Lindstrom, Jeff Marcus and Michael Merrit for information about cultivation of *Carpoxylon* in Australia, Costa Rica, Fiji, Florida, Hawaii and Thailand, and Larry Corbett, Rob King and Ben Wetterling for information about the maintenance and care of the species in the Townsville Palmetum. The Townsville City Council's Asset Management Services Department is thanked for assisting with the map.

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