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Growth of ornamental palms, *Phoenix* and *Washingtonia*, as epiphytes on suburban street trees in Albury, NSW, Australia

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Abstract: Palms are ubiquitous as landscaping plants in many urban areas. Dispersed by frugivorous birds and often tolerated as self-seeded plants by the property owners, *Phoenix canariensis* (Canary Islands date palms) and two species of fan palms (*Washingtonia robusta* and *Washingtonia filifera*) in particular, have become established in many urban spaces. This paper examines the establishment of such self-seeded palms as epiphytic growth in crooks and branch scars of suburban street trees. Given the limited nutrient availability and the restricted space for rootmass development, these palms undergo a natural bonsai process. Some palms have persisted for over a decade without reaching sexual maturity. While the epiphytic growth demonstrates the palms' further dispersal capability, it does not appear to increase their potential invasiveness into new areas of land.

Keywords: *Phoenix canariensis*, *Washingtonia robusta*, dispersal, marginal environments, frugivory

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Introduction

Phoenix canariensis Chabaud (Canary Islands date palms) and *Washingtonia robusta* Wendland (Mexican fan palms) are ubiquitous ornamental plants which were distributed by the horticultural industry during the late nineteenth and early twentieth centuries (Bailey, 1936, p. 63ff; Ishihata & Murata, 1971; Spennemann, 2018a, 2019b; Zona, 2008) well beyond their endemic ranges in the Canary Islands (Naranjo, Sosa, & Márquez, 2009) and northern Mexico respectively (Cornett, 1989; McCurrach, 1960, p. 264f). Both have become major ornamental trees on a global scale, planted in private and public gardens, as well as on occasion, as street trees in many communities with a temperate climate (Spennemann, 2018c).

Phoenix canariensis is a dioecious anemophilous plant which typically grows to a height of 18–20 m, with a trunk diameter between 0.6 and 1.2 m. The crown tends to reach a diameter of 10–12 m, made up of in excess of 200 arching, pinnate leaves of 5–6 m (max 7 m) length. The abscission scars of the fronds are rhomboid, giving the stem a characteristic appearance. *Phoenix canariensis* reaches reproductive maturity and first flowers after six to seven years (in some locales between 8 to 10 years). The date palm readily and reliably sets fruit and seeds freely, annually producing between 5,000 and 30,000 obovoid drupes ('dates') which vary widely in their physical properties (shape, length, diameter, mass, colour) between individual palms (Djouab et al., 2016; Saro, Robledo-Arnuncio, González-Pérez, & Sosa, 2014). The drupes range from 15–30 mm in length, 12–17 mm in thickness and 2–5 g in mass (Djouab et al., 2016), of which the seed contributes less than 0.9–1.5 g. The seed requires germination temperatures of between 25°C and 35°C (Chatty & Tissaoui, 1999) and germinates under natural conditions after 83–110 days. It shows its first two-leave shoots at about one year of age.

Washingtonia robusta is a monoecious, self-compatible plant which typically grows to a height of 15 to 20 m with a trunk diameter of 0.6 to 1.2 m. The palm can have in excess of 30 bright green, costapalmate fronds of 0.9 to 1.8 m with two-cleft divisions, which are attached to the tree with a 1.2–1.5 m long plano-convex petiole which exhibits curved spines on its entire length. The palms reach maturity after they have reached at least 3 m in height. *Washingtonia robusta* seeds freely, annually producing between 100,000 and 300,000 globular drupes. The drupes range from 7–10 mm in length and 6–8 mm in thickness with an average weight of 0.25 g. The seeds germinate well within 14 days at ideal soil temperatures of 25–35°C (summarised in Spennemann, 2018b).

In the Australasian setting, *Phoenix canariensis* has been formally regarded as naturalised in New South Wales (Hosking, Conn, Lepschi, & Barker, 2007), South Australia (Brodie & Reynolds, 2012), south-eastern Queensland (Biosecurity Queensland, 2018), Victoria (Conn & Walsh, 1993), and Western Australia (Lohr & Keighery, 2016, p. 32), as well as Norfolk Island (Biosecurity Queensland, 2018) and New Zealand (Esler, 1987). *Washingtonia robusta* is regarded as naturalised in parts of Western Australia

(Keighery, 2010), New South Wales (Spennemann, 2018e) and the North Island of New Zealand (Martin, 2009).

Both *Phoenix canariensis* and *Washingtonia robusta* are adventitious species. As garden escapees *Phoenix canariensis* have become an invasive environmental plant in a number of countries, even though the exact biomechanical and biochemical processes of dispersal are not yet well understood (Spennemann, 2019c). Likewise, *Washingtonia robusta* can establish, at least temporarily, even in rather marginal places (Martin, 2009; Spennemann, 2018e; Stein, 2010). The long-term success of these occurrences is dependent on stable availability of nutrients as well as a lack of human intervention. Both plants provide significant ecological provisioning services in modified urban/peri-urban habitats and emergent novel ecosystems (Spennemann, 2019d).

While there are numerous papers that discuss epiphytic growth of ferns and other plants on Canary Islands date palms (Brandes, 2001, 2007; Labbe, 1953; Maire, 1942; Morici, 1998; Richter, 1985; Riefner, 2016; Zubčić, 2017), there are no papers that formally describe epiphytic growth of Canary Islands date palms or *Washingtonia* palms on other plants. The author observed and described a *Washingtonia robusta* growing in a branch scar of a London plane tree (*Platanus x acerifolia*) in Albury (Spennemann, 2018g). Subsequently, other occurrences have been noted (described in this paper).

This paper is the first formal discussion of *Phoenix canariensis* and *Washingtonia robusta* palms growing epiphytically on large ornamental trees in public park and streetscape settings.

Methods

Albury is a rural service centre in southwestern NSW with an average annual rainfall of 700 mm and average seasonal temperatures of 2.7°C in winter and 31.2°C in summer. Central Albury is dominated by streets lined with mature trees and well established residential gardens, many of which contain exotic palms (primarily *Phoenix canariensis* and *Washingtonia robusta*). The street trees are all deciduous species, primarily comprised of elm (*Ulmus glabra*), London plane trees (*Platanus x acerifolia*), Red Canadian Maple (*Acer rubrum*), and Green Ash (*Fraxinus pennsylvanica*). Residual Eucalypts only exist peripheral to the urban core, confined to suburb developments post-dating the early 1930s.

All street trees of central Albury were systematically surveyed for the presence of palms growing in the crooks or branch scars. The survey was focussed on residential streets with established street tree plantings. In the first instance, the survey was carried out by vehicle to establish the presence of established large trees. These were then inspected on foot. The survey was carried out in July and August 2019, during the southern winter, when the trees had lost their foliage. This ensured that the trees were observable in their entirety.

Those trees with epiphytic growth of ornamental palms were photographically documented from all angles to be able to assess the growth habit of the juvenile plants and to count the

number of their leaves (Spennemann, 2019e, 2019f, 2019g). In an attempt at establishing the age of the juvenile plants, all available Google Street View imagery was examined.

The time depth for the age assessment varies as the spatial coverage was limited to the main roads at the beginning of the service. The initial coverage by Google in November 2007 also used lower resolution cameras and greater photo intervals.

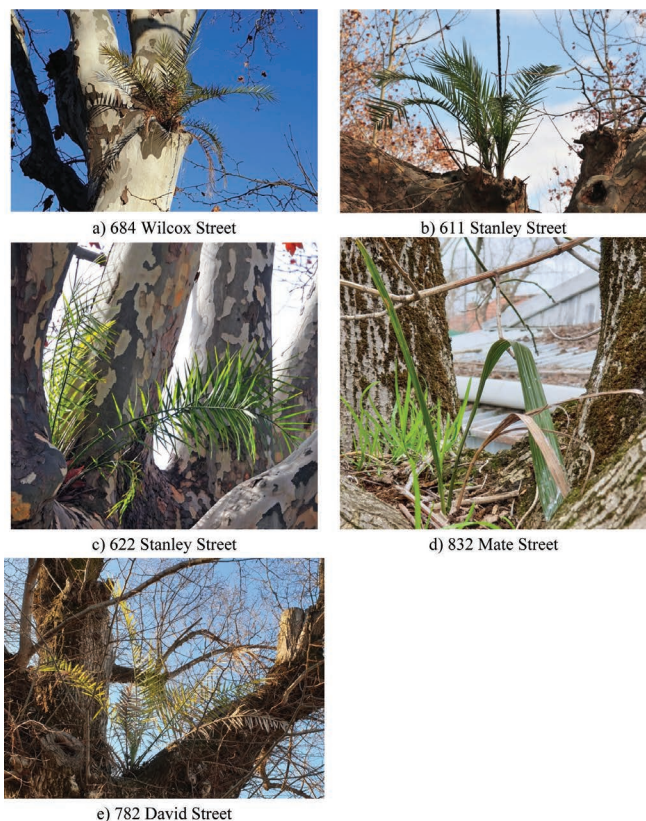


Fig. 1. Examples of *Phoenix canariensis* growing on London plane trees (a–c) and elms (d–e) in Albury.

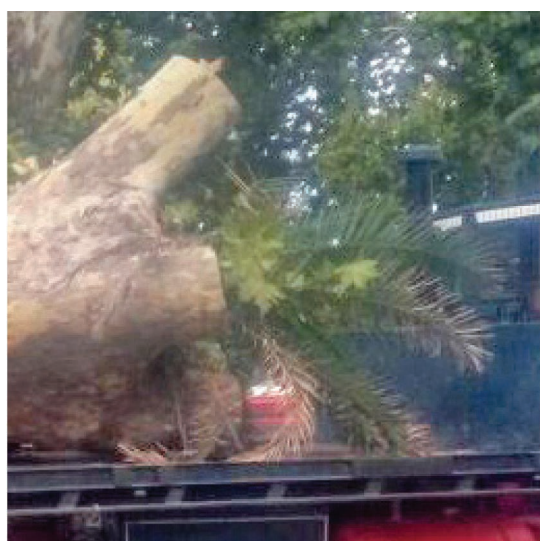


Fig. 2. A felled London plane tree at Noreuil Park, Albury with a *Phoenix canariensis* emerging from the crook of the tree.



Fig. 3. Examples of *Washingtonia robusta* growing on London plane trees (a–d) in Albury.

Results

The survey encountered six juvenile *Washingtonia robusta* plants (at five locations) and four *Phoenix canariensis* plants (at three locations) growing in London plane trees (Table 1 n° 1–4, 10–13) and two *Phoenix canariensis* growing on *Ulmus glabra* (Table 1, n° 8–9). An additional *Phoenix canariensis* once existed at Noreuil Park (Table 1 n° 7), but the London plane tree had been removed during park development in April 2019. Four additional *Phoenix canariensis* were noted outside the survey area, two on *Ulmus glabra* and two on *Platanus x acerifolia* (Table 1 n° 5–6, 8–9) (for photographic documentation, see Spennemann, 2018g, 2019e, 2019f, 2019g). Although, the survey encountered no examples of dead juvenile specimens, it is possible that small dead seedlings may have been overlooked in London plane trees (i.e. interpreted as background leaf matter).

The size of the plants, their growth habit, as well as their approximate ages are set out in Table 1. The ages of the plants are all minimum ages. They are based on the time elapsed since the historic Google Street View image that shows their pinnate leaves, with an additional year added for emergence and formation of the two-leaf seedling.

Table 1. Instances of epiphytic growth of ornamental palms in Albury, NSW (July-August 2019)

N°	Location	Host Tree	plant	Habit	Size (cm)	Leaves		Age (yr)	Image
						green	brown		
<i>Phoenix canariensis</i>									
1	684 Wilcox St	Platanus x acerifolia		juvenile	0.8–1.0	9	7	> 11	Fig. 1a
2	611 Stanley St	Platanus x acerifolia	South	juvenile	0.5–0.6	5	—	> 5	Fig. 1b
3	611 Stanley St	Platanus x acerifolia	North	juvenile	0.5–0.6	5	—	> 5	Fig. 1b
4	622 Stanley St	Platanus x acerifolia		juvenile	0.7–0.9	7	—	< 5	Fig. 1c
5	370 Tribune St	Platanus x acerifolia	South	juvenile	0.6–0.7	4	—	> 3	Fig. 4a
6	370 Tribune St	Platanus x acerifolia	North	juvenile	0.6–0.7	5	1	> 3	Fig. 4a
7	Noreuil Park	Platanus x acerifolia		juvenile	1.1–1.4	?6–8	?4–6	> 3	Fig. 2
8	832 Mate St	Ulmus glabra		seedling	0.3–0.4	2	1	< 2	Fig. 1d
9	782 David St	Ulmus glabra		juvenile	0.7–0.9	8	7	> 3	Fig. 1e
<i>Washingtonia robusta</i>									
10	459 Hovell St	Platanus x acerifolia	South	juvenile	0.8–1.0	3	6	> 5	Fig. 3a
11	459 Hovell St	Platanus x acerifolia	North	juvenile	0.3–0.5	2	6	> 5	Fig. 3a
12	573 Bonegilla St	Platanus x acerifolia		juvenile	0.6–0.8	3	7	> 5	Fig. 3b
13	641 Macauley St	Platanus x acerifolia		juvenile	0.3–0.4	3	5	> 2	Fig. 3d
14	568 Macauley St	Platanus x acerifolia		juvenile	0.4–0.5	3	5	≤ 3	Fig. 4b
15	577 Macauley St	Platanus x acerifolia		juvenile	1.2–1.3	3	45+	> 11	Fig. 3c

Discussion

The height above ground of the crook or branch scar in which the juveniles are growing is determined by the height of pollarding and/or the required clearance for overhead powerlines and thus incidental to the plant's establishment. In all instances, the seeds would have been deposited by a volant vector. The street trees in which *Phoenix canariensis* and *Washingtonia robusta* juveniles are growing are all within 300 m of the closest fruit-bearing palm, and thus in easy flight range for many bird species.

A global review of the vectors responsible for the dispersal of *Phoenix canariensis* (Spennemann, 2019c) and the two *Washingtonia* species (unpublished data) has shown that in the Australian case Pied Currawong (*Strepera graculina*), Starlings (*Sturnus vulgaris*) and Eurasian Blackbirds (*Turdus merula*) are the main vectors, followed by Australian Ravens (*Corvus coronoides*), Common Mynas (*Sturnus [Acridotheres] tristis*) and Blue-faced Honeyeaters (*Entomyzon cyanotis*). While all species, except the Common Myna, are common in Albury, some are less likely to be dispersers due to their behaviour. An example is the Eurasian Blackbird which would take fruit to groundcover rather than carry it to an elevated perch.

The three instances of similar sized *Phoenix canariensis* juveniles growing in the same location (Fig. 1b, e; Fig. 3a) strongly suggests that each originates from a larger, multi-seed regurgitate of Pied Currawongs (see Spennemann, 2018d for appearance of such regurgitate).

Establishment

Both *Phoenix canariensis* and *Washingtonia robusta* readily establish in the managed garden environment of an urban community. Emerging seedlings and juveniles

are commonly tolerated until they reach considerable size, by which time they are difficult to remove. *Washingtonia robusta* seems to have a slightly higher water requirement for successful establishment than *Phoenix canariensis*. Experiences in a non-artificially watered setting in the Southern Riverina have shown that *Phoenix canariensis* will readily establish, but that *Washingtonia robusta* will fail to do so (Spennemann, 2019a). If water is provided, such as in urban garden settings, the *Washingtonia robusta* can establish, at least temporarily, even in rather marginal places such as cracks in the pavements (Martin, 2009; Stein, 2010), concrete drains (pers. obs.), cavities in trees (this paper), or even in flooded wetlands (Spennemann, 2018e, 2018f). For both palms the long-term success of these colonisation attempts is dependent on a stable nutrient supply, as well as a lack of human intervention.

Overseas examples have shown *Washingtonia robusta* to successfully establish in *Pinus* species (San Diego [CA, USA] Nelson, 2019) and *Phoenix canariensis* to establish in *Ulmus* sp. (Auckland [NZ], Sullivan, 2001), *Metrosideros excelsa* (Auckland [NZ], Sullivan, 2015), (*Vitex lucens*) (Auckland [NZ], Sullivan, 2002) and *Fraxinus pennsylvanica* (Gisborne [NZ], Tutty, 2015).

Age of plants

The age structure of these epiphytic palms is difficult to assess. One *Phoenix canariensis* specimen is a seedling without pinnate leaf development, and thus between one and two years old (Table 1 n° 8), while another, based on Google Street imagery, is at least 11 years old (Table 1 n° 1). Several others are at least five years old, as are three of the *Washingtonia robusta*.

An epiphytic *Phoenix canariensis* specimen growing in the fork of a *Metrosideros excelsa* in Auckland has reached an

age of at least five years (Sullivan, 2015), while a specimen growing in the fork of an *Ulmus* street tree in Auckland seems to have survived for at least 19 years, and probably considerably longer (Sullivan, 2001, ages verified via Google StreetView imagery).

Long-term prognosis

In many horticultural settings the size of the root ball, as constrained by the size of the planting container, will define the size of the plant. Palms are no exception. Data on container-grown palms for the horticultural trade show that the growth of palms will be inhibited and retarded when the root mass is confined by container size (Burch, Atilano, & Reinert, 1983; Meerow, 1994). Documented in the literature are extreme examples. For example, in 1905 the Philadelphia-based nursery Bell and Sons (1905b, 1905a) sold a thirty-five year old *Phoenix canariensis*, that had been kept potted through-out its life and only had attained a height of 2.4 m (with a crown of similar dimensions). Similarly, experiences with extreme pot size restrictions, as in the case of bonsaied palms (Calderón et al., 2019; Maidman, 2001), demonstrate the retardation of growth.

While the life expectancy of specimens grown in restricted pots tends to be reduced, with bonsaied palms lasting between four and ten years (Maidman, 2001), there is one *Washingtonia filifera* specimen on record which is twenty years old that has retained the appearance of a six-leaved juvenile (Calderón et al., 2019, p. 82). Likewise, the above cited examples from New Zealand suggest that epiphytic *Phoenix canariensis* can maintain their viability for prolonged periods.

In the Albury situation, all but two of the documented epiphytic palm specimens are growing in London plane trees, even though numerous maples and elm trees in particular exhibited broad forks and well structured, deep-fissure surfaces as well as branch cuts (following branch lopping due to overhead powerlines). Elms were observed to host a range of other epiphytic growth, in particular- mosses, grasses, sedges and occasional climbers. Common to all is that these plants require less soil substrate than palms.

Even where not required for clearance of over-head powerlines, London plane trees had been pollarded in the past for aesthetic reasons, giving rise to crooks and branch scars. A characteristic of the London plane trees is the rapid callus development that encircles the branch cut and grows in thickness and height. This results in a cup-like depression of varied depth, which traps leaf matter, and other plant debris and effectively acts like a shallow planting pot (Fig. 5). By and large, elm trees do not exhibit this characteristic. The substrate in which the palms are growing on the plane tree is primarily comprised of decaying bark and leaf matter, as well as fragments of seed balls of the host tree, with a small amount of wind-borne mineral dust (deposited during mid-summer wind gusts). While branch scars with raised callous rims are not suitable for collecting rainwater running off branches, palm leaves are shaped to maximise the collection of moisture and direct it via the petioles to the palm's growth

point. Flowing rainwater also directs mineral nutrients (air borne dust) collected by the leaves to the growth point.

While both *Phoenix canariensis* and *Washingtonia robusta* are hardy plants once well established, that can survive periods of low moisture provision; the summers in Albury are hot and dry, causing considerable heat stress on plants. With one exception (which benefits from lawn watering - Table 1 n° 13), the palms in the plane trees obtain all their required moisture from direct precipitation and run-off down the palms' petioles and it can be speculated that moisture stress has not proved terminal because during summer the deciduous London plane trees exhibit a dense canopy with large leaves that produces continual dappled shade (Fig. 4). The evapotranspiration of the large-leaved plane tree or other densely-leaved tree both raises ambient moisture surrounding the palm and drops ambient temperature inside the canopy.

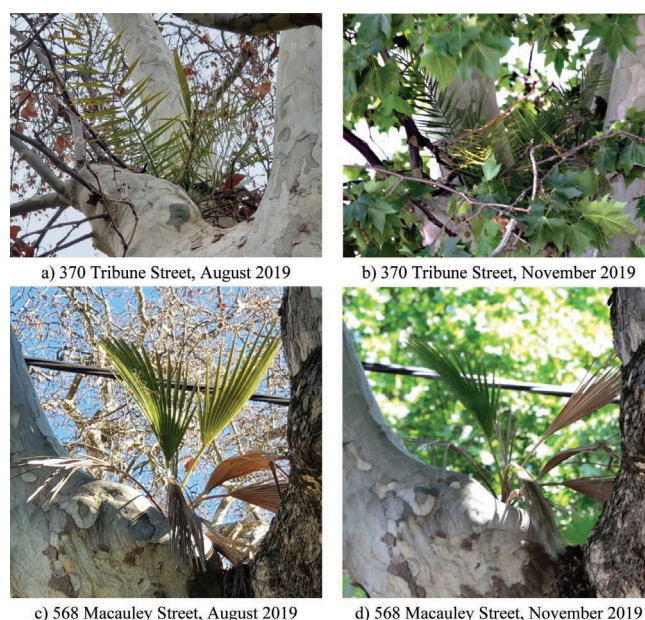


Fig. 4. Examples of *Phoenix canariensis* (a, b) and *Washingtonia robusta* (c, d) growing on London plane trees in Albury. Surrounding canopy cover in late winter (a, c) and early summer (b, d).

The growth rate, and short- to medium-term survival of epiphytic palm specimens is highly variable, as it is subject to the volume of the 'planting container,' *i.e.* the dimensions and in particular depth of the callous-ringed branch scar, as well as the amount of decayed leaf matter that had accumulated there before the deposition of the seed. The differential prevalence of palms on London plane trees is likely to be influenced by climatic conditions. The local climatic condition will have an impact on the survival of self-seeded epiphytic plants on different substrate species. Auckland, for example is more humid and has a higher precipitation rate than Albury, which implies that the bark and branch topography of a greater number of host tree species will provide the required moisture regime (Spennemann, 2019f).

The three observed instances of two specimens growing in the same branch scar (Fig. 1b, e, Fig. 3a) are not sustainable in the long term. In all instances, one of the two specimens is already marginally larger than the other. This differential

will increase as the larger specimen will take a greater share of the nutrients, eventually leading to the death of its competitor.

The observation of the juvenile *Phoenix canariensis* in the felled London plane tree at Noreuil Park is very significant. Fig. 2 shows the felled and sawn-off tree trunk on the truck, with the palm still firmly rooted in the crook of the tree (presumably in a branch scar). This attests to the resilience of the palm as well as the strength of the root ball. It can be surmised that a palm could conceivably survive the collapse of a London plane tree and maintain growth, in particular if it were to come in contact with soil. In the well managed environment of urban street trees and public parks, however, this is a highly unlikely outcome.



Fig. 5. A branch scar on a London plane tree showing callous growth resulting in a ‘planting pot’ situation. Note accumulated leaf matter as well as seeds.

Conclusion

For both palms *Phoenix canariensis* and *Washingtonia robusta* the plants studied so far, indicate the stunted growth and lack of adequate development appears to prevent them from reaching sexual maturity. Thus, from the plant’s point of view, the successful germination and establishment of offspring as epiphytes in the branch scars of street and park trees demonstrates the plant’s dispersal capability, but does not substantively do so in terms of its colonisation of new spaces.

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