Chapter 2

Biology, ecology and threat

This chapter provides detailed information on the characteristics and impacts of cat's claw creeper (*Dolichandra unguis-cati*) and Madeira vine (*Anredera cordifolia*), both listed as WoNS in recognition of their damaging and widespread nature.

Cat's claw creeper profile

At a glance

- **Cat's claw creeper is native to Central and South America and the West Indies and was introduced to Australia as an ornamental plant.**
- **Plants have compound leaves, large yellow flowers and long, leathery seed pods.**
- **It is an invader of natural areas, including riparian zones, forests and woodlands. Cat's claw creeper also grows in gardens and roadsides.**
- **The weight of cat's claw creeper can break branches and kill trees. It also forms thick mats that prevent native plant germination and growth.**
- **Plants reproduce via seeds and underground tubers.**
- **Large numbers of light, papery seeds disperse long distances via wind and water.**

Cat's claw creeper is a yellow-flowering vine native to Central and South America and the West Indies, introduced to Australia as a garden plant. It has a range of features that make it a successful invader:

- vigorous, smothering growth
- large numbers of winged seeds easily dispersed by wind and water
- aerial roots that enable it to climb host trees of any size to reach light
- extensive root and long-lived tuber systems, which enable it to reproduce vegetatively and survive periods of unfavourable conditions such as drought (Downey and Turnbull, 2007).

Today, cat's claw creeper is prevalent throughout tropical, subtropical and some temperate regions of Qld and NSW, where it has escaped from backyards into a range of natural ecosystems.

Short or long pod?

This profile focuses on the short-pod form of cat's claw creeper prevalent in Australia.

A second, long-pod form occurs in isolated sites in South East Qld and, although genetically and morphologically distinct, is classified as the same species.

Studies suggest the long-pod form possesses traits more suited to opportunistic establishment (i.e. fast growth under conditions of high nutrient availability), though the short-pod form has traits that allow it to adapt to environments with different resources (Buru et al., 2014). This may explain why the short-pod form is widespread, and the long-pod form is not.

If you find a population of long-pod cat's claw creeper report it to the local weed authority (see Chapter 6 for contact details), so any distribution changes can be recorded.

See Box 2.1 for key distinguishing features of both forms of cat's claw creeper.

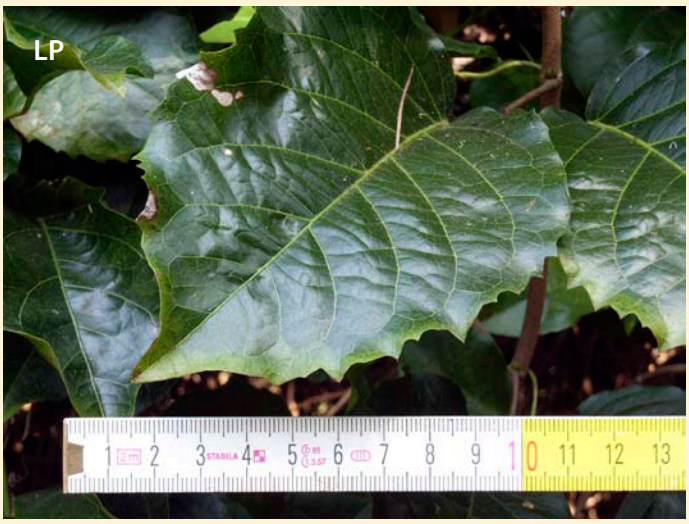
Box 2.1 Distinguishing between short- and long-pod forms

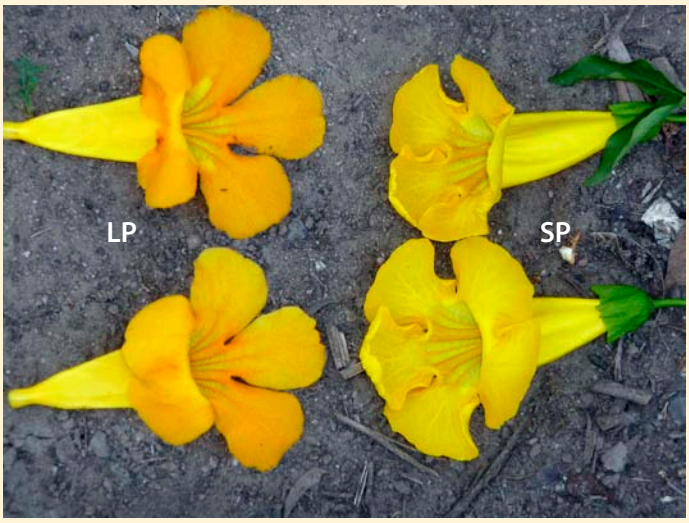
Short-pod form:

- main form found in Australia
- seed pods 15–45 cm long
- leaves 2–7 cm long, 1–3 cm wide
- flowers 2–8 cm long, yellow with darker yellow or orange streaks in the tube

Long-pod form:

- also known as hairy or bat's claw creeper
- only known to be present in a few isolated sites in South East Qld
- seed pods 60–100 cm long
- leaves longer, broader and occasionally toothed
- flowers pale orange to pale yellow





Leaves, pods and flowers of the common 'short-pod' (SP) form and less common 'long-pod' (LP) form of cat's claw creeper. Photos from Shortus and Dhileepan (2010).

Origin

Cat's claw creeper is native to Central and South America and the West Indies region (Downey and Turnbull, 2007). Because of its ornamental value, it has become widely naturalised around the world; for example, it occurs in South Africa, India, China, south-eastern United States of America (USA), Hawaii, the Pacific Islands and Europe (Downey and Turnbull, 2007; Holm et al., 1991; Langeland and Burks, 1998; Rafter et al., 2008; Sherley, 2000).

Cat's claw creeper was introduced to Australia as a garden plant, primarily to screen trellises and walls (Batianoff and Butler, 2003). The first record of sale is dated 1865, when the species was advertised in a Melbourne, Victoria (Vic) nursery catalogue (Downey and Turnbull, 2007). It was recorded as naturalised in South East Qld in the 1950s (Batianoff and Butler, 2002) and in north-eastern NSW in 1966 (Downey and Turnbull, 2007). Genetic studies suggest that most cat's claw creeper infestations in Australia are closely related to each other and likely to have been introduced from a single population in the native range (Prentis et al., 2009).

Impacts

Environmental

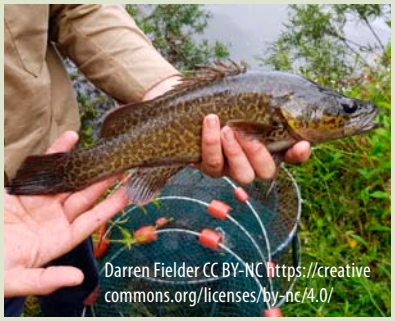
Cat's claw creeper is one of the worst environmental weeds in Qld and NSW. Of South East Qld's 1,060 naturalised species, it was ranked fourth for invasiveness and impact (Batianoff and Butler, 2003); and among NSW's 340 worst environmental weeds, it was ranked eleventh for biodiversity impacts (Downey et al., 2010).

In heavily infested areas, the weight and shading of cat's claw creeper in the canopy can break branches and kill trees (Sparks, 1999). In the understorey, it forms thick mats that can prevent native plant germination and growth (Dhileepan et al., 2010; Downey and Turnbull, 2007). It can germinate in low light conditions (Vivian-Smith and Panetta, 2004) and, with its aerial roots immediately enabling it to climb large trees, it is not reliant on disturbance to invade a site. Cat's claw creeper is able to invade a forest, degrade the structure and open the canopy to allow more light to enter, which provides opportunities for other weeds to invade. In this way it can alter ecosystem functions and is referred to as a 'transformer species' (sensu Richardson et al., 2000).

A threat to endangered and vulnerable fauna

Coxen's fig parrot
(*Cyclopsitta diophthalma coxeni*)
- Critically Endangered (NSW)
- Endangered (Qld)

Grey-headed flying fox
(*Pteropus poliocephalus*)
- Vulnerable (NSW and nationally)



Eastern freshwater cod
(*Maccullochella ikei*)
- Endangered (NSW and nationally)

Reason for population decline:

Degradation of habitat due to cat's claw creeper invasion (Coutts-Smith and Downey, 2006)	Combined effect of canopy loss and tree mortality caused by vines, including cat's claw creeper, and the subsequent reduction in the availability of habitat and food	Loss and modification of riparian vegetation, stream banks and the effects of cat's claw creeper on water quality, food and shelter (Downey and Turnbull, 2007)

Chapter 2

Cat's claw creeper poses a significant risk to threatened ecological communities. Its ecosystem-altering tendencies can create a positive feedback loop in which it establishes and degrades communities. Often fragmented and already vulnerable to other threatening processes such as fire, storms and cyclones, this can cause these communities to be even more susceptible to further degradation and invasion by other weeds.

Economic

Cat's claw creeper has major and varied impacts on forestry. Its claw-like tendrils and aerial roots allow it to cling tightly to host trees. This creates issues in hoop pine (*Araucaria cunninghamii*) plantations as extra time and effort is needed to remove cat's claw creeper stems. If this is not done, automatic harvesting sensors can over-estimate the diameter of hoop pine trunks, leading to processing issues after harvest (I. Last, pers. comm.). Its many windblown seeds allow it to easily infest fallow areas, and substantial time and money must be spent on its control (I. Last, pers. comm.).

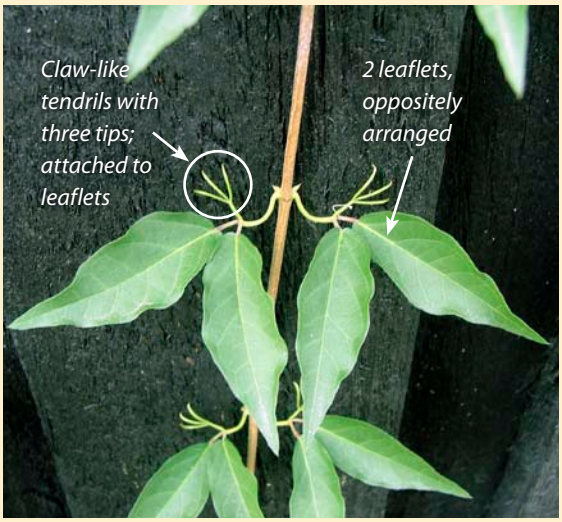
Cat's claw creeper can also impact linear reserves such as power easements and railways. It has the potential to cause localised power interruptions by growing up power poles and lines, where its weight can damage the poles or even cause them to fall (Downey and Turnbull, 2007). Linear reserves also provide a pathway for the introduction and spread of vines and scramblers into intersecting bushland.

Social

Like other vines and scramblers, cat's claw creeper can create access issues along walking tracks and trails. It can also reduce the aesthetic value of parks and bushland by smothering other plants. The climbing style of cat's claw creeper allows it to grow over most surfaces, which can create issues in urban settings, where damage has been reported to fences, walls and even roof tiling (Downey and Turnbull, 2007). Removal of the vine from these surfaces is difficult because of how tightly the tendrils and aerial roots adhere to them, which creates further damage.

Identification of short-pod form

Leaves and tendrils	Leaves are compound, usually consisting of 2 leaflets with a tendril between them; there may be up to 5 leaflets per group in young plants The leaflets are dark green above and lighter green below, 2–7 cm long, 1–3 cm wide, oval to oblong in shape and with a pointed tip The compound leaves, and their leaflets are oppositely arranged The tendrils are 3-pronged and have stiff tips that form hooks, resembling claws



Sheldon Navie

Flowers	The large (2–8 cm long), showy flowers are yellow in colour and often have darker yellow or orange streaks in the tube Grow from the leaf axis, sometimes solitary or in small clusters Present in spring	 Sonia Jordan
Fruit and seeds	Seeds are contained in seed pods 15–45 cm long and 0.8–1.3 cm wide Seed pods are leathery and can contain up to 80 seeds The seeds themselves are 2–4 cm long, 0.5–1 cm wide and paper thin; they have 2 papery wings, which allows for wind and water dispersal The pods mature in late summer to autumn, splitting open along lateral seams to release large numbers of seeds	  Sheldon Navie
Stems	Woody, up to 30 m long and 15 cm thick Younger stems are reddish in colour, with golden tips Older stems are light brown and often densely covered by aerial roots	 Adam Bernich
Roots and tubers	The root system is extensive and deep, with tubers being produced every 50 cm along lateral roots Each tuber can be up to 40 cm long (although the majority are 0.5–10 cm) Entwined roots and tubers form a dense underground mat in mature infestations	  Matt Sheehan

Similar species

The characteristic 'cat's claws' and yellow flowers make cat's claw creeper stand out; however, when no fruits or flowers are present, large stems on some other species with aerial roots can look similar, as shown in the following examples.

Cat's claw creeper *Dolichandra unguis-cati*	**Common silkpod** *Parsonisa straminea*	**Giant pepper vine** *Piper hederaceum*
Exotic species widespread in coastal and subcoastal areas of Qld and NSW.	A native, occurring in rainforest and floodplains along the entire east coast of Australia.	A native that is widespread in warmer coastal rainforest along the entire NSW and Qld coasts.
Stems are numerous; long aerial roots grow from any part of the stem.	Stems have rough bark with lenticels (holes used for gas exchange), and small aerial roots. Stem diameter is smaller than cat's claw creeper (up to 9 cm).	Stems grow to 15 cm thick. Larger stems have horizontal scarring from where leaf nodes used to be. Unlike cat's claw creeper, roots are confined to and protrude from leaf nodes.
 Adam Bernich	 Adam Bernich	 Adam Bernich

Current distribution

Cat's claw creeper is widespread in coastal and subcoastal areas of Qld and NSW, extending from the Atherton Tableland to south of Sydney (Figure 2.1). It is often found in Lowland Subtropical Rainforest, Littoral Rainforest and other threatened communities.

There are also records from north of Cooktown but there is no evidence of this population naturalising. It has been reported that the worst infestations occur along the Clarence River in northern NSW, spanning approximately 150 km (T. Moody, pers. comm. *in* Downey and Turnbull, 2007); however, major infestations also occur around Gympie and in the Boyne Valley near Gladstone in Central Qld.

Cat's claw creeper is typically considered a tropical and subtropical species. However, in Australia it has also established in temperate regions such as the New England Tablelands and the Sydney region (Downey and Turnbull, 2007), and has spread into nearby dry sclerophyll forests (e.g. forest dominated by spotted gum, *Corymbia maculata*; T. Moody, pers. comm. *in* Downey and Turnbull, 2007).

Cat's claw creeper is not well established elsewhere in the country, but naturalised plants have been collected from Darwin in the Northern Territory (NT) and Melbourne (Downey and Turnbull, 2007); and overseas it has invaded savannas, secondary forests and remnant high forests (Downey and Turnbull, 2007), suggesting it has the potential to spread and establish in drier environments.

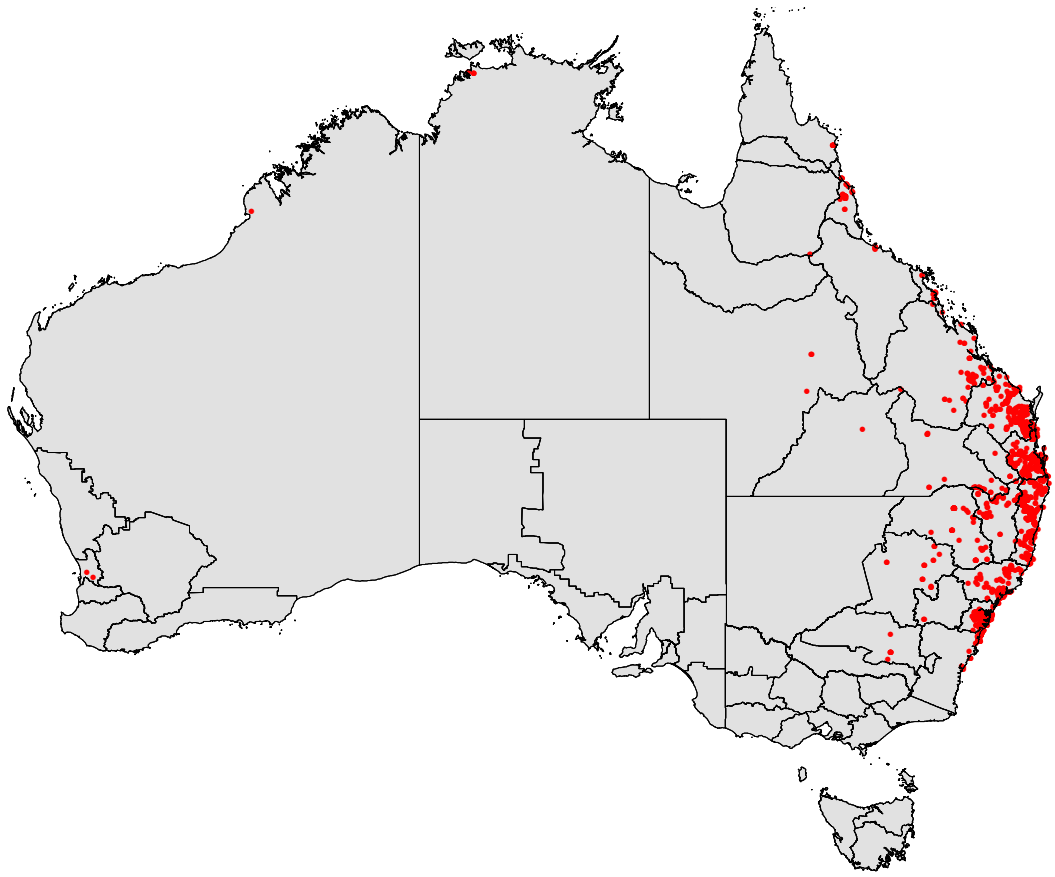


Figure 2.1 Current distribution of cat's claw creeper in Australia. Records from Atlas of Living Australia (2022).

Potential distribution

Climatic modelling as shown in Figure 2.2 indicates that the most suitable habitat for cat's claw creeper occurs in coastal regions from southern NSW to Far North Qld. Coastal areas of south-western and northern Western Australia (WA) and northern NT, south-western Vic and southern South Australia (SA) may be suitable. It is widely cultivated (in gardens) in southern Australia, which provide a source for further spread.

Other areas of Australia likely do not provide suitable habitat for cat's claw creeper. However, under future climates, the predicted suitable habitat for cat's claw creeper moves southward, with there being some habitat of low suitability predicted in the northern areas of Tasmania (Tas; Figure 2.2b).

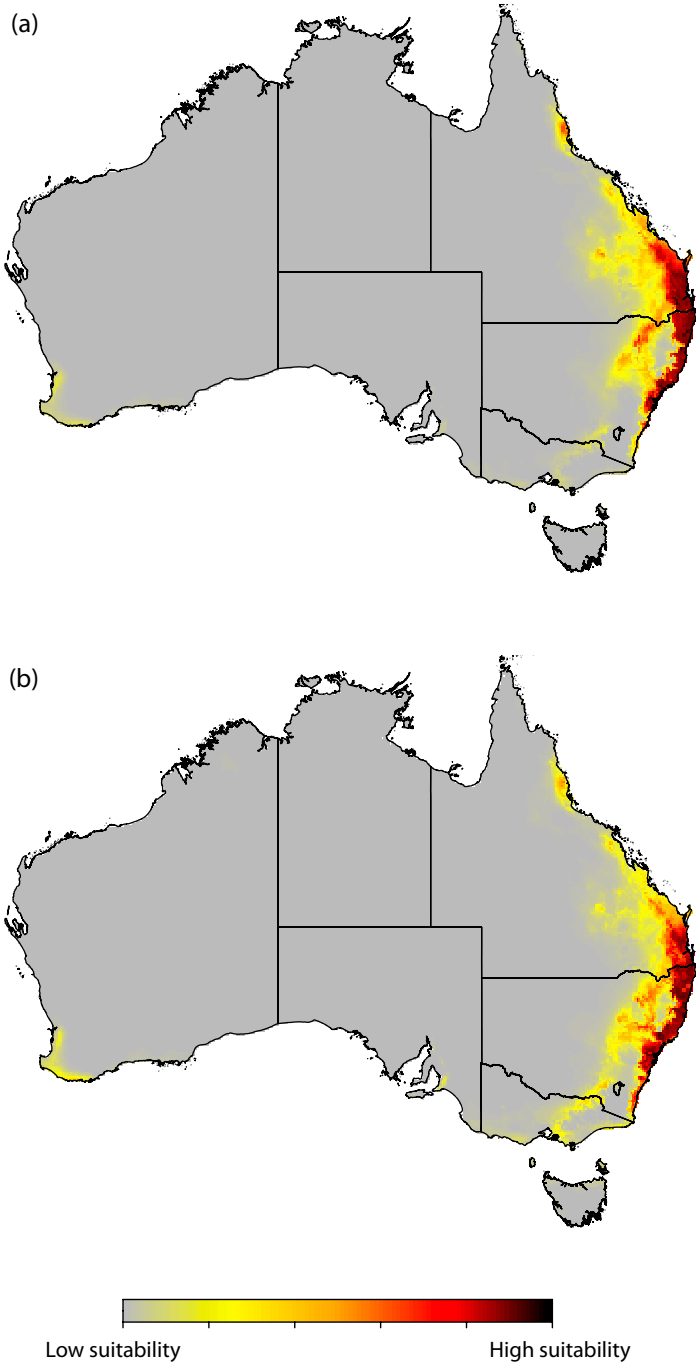


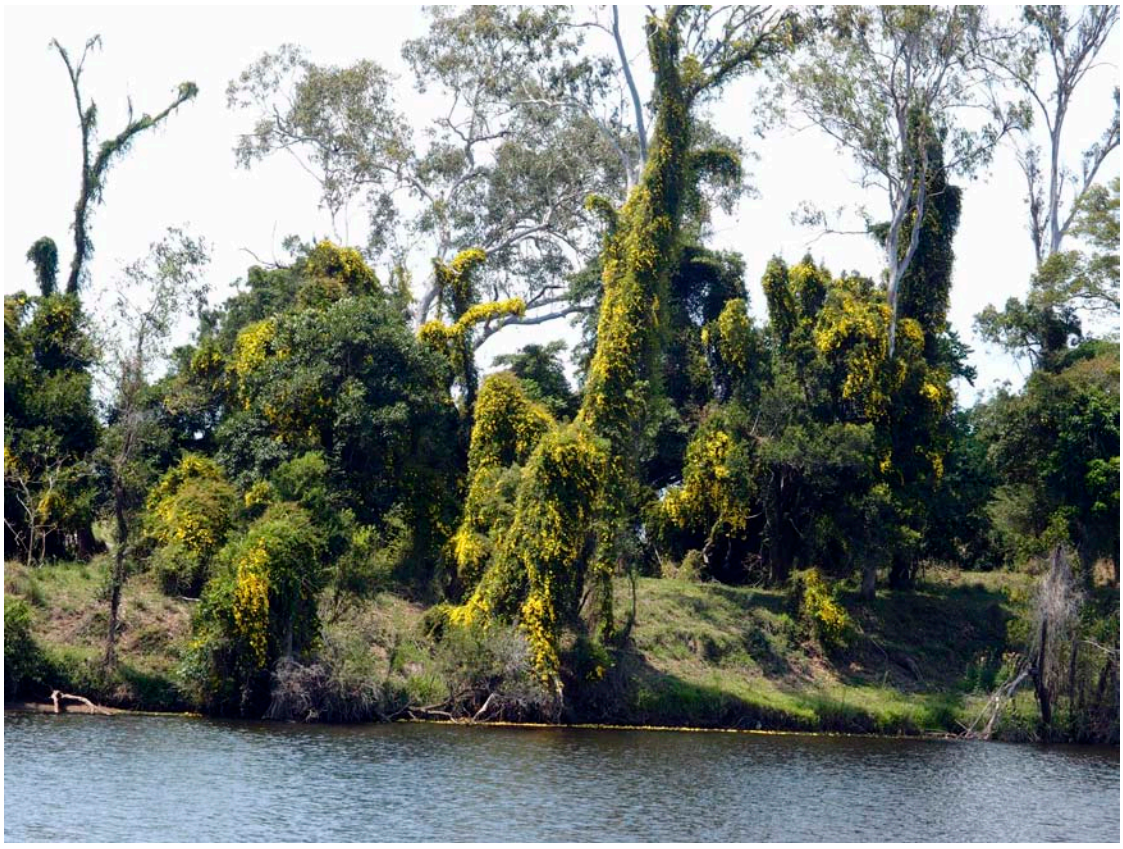
Figure 2.2 Areas of habitat suitability for cat's claw creeper modelled under (a) current climatic conditions and (b) predicted climatic conditions in 2050 under the SSP2-4.5 climate scenario. SSP2-4.5 is an intermediate greenhouse gas emissions scenario where global carbon dioxide emissions continue around current levels until 2050 and then decrease but do not reach net zero by 2100 (Riahi et al., 2017). Black and dark red pixels represent the most suitable habitat.

Preferred habitat and limiting factors

In its native range, cat's claw creeper grows in areas with mean annual rainfall of 750–2,400 mm and at elevations from near sea level to over 600 m (Francis n.d. *in* Downey and Turnbull, 2007). In Australia, cat's claw creeper has been found growing in the Blue Mountains at altitudes of 1,100 m, although it is uncertain whether these plants produce seed.

It thrives in full sun or partial shade and has relatively shade-tolerant seedlings. Mature plants are tolerant of both drought and frost, and can die back and reshoot from the underground tubers (Downey and Turnbull, 2007). However, particularly severe conditions may reduce cat's claw creeper's capacity to spread, possibly affecting seed production and germination. For example, anecdotal evidence from Tambo in Central Qld suggests that cat's claw creeper may not seed in areas that experience hot dry summers and severe winter frosts. It appears that cat's claw creeper does not flower when environmental conditions are unfavourable, such as during droughts, or when growing at high altitudes (Shortus and Dhileepan, 2010).

Cat's claw creeper grows in a range of soil types but prefers uniform soils of sandy or clay origin (Downey and Turnbull, 2007). It does not tolerate poorly drained soils (Csurhes and Edwards, 1998) but can withstand saline soils (Downey and Turnbull, 2007). There are no records of cat's claw creeper growing in dune systems.



Sonia Jordan

Cat's claw creeper in riparian zone, South East Qld.

Reproduction and spread

Flowers and seeds

Flowers are usually present on mature plants that have reached the canopy of their host trees. Flowering takes place during spring, with the pod-like fruit maturing in late summer to autumn (January–May), approximately 6–10 months after flowering (Downey and Turnbull, 2007). As the pods age, they brown and split open, each releasing 90–200 seeds (Downey and Turnbull, 2007; King et al., 2011). Seed drop begins in late May and peaks in July–August.

Vegetative reproduction

The main vegetative reproductive strategy employed by cat's claw creeper is underground tubers. Tubers begin to be produced early in the life cycle, when seedlings produce their first true leaves (Downey and Turnbull, 2007), and are continuously produced. Therefore, all mature plants have well-established tuber systems that readily reshoot after disturbance such as fire or mechanical removal (King et al., 2011). Trailing stems are also able to produce roots at the nodes, and stem fragments severed from the parent plant can survive and give rise to new plants (Downey and Turnbull, 2007).

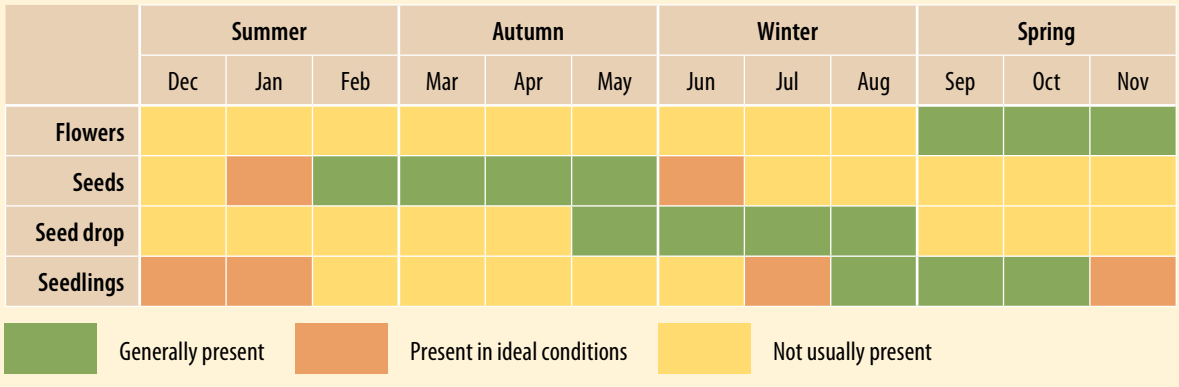
Germination, seed banks and tuber longevity

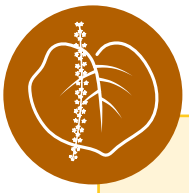
The seeds of cat's claw creeper germinate rapidly at various temperatures with germination success of up to 70% (Buru et al., 2014). However, as seeds are only viable for 12 months (Buru et al., 2014; Vivian-Smith and Panetta, 2004) there is no persistent seedbank. It is not clear how long tubers remain viable in the soil, but reports suggest that tubers allow for cat's claw creeper to regenerate for many years following damage to aboveground parts of the plant (Osunkoya et al., 2009).

Dispersal

The thin, papery seeds of cat's claw creeper are adapted for wind and water dispersal. Wind appears to be the primary dispersal method, but the prevalence of cat's claw creeper in riparian areas suggests that water dispersal is also important. The seeds can float for up to 54 days (Downey and Turnbull, 2007), and therefore can be dispersed long distances by water. These effective dispersal methods allow for cat's claw creeper to spread over long distances via seeds, while tubers allow it to persist at sites and increase in density.

Seasonal patterns of cat's claw creeper





Madeira vine profile

At a glance

- **Madeira vine is native to South America and was introduced to Australia as an ornamental plant.**
- **Plants have large heart-shaped leaves and long creamy-white flower spikes.**
- **It is a fast and aggressive invader of natural areas, including riparian zones and forests. Madeira vine also commonly grows in gardens and roadsides.**
- **The weight of Madeira vine can break branches and cause host trees to collapse.**
- **Plants mainly reproduce via masses of aerial and underground tubers.**
- **Long-distance dispersal occurs via dumping of garden waste, streams and flood waters.**

Madeira vine, also known as lamb's tails, is a South American vine introduced to Australia as an ornamental plant. It is easily distinguished by its large and numerous aerial tubers, fleshy leaves and white flowers clustered on long spikes that often resemble a lamb's tail. It has a range of features that make it a successful invader with a competitive advantage over other vine species:

- vigorous and fast growing
- extensive tuber production, both aerial and underground, allowing the species to quickly spread and persist for many years
- tubers contribute to the weight of Madeira vine, which can cause host trees to collapse or loose limbs.

Currently, Madeira vine is most common in NSW and Qld; however, there are small populations present in Vic, SA, WA and Tas.

Origin

Madeira vine is native to tropical and subtropical South America, in countries such as Bolivia, Brazil, Paraguay and Argentina. In Australia it was introduced as an ornamental plant with its first record of sale in 1906. It was first reported as naturalised in the 1960s in both Qld and NSW (Vivian-Smith et al., 2007). It has also been introduced to China, Japan, India, the USA, New Zealand and parts of Africa, likely as an ornamental plant; however, it has also been used as a medicinal plant in some countries (Bari et al., 2019).

Impacts

Environmental

The fast growth rate and tuber system of Madeira vine make it an aggressive invader and a serious threat to many ecological communities. Plants can grow at a rate of 1 m/week under favourable conditions (Starr et al., 2003; Vivian-Smith et al., 2007). The vine's biomass is particularly high because of the prolific growth of semi-succulent leaves and masses of aerial tubers, causing the collapse of host trees. Its fast growth rate and ability to quickly reach high densities mean that it can rapidly invade and degrade forests. This has led to it being ranked as NSW's worst environmental weed for biodiversity impacts (Downey et al., 2010) and the fifth worst in Qld (Batianoff and Butler, 2002).

Madeira vine generally invades areas with high water availability, such as riparian vegetation, rainforests and wet sclerophyll forests (Vivian-Smith et al., 2007), though it is also often seen in disturbed areas such as road edges and backyards. It typically invades forests with closed canopies where low light levels enter the understorey; however, Madeira vine's ability to break branches and even collapse canopy trees allows for more light to reach the understorey, providing opportunities for other sun-loving weeds to establish. Madeira vine is therefore considered a transformer species.

There is a lack of knowledge of the allelopathic potential of Madeira vine. However, recent research has revealed allelopathic chemicals present in the leaves can hamper the growth of common food crops (Bari et al., 2019). Further research is needed to determine how Madeira vine leaves can affect the growth of nearby native plants.

RG & FJ Richardson

Madeira vine is an aggressive invader and a serious threat to many ecological communities.

Economic

Madeira vine's impact on the economy is a key knowledge gap. Its fast growth rates and heavy stems likely affect timber plantations but detailed information is lacking. There have been reports of poisoning occurring to livestock after Madeira vine consumption, though information is contradictory. It appears that it is rarely consumed and may cause diarrhoea in sheep and pigs (Vivian-Smith et al., 2007).

Social

Madeira vine is often seen in urban areas where it can grow as a weed in gardens and parklands, causing damage to structures and reducing aesthetic values. In nature reserves, it can grow over walking trails and its canopy weight can increase the chance of tree fall over trails and roads, potentially reducing access to areas. It can degrade natural areas, reducing enjoyment of them and increasing risk of injury from falling limbs.

Kym Johnson

Madeira vine can quickly grow over infrastructure, with potential impacts for maintenance costs and safety.

A threat to endangered native plants and ecosystems

Purple-leaf muttonwood (*Myrsine richmondensis*) and Illawarra socketwood (*Daphnandra johnsonii*)—shown here—are just two endangered plant species threatened by Madeira vine. Nielsen Park sheoak (*Allocasuarina portuensis*) is another. The closed-canopy threatened ecological communities in which these species occur—among them Littoral Rainforest, Lowland Subtropical Rainforest and Riverflat Eucalyptus Forest on coastal floodplains—are particularly vulnerable to Madeira vine invasion.

Madeira vine has not yet reached its potential distribution and may threaten many more ecological communities, plants and animals.

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Purple-leaf muttonwood (endangered).

Gavin Phillips NSW DCCEEW

Illawarra socketwood (endangered).

Identification

Leaves

Heart shaped (cordate), fleshy 3–15 cm long and 2–10 cm wide; mature leaves are on the larger end of this scale, and are much darker in colour than juvenile leaves

Hairless, occasionally glossy; leaf margins may be wavy

Alternately arranged

Matt Sheehan

Flowers

Small (6 mm in diameter) white to cream, sweet scented and occur as clusters along flower spikes (racemes)

Flower spikes 6–30 cm long

Flowers late summer to autumn

Matt Sheehan

Matt Sheehan

Fruit and seeds

Fruit and seeds very rarely produced in Australia

When present, fruits are tiny, 0.9–1.1 mm long, globe shaped and single seeded

Stems

Initially green or red–green, hairless and cord like, becoming green to grey; semi-woody and rope like with age

Flexible and climbs by twining; stem width can exceed 5 cm

Does not produce sap or milky latex

Small lenticels (raised pores for gas exchange) present along larger stems

Matt Sheehan

Tubers

Aerial: Light brown or green

Variable shapes, ranging from round to irregular with a 'warty' appearance

Up to 25 cm in diameter, though usually much smaller

Thousands produced at nodes along the stems

Underground: Found to a depth of 1 m

Potato like, commonly 20 cm in diameter

Aerial and underground tubers can be similar in size and appearance

Sonia Jordan

Matt Sheehan

Similar species

Madeira vine is easily identified by its fleshy leaves, distinctive flowers and mass of aerial tubers. Tubers are usually present year round; however, flowers are usually absent June–November, during which time it may look superficially like other vines. Examples of some vines that may be mistaken for Madera vine and share a similar distribution are shown below.

Malabar spinach *Basella alba*	**Climbing lignum** *Muehlenbeckia adpressa*	**Climbing grounsel/Cape ivy** *Senecio angulatus*
An introduced tropical climber commonly grown as a garden vegetable. Recorded in NSW, Vic, Tas, Qld and WA.	A native climber found predominantly in coastal regions of southern NSW, Vic, Tas, SA and WA.	A weed mostly found in southern Qld, NSW, Vic, Tas, SA and WA.
 Creative Commons Pubic Domain	 © Melvin Xu Creative Commons CC BY-SA 4.0	 RG & FJ Richardson
Similar fleshy leaves but lacks the aerial tubers.	Similar leaf shape but they have finely crinkled margins. Lacks aerial tubers.	Similar glossy and fleshy leaves but they are more narrow and less rounded. It also has yellow daisy-like flowers.

The introduced weeds Cape ivy (*Delairea odorata*) and Japanese honeysuckle (*Lonicera japonica*) may also be confused with Madeira vine; see profiles in Chapter 6.

Current distribution

In Australia, Madeira vine mainly occurs in subtropical and warm temperate coastal areas of NSW and Qld, from Rockhampton to Narooma, though it is recorded growing as far north as Cairns, and south to Eden (Figure 2.3). There are also naturalised populations around Perth in WA; East Gippsland and Melbourne in Vic; and near Adelaide and Mount Gambier in SA. It has also been recorded as growing in Tas, Lord Howe Island and Norfolk Island.

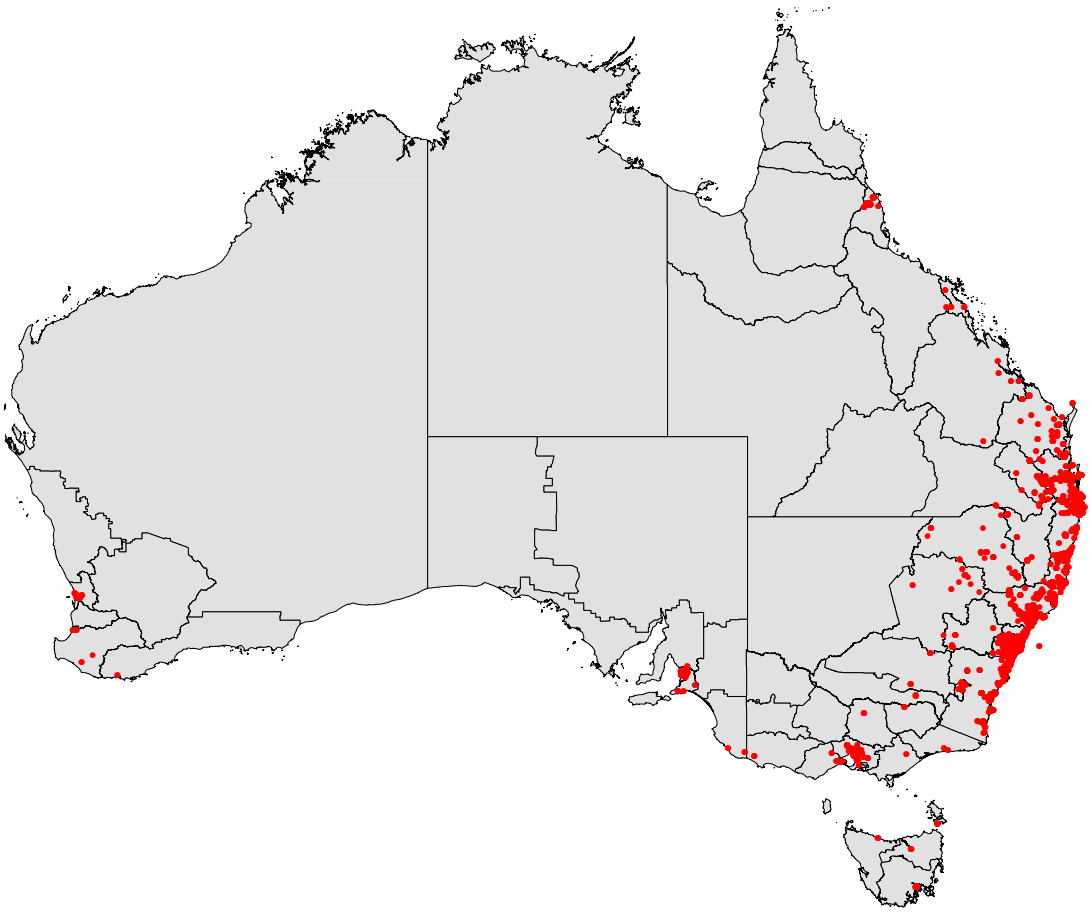


Figure 2.3 Current distribution of Madeira vine in Australia. Records from Atlas of Living Australia (2022).

Potential distribution

Future climate modelling suggests that although forests in tropical Australia will likely become less suitable for Madeira vine (Gallagher et al., 2010; Zhang et al., 2020), the climate will be more suitable in southern coastal areas (Figure 2.4). Therefore, naturalised populations in the southern states could become more of a threat under future climatic conditions.

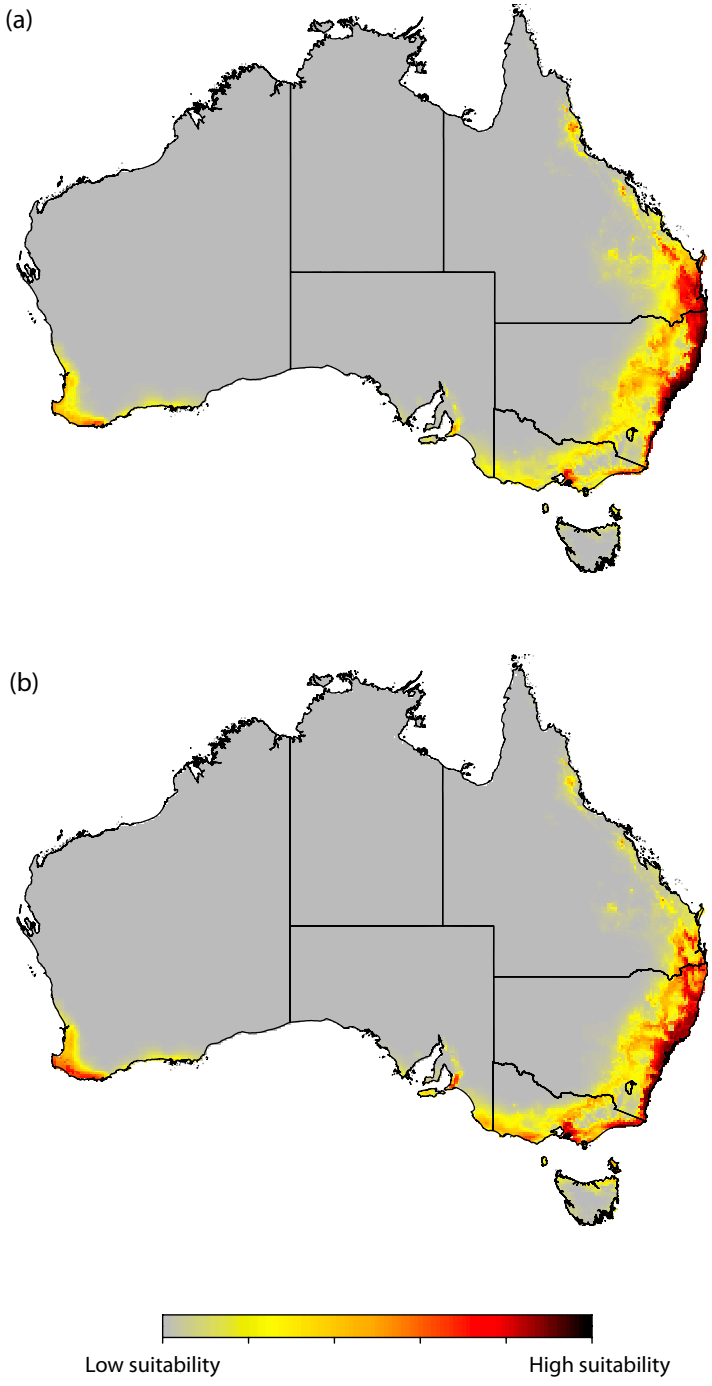


Figure 2.4 Areas of climatic suitability for Madeira vine modelled under (a) current climatic conditions and (b) predicted climatic conditions in 2050 under the SSP2-4.5 climate scenario. SSP2-4.5 is an intermediate greenhouse gas emissions scenario where global carbon dioxide emissions continue around current levels until 2050, then decrease but do not reach net zero by 2100 (Riahi et al. 2017). Black and dark red pixels represent the most suitable habitat.

Preferred habitats and limiting factors

Madeira vine is most impactful in riparian areas, rainforests and wet sclerophyll woodlands where there is high and consistent water availability. In Australia, it is often observed in disturbed areas such as railway corridors and roadsides, as well as on rocky outcrops and cliff faces (Vivian-Smith et al., 2007). In its native range, the average rainfall is 500–2000 mm/year and average temperatures are 20–35°C in summer and 10–30°C in winter (Vivian-Smith et al., 2007). However, Madeira vine has adapted to a range of climates, including Mediterranean, subtropical and tropical. Species distribution modelling suggests that the ideal mean annual temperature and annual precipitation range for Madeira vine is 20–30°C and 800–2,000 mm, respectively.

Leaves are short lived and easily die off in situations where water or other resources are depleted (Boyne et al., 2013), or under drought or heavy frost conditions. However, plants usually survive, reshoot from tubers and quickly re-establish when conditions are favourable.

Madeira vine can persist in heavy shade, but grows more vigorously in full sunlight (Boyne et al., 2013). It can creep across the forest floor and co-exist with other scramblers, but tends to produce more leaves and tubers in climbing stems (French et al., 2017).

Reproduction and spread

In Australia, Madeira vine mainly reproduces vegetatively through aerial and underground tubers but has been recorded to occasionally produce viable seeds (Vivian-Smith et al., 2007). Additionally, it can reproduce via stem cuttings and rhizomes.

A competitive edge

Research indicates that Madeira vine:

- has a very simple leaf structure and can produce leaves quickly and in large numbers with little cost to the plant, making photosynthesis more efficient (Boyne et al., 2013)
- is 'amphistomatous', meaning it produces stomata on both sides of its leaves and produces more stomata in full-light situations (Boyne et al., 2013)
- produces more biomass (leaves, stems and tubers) in climbing stems (French et al., 2017).

It is hypothesised that the leaves and their greater photosynthetic potential in full-light situations allow Madeira vine to grow quickly and exploit gaps in the canopy. This gives Madeira vine a competitive advantage over many other species and may be one reason why it is such a successful invader, particularly following disturbance events such as storms and fire.

Matt Sheehan

Madeira vine 'tuberlings' growing from a fallen tuber.

Matt Sheehan

*Arrows indicate where Madeira vine, spreading across the forest floor, is emerging above another highly invasive creeper – trad (*Tradescantia fluminensis*).*

Tubers

One of Madeira vine's most characteristic features is its extensive tuber production, both aerial and underground. Aerial tubers are produced in the nodes along the stem and have a warty appearance. These tubers easily break off and drop to the ground following disturbance (including treatment). Each tuber can produce a 'tuberling' (similar to a seedling but originating from a tuber, rather than a seed) that can produce more aerial tubers within six months in ideal conditions (French et al., 2017).

Each stem produces a mass of aerial tubers, with densities as high as 1,500 tubers per square metre recorded under the canopy of dense infestations (Vivian-Smith et al., 2007). Aerial tubers grow all year (Vivian-Smith et al., 2007), meaning Madeira vine can spread at any time. Aerial tubers that are attached to living stems will gradually enlarge until they drop off because of weight or disturbance. While they are attached to stems aerial tubers are believed to remain viable for several years, and possibly indefinitely (G. Vivian-Smith pers comm., October 2023).

Tubers that are detached from stems are viable for shorter periods. Trials in South East Qld showed that tubers either buried, placed on the soil surface or suspended from trellises in mesh bags (to replicate those held in the vine canopy) experienced a steep decline in viability over a two-year period, with no viable tubers at 24 months (G. Vivian-Smith pers comm., October 2023).

Underground tubers are similar in shape and appearance to aerial tubers and can grow at depths of 1 m and reach 20 cm in diameter (Vivian- Smith et al., 2007). Being underground, these tubers allow for stems to regrow following mechanical control or other disturbances and may also support regrowth following herbicide treatment. This adds to the difficulty of removing Madeira vine from a site.

S. Burchill

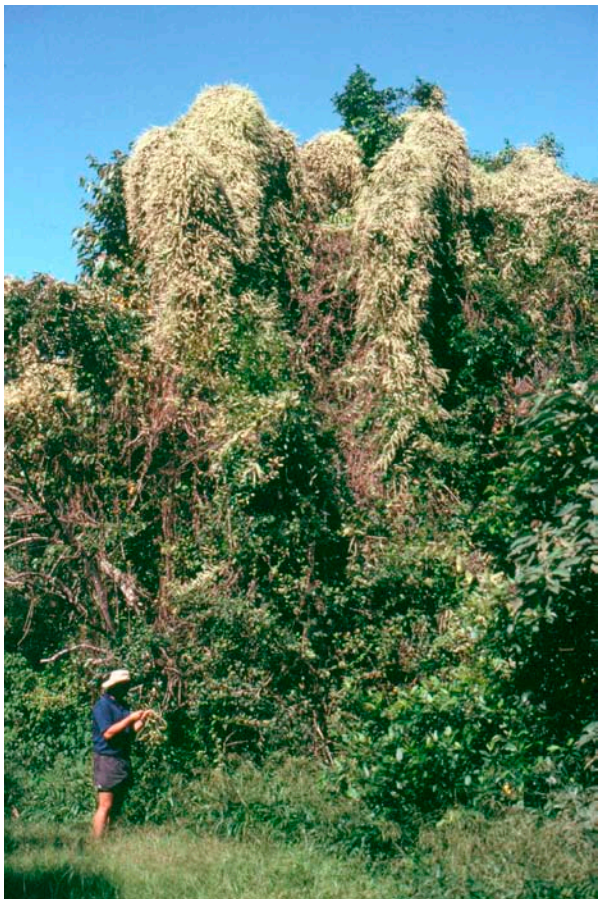
Underground tubers of Madeira vine.

Flowers and seeds

In Australia, Madeira vine's long spikes of white flowers are present from December to May, with large numbers produced by each plant. Pollination information is limited, even in its native range. The flowers are similar to those pollinated by insects, being scented and containing nectar (Vivian-Smith et al., 2007); in Hawaii, flowers have been observed to be visited by bees, wasps and ants but not followed by fruit set. Further study into the pollination requirements of Madeira vine is needed.

Although Madeira vine flowers can be abundant, they are believed to rarely produce seeds in the introduced range. Madeira vine seeds are very small (1 mm long), produced in very low numbers and difficult to differentiate from dry flowers, so it is possible that seeds are produced but go unrecorded. Some seeds were collected and successfully germinated in a laboratory setting from a small number of Qld populations in Brisbane and Samford Valley. However, it was considered unlikely that these seedlings would survive in field situations (G. Vivian-Smith pers comm., October 2023).

The absence of genetic studies to determine the relationships among Australian populations, and the lack of knowledge regarding germination requirements and seed viability, makes it difficult to quantify the role seeds play in Madeira vine reproduction and spread. However, given Madeira vine is primarily spread vegetatively through the production of masses of tubers, spread via seed is considered insignificant.



Andrew Storrie

Madeira vine flowers abundantly, but very rarely produces seeds in Australia.

Dispersal

Madeira vine's reliance on vegetative reproduction in Australia means that it is often spread by humans, likely from activities such as dumping of garden waste that contains viable plant fragments (tubers, stems and rhizomes). Natural dispersal over short distances (i.e. within forests or sites) would be possible through gravity when tubers fall off canopy stems, and potentially via animals such as brush turkeys (*Alectura lathami*) spreading tubers when building nests. Streams and floodwaters are a major mechanism for long-distance spread of tubers and stem fragments (Vivian-Smith et al., 2007). Tubers generally do not float, but experiments have shown that 33% of tubers can survive up to 30 days underwater (Vivian-Smith et al., 2007).

Matt Sheehan

Madeira vine is commonly spread via water.

Seasonal patterns of Madeira vine

	Summer			Autumn			Winter			Spring		
	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Tuber production	■	■	■	■	■	■	■	■	■	■	■	■
Tuberlings	■	■	■	■	■	■	■	■	■	■	■	■
Flowers	■	■	■	■	■	■						
Leaves	■	■	■	■	■	■	■	■	■	■	■	■

■ Generally present ■ Not usually present