



Weed of National Significance



Opuntiooid Cacti

Management Guide

Best practice information for *Austrocylindropuntia*,
Cylindropuntia and *Opuntia* species in Australia



Australian Government



GOVERNMENT OF
WESTERN AUSTRALIA

Department of
Primary Industries and
Regional Development



Government of South Australia
Primary Industries and Regions SA



Cylindropuntia tunicata (brown-spined Hudson pear)

Matt Sheehan

Key points

- **Australia does not have any native cacti.**
- **Opuntioid cacti impact on Australia environmentally, agriculturally and aesthetically, as well as posing a risk to animal welfare and human safety.**
- **Invasive cacti are drought resistant and hardy, surviving in low rainfall environments.**
- **All species spread vegetatively through the rooting of cladodes (stem segments), fruits or flowers. Some species also spread by seed.**
- **Opuntioid cacti vary significantly in their form and habit, ranging from low-growing shrubs under 50 cm to erect trees up to approximately 6 m tall.**
- **Australian rangelands are especially vulnerable to cacti invasion.**
- **The cost of control often exceeds the value of infested land.**
- **There are approximately 31 species of invasive opuntioid cacti present in Australia, and while cacti have naturalised in all Australian states and territories, there is still potential for further spread.**
- **Opuntioid cacti can be effectively managed through a well-planned approach that combines several control methods (integrated management) and a long-term commitment.**

The weed

Opuntioid cacti are a group of plants that belong to the sub-family Opuntioideae within the **family** Cactaceae. Originally from the Americas, some **species** were introduced into Australia to support cochineal dye production, while others were planted as garden ornamentals or hedges. One of the most well-known opuntioid cacti is *Opuntia stricta* (common prickly pear), which covered some 240,000 km² before the introduction of the cactoblastis moth, a highly successful biological control agent, in 1926. There are around 31 species of opuntioid cacti that have **naturalised** in Australia, with infestations in all states and territories.



Opuntioid cacti are distinguished from other Cactaceae sub-families by the presence of **glochids** – small, detachable barbed bristles. Glochids grow from **areoles**, the small pits or depressions on the surface of **cladodes**. Areoles are also the points from which new shoots, spines, glochids, flowers, fruits and roots can grow and are present on cladodes, fruit and the tissue surrounding flowers. Cacti have adapted to arid conditions through an evolved process of photosynthesis known as Crassulacean Acid Metabolism. Their **stomata** (pores) close during the day, reducing moisture loss and allowing gas exchange to occur during the cooler night period.



Spines emerging from a *Cylindropuntia imbricata* (devil's rope) areole

Shauna Potter

Table 1. Generalised growth and treatment calendar for all opuntoid cacti species across Australia

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Flowering												
Fruiting												
Germination												
Vegetative regrowth												
Optimal treatment time	<p>General tips: Treat weeds when they are young. Wear appropriate PPE (personal protective equipment) when working in dry conditions to avoid glochid injury.</p> <p>Chemical control: Treat weeds when actively growing and as per label.</p> <p>Mechanical removal: Avoid working in wet conditions to minimise weed spread.</p> <p>Hand removal: This works best when soils are moist.</p> <p>Biological control: These should be released between August and May.</p>									<p> general growth period</p> <p> growth under suitable conditions</p>		

The problem

Three **genera** of opuntoid cacti have naturalised in Australia and are Weeds of National Significance: *Austrocyllindropuntia*, *Cylindropuntia* and *Opuntia*. Dense infestations compete with native vegetation, limiting the growth of small shrubs and groundcover species. The plant's sharp spines or barbs can cause serious injury to humans, stock and native animals and contaminate wool and hides, reducing or preventing grazing activities and productivity. Large stands of cacti provide harbour for pest animals, such as foxes and rabbits and, due to their spiny nature, can limit access for stock mustering and recreational activities. Cladodes kept in sealed containers have been known to survive indoors for three years without soil or water, demonstrating their ability to persist even in severe conditions. Opuntoid cacti are very adaptable, growing in a range of soil types and areas that receive above 150 mm of rainfall annually.

Identification

The appearance of opuntoid cacti can vary significantly, from the more familiar tall, erect and flat segmented *Opuntia stricta* (common prickly pear), through to small shrubs with narrow, cylindrical, rope-like segments such as *Cylindropuntia pallida* and *C. tunicata* (Hudson pears).

Austrocyllindropuntia originate in South America and are shrubby with cylindrical to club-shaped cladodes. They differ from *Cylindropuntia* species in that their spines lack papery **sheaths**. Of the 11 species worldwide, two have naturalised in

Australia – *Austrocyllindropuntia cylindrica* and *A. subulata*. These species are popular in cultivation in other parts of the world.

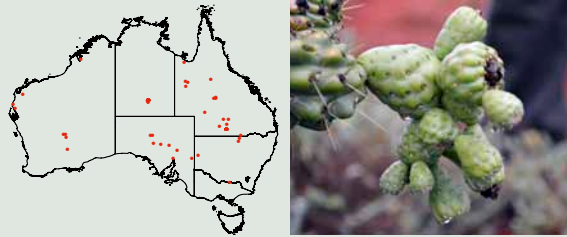
Cylindropuntia are native to south western USA, Mexico and the West Indies. They have cylindrical segments and spines with papery sheaths that separate from the spine in their first year. Many species have easily detachable cladodes, such as *Cylindropuntia prolifera*, commonly known as jumping cholla, due to its ability to seemingly 'jump' onto passing animals, humans and vehicles.

Opuntia originate in North America, the West Indies and South America. They are branched shrubs, typically up to two metres high, though they can grow taller. They have flattened cladodes, commonly referred to as pads, which are usually round or oval-shaped. The most well-known *Opuntia* species is *Opuntia stricta* (common prickly pear), introduced to Australia in the 19th century.

Growth pattern

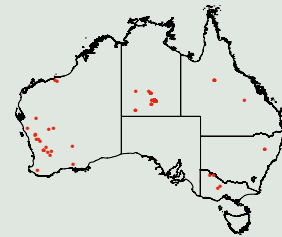
Opuntoid cacti are perennial plants that are generally long-lived (>10 years). Flowering typically occurs from spring through to summer, with fruits forming in late summer and into autumn. Not all species develop **viable** seed, but those that do can produce numerous seeds, with a hard seed coat enabling longevity. Seed can germinate year-round depending on rain, though seedlings are less likely to survive if they are in exposed conditions. Seedlings can be difficult to detect when small. See Table 1 for a generalised growth calendar for all cacti species, and how this can inform management.

Common opuntioid cacti in Australia



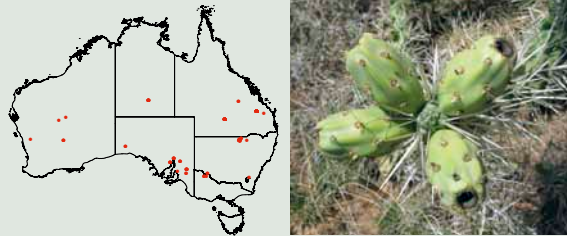
Cylandropuntia fulgida var. *mamillata* (coral / boxing glove cactus)

Henry Rutherford (habit and fruit), Matt Sheehan (distorted cladode)



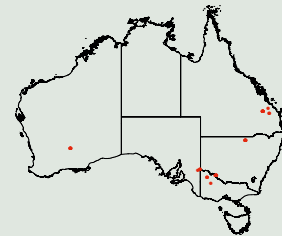
Cylandropuntia imbricata (devil's rope, rope pear)

Bob Chinnock



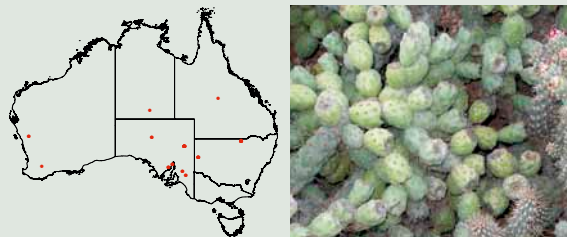
Cylandropuntia pallida (syn. *C. rosea*) (white-spined Hudson pear)

Bob Chinnock



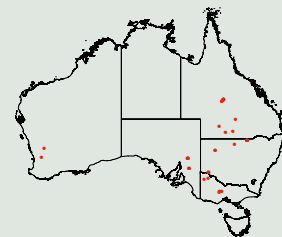
Cylandropuntia tunicata (brown-spined Hudson pear)

Bob Chinnock



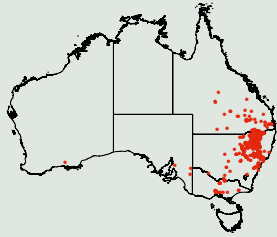
Cylandropuntia prolifera (jumping cholla)

Bob Chinnock



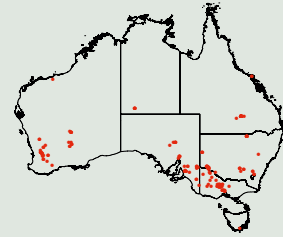
Cylandropuntia spinosior (snake cactus)

Shauna Potter (habit and fruit), Bob Chinnock (flower)



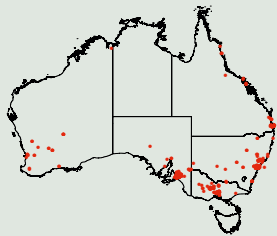
Matt Sheehan (habit), Bob Chinnock (flowers)

Opuntia aurantiaca (tiger pear)



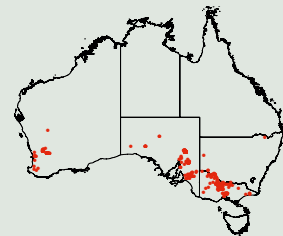
Matt Sheehan (habit), Shauna Potter (cladodes, fruit), Bob Chinnock (flowers)

Opuntia elata (Riverina pear)



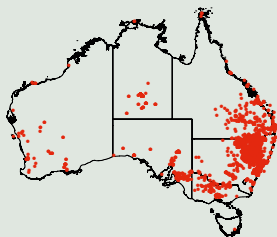
Rob Richardson

Opuntia monacantha (drooping tree pear)



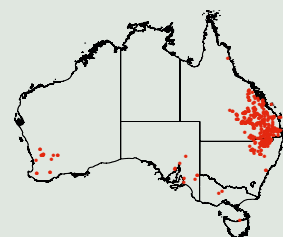
PIRSA

Opuntia robusta (wheel cactus)



Henry Rutherford (habit and fruit), Shauna Potter (flower)

Opuntia stricta (common prickly pear)



Henry Rutherford (habit), Shauna Potter (flowers), Bob Chinnock (fruit)

Opuntia tomentosa (velvet tree pear)

How they spread

Vegetative spread is the most common form of dispersal, and can occur year-round when cladodes, immature fruit or flowers detach and make ground contact. New cladodes then grow from areoles on the upper surface of the cladodes. Cladodes of many opuntoid cacti will attach easily to clothing, footwear and the fur and limbs of animals, aiding their spread. New growth (and spread) can also occur from flowers, from which new segments or roots can grow. Most spread in Australia has been by people, either as garden plants and hedges, or through dumping in rubbish tips or bushland. Seed spread is less common, as it only occurs in species that produce viable seed. Species such as *Opuntia robusta* (wheel cactus) and *O. stricta* (common prickly pear) produce bright, large fruit that are eaten by wildlife and pest animals, aiding dispersal. The seed and vegetative spread of cacti is also aided by the movement of water; hence distribution often occurs along watercourses, drainage lines and across flood plains. Many species, including *Cylindropuntia pallida* (white-spined Hudson pear), *C. tunicata* (brown-spined Hudson pear) and *O. aurantiaca* (tiger pear), are very easily spread by water.



Opuntoid cacti can occur as a weed on neglected land, parks, gardens and reserves where garden waste is commonly disposed. Old homesteads (in urban and rural settings) are a frequent source of invasion. Here Opuntia stricta (common prickly pear) has spread out from an old homestead.



Matt Sheehan



Shauna Potter

Segments of cacti easily attach to vehicles, animals and people, contributing to long distance dispersal

Where they grow

Opuntoid cacti grow throughout a wide climatic range, from arid, semi-arid environments to warm temperate, sub-tropical and tropical areas. They are native to the Americas, from Canada to southern South America. They have become weedy in Australia, South Africa and Eurasia, where they were introduced as food, fodder, ornamentals and for the former cochineal industry. In Australia, they appear to have no preference for soil types and are found growing in calcareous loam, shallow granite, red earths and clay soils. Cacti flourish around old homesteads, dumps and mine sites. Opuntoid cacti are found in all Australian states and territories, with some species more widespread than others.

Potential distribution

Opuntoid cacti have the potential to expand their range in Australia and research is currently underway to model the potential distribution of cacti species. Opuntoid cacti are capable of establishing in the majority of soil types and climatic zones throughout Australia. Further information on our current understanding of habitat suitability can be found at www.weedfutures.net.



Matt Sheehan

New *Opuntia monacantha* (drooping tree pear) plants establishing on a flood plain from fragments washed down during a flood event

Spread prevention

Opuntoid cacti are spread from the movement of seeds, fruit and cladodes via birds, animals, water, vehicles, equipment and people. Good hygiene is essential when working in infested areas, including staying on tracks. All cladodes and fruits should be removed from an area during control activities as they are capable of regrowing, even under very harsh conditions. The most efficient and effective weed control strategy is prevention.



Matt Sheehan



Matt Sheehan

Before entering a site, use a wash- or brush-down facility to make sure vehicles are clean. On leaving the cacti infestation, conduct visual inspections in a designated 'clean-down area', of vehicles, boots, clothing and equipment to make sure they are free of weed seeds and other propagules.



Aimee Linke and Kym Haebick

Equipment for stem injection, including Daconate herbicide, stem injection kit, drill, plastic gloves and face shield

Chemical control

Four herbicides are registered for the control of opuntoid cacti. These are MSMA, triclopyr, picloram + triclopyr, and amitrole, under various trade names. The Australian Pesticides and Veterinary Medicines Authority (APVMA) regulates the use of chemicals in Australia. In some instances off-label permits are issued by the APVMA, to allow for uses that are not specified on the label. For more details on herbicide registration and permits visit the APVMA website www.apvma.gov.au.

Registration of herbicides varies across states and territories. You should always check the product label and seek advice from your local council or state/territory weed management agency for information on spray rates and adjuvants.



Andy Winter

Adequate PPE (e.g. rubber gloves, eye protection, respiration masks, long-sleeved shirts, long pants, boots) should be worn when foliar spraying cacti.



Perri Carter



Lee Mead

Pad injecting with glyphosate using a Velpar Spot Gun with a drenching nozzle (top) and 47 cm spear nozzle (bottom)

Table 2 provides a summary of the registered herbicide options available for the control of opuntoid cacti in Australia. Check <https://portal.apvma.gov.au/home> to ensure the listed methods and herbicides are on label or permitted in your state or territory.

Opuntia species respond well to stem injection (includes pad injection and drill and fill), while many *Cylindropuntia* species require overall spraying. When using herbicides, care must be taken to ensure adequate coverage of the plant (all sides of the cladodes) to prevent regrowth. In the case of foliar spraying, the addition of a marker dye will assist with identifying missed plants or cladodes.

Plants should be actively growing and not under stress from heat, drought or cold conditions. Plants may die quicker as a result of warm weather spraying, as cooler conditions can slow the uptake of herbicides. Herbicides may not result in a complete kill. Control sites should therefore be monitored for regrowth and follow-up control activities carried out as required.

Table 2. Herbicide options for opuntoid cacti management

Method	Herbicide	Comments	Advantages	Cautions
Foliar spray	MSMA, e.g. Daconate® Triclopyr, e.g. Garlon™ Picloram + triclopyr e.g. Grazon Extra™	Used mixed with water and spray oil; or diesel. Follow permit/label instructions	<ul style="list-style-type: none"> Complete coverage. No specialised equipment needed. Suits large infestations and roadsides. Relatively cost effective. 	<ul style="list-style-type: none"> Potential for off-target damage. Usually relies on vehicle access. Do not spray when plants are stressed. Use of MSMA requires accreditation*.
Stem (pad) injection	Amitrole, e.g. Amitrole T Glyphosate MSMA, e.g. Daconate®	Injection of measured dose of neat chemical applied into cladodes or trunks of cacti. Follow permit/label instructions	<ul style="list-style-type: none"> Suits isolated, small infestations or difficult to access sites. Can be used year round. Low volumes of herbicide required. Glyphosate suitable for volunteers with appropriate training. Minimal off-target damage. 	<ul style="list-style-type: none"> Requires specialised equipment, e.g. injector gun, drills etc. Use of MSMA requires accreditation*.
Basal bark/cut stump	Picloram+ triclopyr, e.g. Access™ Triclopyr, e.g. Garlon™	Used neat or with diesel (depending on herbicide). Follow permit/label instructions	<ul style="list-style-type: none"> Effective for isolated plants. Minimal off-target damage. 	<ul style="list-style-type: none"> Need to apply to all 'branches'. All cut material must be disposed of in deep burial to prevent spread.

* MSMA is a Schedule 7 herbicide and its use is restricted to qualified persons (e.g. Chemcert accredited).



Henry Rutherford

The use of thick leather gloves, pliers, knife and long-handled tongs for manual removal will reduce the likelihood of injury.



Kevin Teague, Yorke Peninsula NRM Board

Mechanical control using a grapple arm to 'pluck' *Opuntia robusta* (wheel cactus) from the ground

Physical control

Under the right circumstances physical control, either by manual (hand) or mechanical (machinery) removal, can be a feasible and cost-effective management option for all opuntoid cacti species. Hand removal can be very effective for small plants and scattered infestations, while mechanical removal with machinery can be effective for large, dense, impenetrable stands.

Care must be taken when undertaking physical control of opuntoid cacti due to their spiny nature. Some species, such as *Cylindropuntia pallida*, *C. tunicata* (Hudson pear) and *C. imbricata* (devil's rope), can pose significant risk of injury when handled.

Physical removal can also dislodge cladodes, which can regrow to form new plants. Material must be disposed of appropriately via deep burial.

Biological control

There are two main agents used in the biological control of opuntoid cacti: *Cactoblastis cactorum*, a stem-boring moth, and several *Dactylopius* species, cochineal scale insects. *Cactoblastis* has been extremely successful in controlling *Opuntia stricta* (common prickly pear) in most situations, although it is less effective in cooler, wetter areas or very dry locations. *Cactoblastis* larvae feed on cladodes, resulting in the collapse of plants. They can feed on a range of opuntoid cacti, but are most effective at controlling *O. stricta* (common prickly pear).

There are several *Dactylopius* species (cochineal) present in Australia. The species all look similar to the naked eye **so it is important to use the correct cochineal**. A full list of cacti and their agents is provided in Table 3.

It is relatively easy to infect vulnerable cacti species with *cactoblastis* and cochineal by re-distributing the agents either as eggs (in the case of *cactoblastis*) or by placing infected segments on unaffected plants (in the case of *cactoblastis* larvae or cochineal). Heavy rain and cold weather can inhibit the effectiveness of cochineal.



Andrew McConachie

Placing cladodes infected with cochineal onto *Cylindropuntia fulgida* var. *mamillata* (coral cactus)



Ignacio Baez, USDA ARS, Bugwood.org

Adult female cactoblastis moth laying eggs



Matt Sheehan

Red-stained, meringue-like coverings on pads indicate cochineal scale insects are present



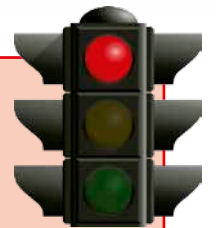
Kay Bailey

Cactoblastis larvae hard at work

Table 3. Cactoblastis and Dactylopius species for use on opuntioid cacti in Australia

Cactus species	Biocontrol agents
<i>Cylindropuntia fulgida</i> var. <i>mamillata</i>	<i>D. tomentosus</i> (South African biotype)
<i>Cylindropuntia imbricata</i>	<i>D. tomentosus</i> (<i>imbricata</i> biotype)
<i>Cylindropuntia kleiniae</i> *	<i>D. tomentosus</i> (<i>Cylindropuntia</i> sp. biotype)
<i>Cylindropuntia leptocaulis</i> *	<i>D. tomentosus</i> (<i>Cylindropuntia</i> sp. biotype)
<i>Cylindropuntia spinosior</i> *	<i>D. tomentosus</i> (' <i>bigelovii</i> ' biotype)
<i>Cylindropuntia tunicata</i> *	<i>D. tomentosus</i> (' <i>acanthocarpa</i> × <i>echinocarpa</i> ' biotype)
<i>Opuntia aurantiaca</i>	<i>D. austrinus</i> and <i>C. cactorum</i>
<i>Opuntia humifusa</i>	<i>C. cactorum</i>
<i>Opuntia dillenii</i>	<i>C. cactorum</i>
<i>Opuntia elata</i>	<i>D. ceylonicus</i> and <i>C. cactorum</i>
<i>Opuntia elatior</i>	<i>D. opuntiae</i> and <i>C. cactorum</i>
<i>Opuntia ficus-indica</i>	<i>D. opuntiae</i> and <i>C. cactorum</i>
<i>Opuntia monacantha</i>	<i>D. ceylonicus</i> and <i>C. cactorum</i>
<i>Opuntia robusta</i>	<i>D. opuntiae</i> and <i>C. cactorum</i>
<i>Opuntia streptacantha</i>	<i>D. opuntiae</i> and <i>C. cactorum</i>
<i>Opuntia stricta</i>	<i>D. opuntiae</i> and <i>C. cactorum</i>
<i>Opuntia tomentosa</i>	<i>D. opuntiae</i> and <i>C. cactorum</i>

* Biocontrol agents for these species were approved for release in October 2017. There will be a lag time of several months before field releases can be made and agents establish in the field.



Stop and think before you control

- Seek advice/permission from land manager, council or state/territory government before carrying out control.
- Determine any laws relating to vegetation clearing, soil, conservation or cultural heritage that may need consideration.
- Wear appropriate personal protection equipment (PPE) when working with cacti.

Legislation

Under the *Commonwealth Biosecurity Act 2015*, the WoNS opuntioid cacti are prohibited entry into Australia. These species are also declared weeds in many states and territories. Legal obligations vary between species and jurisdictions and range from the prevention of movement and sale to an obligation to control. Contact the weeds authority in your state and territory for further information.



Weed control contacts

	Department	Phone	Email	Website
Federal	Department of the Environment and Energy	1800 803 772 (general enquiries)	Submit enquiry at: http://www.environment.gov.au/about-us/contact-us	http://www.environment.gov.au/biodiversity/invasive/weeds/
ACT	Environment, Planning and Sustainable Development Directorate	13 22 81	environment@act.gov.au	http://www.environment.act.gov.au/parks-conservation/plants-and-animals/Biosecurity/weeds
NSW	Biosecurity NSW, Department of Primary Industries	1800 680 244	invasive.species@dpi.nsw.gov.au	www.dpi.nsw.gov.au/biosecurity/weeds
NT	Department of Environment and Natural Resources (Weed Management Branch)	Alice Springs (08) 8951 9210 Darwin (08) 8999 4567 Katherine and the Gulf (08) 8973 8857 Tennant Creek (08) 8962 4314	weedinfo@nt.gov.au	https://nt.gov.au/environment/weeds/weed-management-branch-contacts
QLD	Biosecurity Queensland, Department of Agriculture and Fisheries	13 25 23	callweb@daff.qld.gov.au	https://www.daf.qld.gov.au/plants/weeds-pest-animals-ants/weeds
SA	Biosecurity SA, Department of Primary Industries and Regions SA	(08) 8303 9620	nrmbiosecurity@sa.gov.au	www.pir.sa.gov.au/biosecuritysa/nrm_biosecurity/weeds
TAS	Department of Primary Industries, Parks, Water and Environment	(03) 6165 3777	Weed.Enquiries@dPIPWE.tas.gov.au	http://dPIPWE.tas.gov.au/invasive-species/weeds
VIC	Agriculture Victoria (Department of Economic Development, Jobs, Transport and Resources)	136 186	Submit enquiry at: http://agriculture.vic.gov.au/about-us/contact-us	http://agriculture.vic.gov.au/agriculture/pests-diseases-and-weeds/weeds
WA	Department of Primary Industries and Regional Development	(08) 9368 3333	padis@dpird.wa.gov.au	https://www.agric.wa.gov.au/pests-weeds-diseases/weeds



Glossary

Adjuvant Substance added to a herbicide mixture to aid or modify the action of the herbicide.

Areole Highly condensed and modified short-shoot, growing in the leaf axil as a felted cushion, unique to cacti, usually hairy and/or spiny; from them the flowers and roots and new cladodes arise.

Biotype Of biological control agents: two or more morphologically indistinguishable forms of a species that can interbreed, but can only be recognised by their survival and development on different hosts and their distinct host preference for feeding or egg laying.

Cladode Modified, swollen, water storing stem segment that forms the leaves. Cladodes can be cylindrical (e.g. in *Austrocylindropuntia* and *Cylindropuntia* species), or flattened (e.g. in *Opuntia* species, where they are commonly referred to as pads). In opuntoid cacti, cladodes are jointed.

Family Taxonomic rank used in the biological classification of living and fossil organisms, that groups related genera (see genus). For example, the family of Cactaceae contains about 140 genera.

Genus/Genera (pl.) A taxonomic rank used in the biological classification of living and fossil organisms, that groups closely related species.

Glochid Small, detachable, barbed bristles usually protruding from areloes on cladodes and fruit.

Naturalised Originating elsewhere, but established and reproducing itself in a new area without assistance.

Propagule Any part of a plant that can become detached to produce a new plant; e.g. bud, cladode, seed.

Sheath Papery outer covering of the spine. Only present in *Cylindropuntia* species.

Species Group of living organisms consisting of similar individuals capable of exchanging genes or interbreeding. A species ranks below genus.

Stoma/Stomata (pl.) Pores found in the epidermis of leaves, stems and other organs, that facilitate gas exchange between tissues and the atmosphere.

Synonym (syn.) Outdated or alternative name for the same taxon (e.g. *Cylindropuntia rosea* is the synonym of *C. pallida*).

Viable Able to survive and develop.

Further information

<http://weeds.ala.org.au/WoNS/opuntoidcacti/>

<http://agric.wa.gov.au/cactusmanual>

Sheehan, M.R. and Potter, S. (2017). Managing Opuntoid Cacti in Australia: Best practice control manual for *Austrocylindropuntia*, *Cylindropuntia* and *Opuntia* species. Department of Primary Industries and Regional Development (WA), Perth.

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