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Australian Plants



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Front and back covers: Front: unknown fly on *Drosera binata*; Back: *Utricularia hamiltonii*, Darwin area. Photos: Greg Bourke

Australian Plants articles

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Editorial

John Aitken, Co-editor, *Australian Plants*

Welcome to this issue of *Australian Plants* which features Australian carnivorous plants. When most of us think about Australian native plants, we tend to overlook this fascinating group, despite the fact that they are very common. Australia has the most diverse range of carnivorous plants of any country in the world with almost 240 species spread out over nearly 97 per cent of the continent.

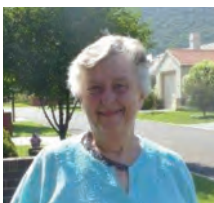
This behoves the question; if they are so common why aren't they more widely publicised and cultivated within the Australian Plants Societies? Perhaps it is because of their generally small size, the fact that many are often found in swampy nutrient deficient areas, or that their flowers are generally not as conspicuous as other native plants?

Many of our carnivorous plants live in soils which have been leached of nutrients over millions of years. In order to survive in these hostile aenvironments, carnivorous plants have evolved mechanisms to lure, trap and kill insects in order to absorb nutrients from their victims, which they would not otherwise obtain from the soils in which they are found.

I am confident that this issue of *Australian Plants* will provide you with greater insight into this fascinating group of plants and will, hopefully, encourage you to grow them.

I would like to thank Greg Bourke, Curator-Manager, Blue Mountains Botanic Garden, Mt Tomah and Vice President for Botanic Gardens Australia and New Zealand, for compiling this exciting issue of *Australian Plants*. Greg has an unbridled passion for carnivorous plants and has given many talks on this subject over the years. For those readers who would like to hear more from Greg, visit:

www.abc.net.au/radio/sydney/programs/drive/siw-greg-bourke/10124412



Congratulations to Merle Thompson, co-editor of *Australian Plants*, on her award of the Order of Australia Medal (OAM) in the recent Australia Day awards list. Merle, who will be known to most of our readers, thoroughly deserves this public recognition for her dedicated service to the community through a range of organisations including Polio NSW,

Australian Federation of Graduate Women and the Australian Plants Society NSW. Merle has been a tireless advocate for the growing, promoting and conserving Australian native plants.





Introduction

Greg Bourke

Greg is Curator Manager, Blue Mountains Botanic Gardens, Mount Tomah and is an active member of the Australasian Carnivorous Plants. Society.



We all know that Australia has an incredible diversity of native plants, many of which are found nowhere else on earth. The continent has been isolated for millennia with relative geological and climatic stability which has helped drive this diversity, and the focus group of plants for this issue is no exception. In fact, carnivorous plant diversity is greatest in Australia! But what

is a carnivorous plant and why would a plant evolve to eat meat? The answers to these questions and much more are revealed in this issue.

Carnivory in plants was considered impossible until the late 1800s as it went against God's will and to suggest such a thing was considered blasphemous. However, the release of Charles Darwin's *Origin of Species* in 1859 opened the minds of the scientific community and by the time he published his work *Insectivorous Plants* in 1875, evolution was widely accepted by the community. Still, carnivory in plants was too big a step for many who refused to accept such a concept.

We are still discovering more about this incredible group of plants today and the list of species and even genera considered to be carnivorous continues to grow. The over 800 species currently accepted have their origins in seven different plant lineages. To put this in perspective, the relationships between some carnivorous plant families could be compared to the relationship between humans and flat worms! Eleven families and 18 genera are represented, and Australia is home to an impressive 250 or so species spanning five families and six genera. Most of Australia's carnivorous plants are endemic.

When I was asked to curate this issue of *Australian Plants*, I was excited to promote the group of plants that has captivated my imagination since I was a child, as it has done for all the authors who made contributions. I trust you will enjoy learning about this enigmatic group of Australian native plants and hope that you too will be excited to see them when you are next out walking in your local patch of Australian bush.



Australasian Carnivorous Plant Society





Trapping mechanisms of Australian carnivorous plants

Greg Bourke

Greg has been fascinated by the natural world since he was a child. His early career was in the electrical and telecommunications industries while his studies of native and carnivorous plants remained a serious hobby. In 2011 Greg decided to convert his passion into a career and is now Curator Manager at the Blue Mountains Botanic Garden Mount Tomah. Greg is also an author and photographer.

When we talk about a “group” of plants we often talk about a genus such as *Banksia* or a family such as Proteaceae but carnivorous plants are a group that spans many genera and even families. It is not your average group in the taxonomic sense and when you understand the true diversity of the group, there’s only one thing in common, the need to eat meat!

Before we dig deep into Australia’s carnivorous plants and how they work, we need to understand what makes a plant carnivorous. When Charles Darwin was experimenting with *Drosera rotundifolia* in the mid 1800s, and indeed until recent years, the definition of a carnivorous plant was simply one that attracts, captures and digests animals. We now know that nature is not quite as simple as that and as we have learnt more about these incredible plants and the relationships they have with other animals, our definition has become a little less rigid.

Carnivory evolved independently in at least seven different plant lineages and is considered an evolutionary last resort due to the high cost to produce a carnivorous trap when compared to a typical leaf. Despite this, carnivorous plants have evolved to survive in all but the harshest of environments and we currently recognise more than 800 species globally. Two non-carnivorous plant leaf types have been refined over millions of years: the hairy leaf and the wet leaf. Further refinement has produced some of the most unusual members of the plant kingdom.

The hairy leaf is one that is commonly seen in plants. It is less edible, more able to capture moisture from the air and can be more resilient to extreme conditions such as heat and cold. It is also more able to capture drifting particles such as dust. In some plants such as petunias and tomatoes, these hairs have evolved further to become sticky glands. These are less desirable to predating insects, but they also occasionally capture and kill unsuspecting insects. In some plants,





these sticky glands evolved further to the point where the plant was able to produce and release enzymes to take advantage of the captured insects, therefore becoming truly carnivorous.

The wet leaf is thought to have started its life as a fairly typical leaf but one that simply held a little water following rain. This pooled water was able to capture drifting particles but was also attractive to insects, some of whom may have drowned in the water. This in turn produces nutrients available to the plant as those insects become food for others or simply broke down, providing nutrients that dropped to the ground and were then absorbed by the plant or absorbed directly through the leaf. This success drove the evolution of these plants to produce deeper cupped leaves and, over time, enzymes to directly take advantage of the captured prey. Here, the pitcher trap was born.

The two evolutionary paths described above take us to the very beginning of true carnivorous plants as much as 60 million years ago. Some like *Drosera arcturi* have changed little in that time while others have evolved considerably. The incredible Venus Flytrap (*Dionaea muscipula*) evolved from the sticky leaf and is, as Charles Darwin described it, “the most wonderful plant in the world”.

Generally speaking, carnivorous plants are best suited to moist warm environments yet Australia, the driest continent, is home to the greatest diversity of carnivorous plants. We have six genera split across five families and an impressive 250 or so species. The greatest diversity



is in the south west of the continent, but carnivorous plants are distributed right across the continent from near the summit of Mount Kosciuszko to Uluru.

Here I describe the various trapping mechanisms employed by Australia's carnivorous plants and highlight a few examples in greater detail to show just how diverse this group has become.

Drosera arcturi is found in the Australian Alps and Tasmania. It's the most basal of Australia's sundews.





Waterwheel Plant (*Aldrovanda vesiculosa*)

In the family Droseraceae, the Waterwheel Plant is a distant relative of the sticky leafed sundews. As the name suggests, this is an aquatic plant but surprisingly, its closest living relative is the famous Venus Flytrap (*Dionaea muscipula*). Like the Venus Flytrap, this plant has rapid moving snap traps but on a much smaller scale. The small leaves are produced in whorls of up to nine leaves along the short aquatic stem. Each leaf is divided into two lobes containing sensitive trigger hairs. When prey, such as water fleas or other small aquatic invertebrates, comes into contact with the trigger hairs, the trap snaps shut. Digestive enzymes are released, and the prey digested.

This plant has a rather disjunct distribution in Australia with just three widely dispersed populations in New South Wales (where it is listed as threatened), a single population near Esperance, Western Australia, (where only a few individuals remained when it was last surveyed) with the remainder of populations found in the Kimberley, Northern Territory and eastern Queensland where it is relatively common in clean, still, mostly permanent water bodies. In cool climates, the plant recedes to form a dormant bud called a turion which helps it survive periods of cold or dry.



Aldrovanda vesiculosa showing whorls of leaves and traps. The growing point at the far right continues to produce new growth branching occasionally





Rainbow Plant (*Byblis* spp.)



Byblis rorida from the northern Kimberly

The only genus in the family Byblidaceae, *Byblis* contains eight species found across northern and Western Australia. The plant is a small annual herb or perennial subshrub with long thin leaves covered in two types of glandular tentacles. Long tentacles produce the sticky mucilage that captures prey while shorter tentacles produce digestive enzymes and absorb nutrients. The long tentacles are able to detect animal prey and following a period of stimulation, collapse, drawing prey in to the digestive glands. This movement has only recently been discovered and is not yet fully understood.

All *Byblis* species have been observed with bugs of the genus *Setocoris* on them. Commonly referred to as Sundew Bugs, they are able to move about on the leaves without being trapped. The Sundew Bugs detect the movement of struggling prey as a spider would prey in its web. When the prey has weakened enough, the Sundew Bug spears it with its proboscis and feeds on its insides. The Sundew Bug then deposits its droppings on the plant's leaf, fertilising the plant.

Albany Pitcher Plant (*Cephalotus follicularis*)

A truly unique Australian plant, *Cephalotus follicularis* is not only the only member of the genus but the family Cephalotaceae. It forms a pitcher trap with a lid to prevent rain from diluting digestive fluids. The mouth of the pitcher is lined with slippery teeth and the front and sides have ribs lined with hairs to aid crawling prey gain access to the trap. The inside of the trap below the rim has a collar to assist in prey retention and the lower, fluid filled digestive part is dark which is thought to help raise fluid temperature, therefore increasing rate of digestion.

The Albany Pitcher Plant has a close symbiotic relationship with a fly (*Badisis ambulans*) who's larvae develop in the pitchers, feeding on captured prey and therefore fast-tracking the digestive process. The





Cephalotus follicularis pitchers lined up and awaiting their insect prey.

presence or absence of these insects can affect whether the plant invests energy in pitcher production as opposed to leaves.

Sundew (*Drosera* spp.)

The Sundews, the largest group of carnivorous plants in Australia, are incredibly diverse from small annual rosetted species with touch sensitive trigger tentacles to ancient very long-lived perennial alpiners. There are tuberous species in the south west that can reach 3 m in height, pygmy species with special propagules called gemmae, and strange hairy globous plants able to withstand searing heat and fire, and even a few rainforest specialists.

All the sundews produce leaves with sticky tentacles that are highly mobile. When prey comes into contact with one or more tentacles, the movement of the prey stimulates movement of tentacles and, in some species, the entire leaf, to bend and envelop the prey. The strategy is simple: the more tentacles in contact with the prey, the faster the digestion process.

Some species have highly mobile unifacial marginal glands that are not sticky but at their ends, a sensitive pad detects the footsteps of the tiniest insects. One species, *Drosera glanduligera*, is able to flick





the prey into the centre of the leaf where the sticky glands await. This happens faster than the blink of an eye!

The *Drosera* of the section *Arachnopus* have unusual eglandular appendages of various shapes and sizes. In *Drosera hartmeyerorum* these may attract prey as they refract light and appear to glow,



Above: *Drosera burmannii* has rapid moving elongated unifacial marginal glands that have bent over to press the thorax of the saw fly.



Left: *Drosera ordensis* is one of a number of tropical species commonly referred to as the *Petiolaris* complex. It is able to withstand fire.





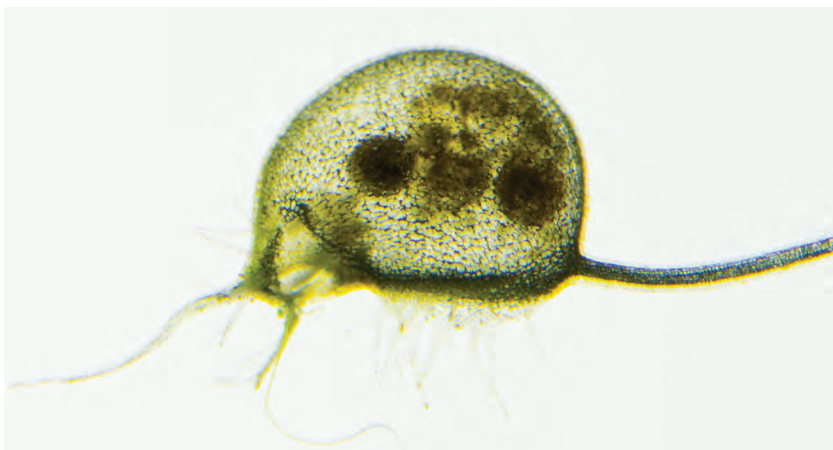
particularly in the morning and afternoon sun. Others may be visually attractive or release scent to attract prey or pollinators. Further research is required to unlock the secrets of these unusual glands.

Like the Rainbow Plants, many sundew species have close associations with Sundew Bugs. We understand very little about how much some species benefit from this association but given that both Sundews and Sundew Bugs can be found together all over Australia, it suggests the relationship is important to both.

Drosera hartmeyerorum

Bladderworts (*Utricularia* spp.)

Sharing a common ancestor with the carnivorous sticky leafed Butterworts (*Pinguicula* spp.), the Bladderworts are considered the most recently evolved of all carnivorous plants. The tiny bladder traps are not commonly noticed, being borne below the substrate in many terrestrial species, and all are just a few millimetres across. The trap has a hinged door with trigger hairs near its opening. The body of the trap pushes water out through the cell walls to create negative pressure and when prey (usually protozoa and rotifers but as large as mosquito larvae) comes into contact with a trigger hair, the door caves in, water is sucked into the trap and the door snaps shut – all in as little as 10



The tiny bladderwort trap with door to the left and prey inside





milliseconds. During this time, the prey can be accelerated as much as 2800 times that of gravity. To put it in perspective, if a human was accelerated at such a rate, it would be killed.

Despite the incredible highly evolved trapping mechanisms of the Bladderworts, it's the flowers that impress most of us with many species flowering en masse when conditions are favourable. The array of flower colours and shapes is also impressive, yet little is known about many of them. Many species have only recently been described including six in 2018 alone.

Bladderworts can be found across much of Australia from artesian springs of the desert country, granite outcrops in the south west, right across the top end and even in the alps. They are terrestrial or aquatic and all require unpolluted water for survival.



Some of the floral diversity seen in Australian Bladderworts. Clockwise from top left; *Utricularia fulva*, *U. menziesii*, *U. dichotoma*, *U. dunstaniae*, *U. chrysantha*, and *U. holtzii*





Climbing Pitcher Plants (*Nepenthes* spp.)

Made famous by the rat eating *Nepenthes rajah* of Borneo, the liquid filled traps of these plants while effective killers, do not target large prey, instead favouring small, easily digested insects. The trap, or pitcher is formed at the end of a tendril and either positioned on the ground or in the air if the tendril is able to twine around surrounding vegetation. It has a lid which prevents rain from entering and acts as a landing platform for flying insects. On the underside, special glands secrete nectar used to attract prey. The rim or peristome at the opening of the trap is a highly evolved, slippery when wet surface beneath which lies the partially filled body. Above the fluid line, flaky wax plates prevent escape while below, digestive glands secrete enzymes and draw in nutrients. On the front side of most lower pitchers, wings aid access for crawling insects.



The sweet nectar produced by the climbing pitcher plant (*Nepenthes mirabilis* x *rowaniae*) can clearly be seen on the underside of the lid.





Climbing Pitcher Plants are known to have some of the most incredible relationships with animals the shrews and rats in Borneo using some as toilet bowls, one is home to a species of bat which roosts inside the pitcher of *Nepenthes hemsleyana* while the hollow tendrils of *Nepenthes bicalcarata* are home to species of swimming ant, *Camponotus schmitzi*. The pitchers of the Cape York endemic *Nepenthes rowaniana* are large and therefore possibly have an association with an animal but this is yet to be discovered.

In Australia, climbing pitcher plants are restricted to the swamps and river banks of the Cape York Peninsular with *Nepenthes mirabilis* extending as far south as Babinda, South of Cairns.



Drosera subtilis,
Theda Station





The diversity of Australian *Drosera*

Richard Nunn

Richard Nunn is a senior executive in the financial services sector. He has been a passionate naturalist for over 40 years, since growing up in the bushland of the Adelaide Hills. His primary interests are carnivorous plants and Triggerplants and this hobby has taken him around Australia and the world to photograph and record these amazing plants in their natural habitat. Richard has co-authored several books on carnivorous plants and has been published in many journals. He is the Vice President of the International Carnivorous Plant Society.

The *Drosera* genus is a large and diverse genus of sticky-leaved insect-eating plants commonly known as the sundews. They lure, capture and digest insects using stalked mucilaginous glands present on their leaves. The insects are used in this way to supplement the poor mineral nutrition of the soil in which the plants grow. There are approximately 250 described taxa globally and more are being described regularly. *Drosera* are found on every continent except Antarctica, from where only fossil pollen records exist, and in most countries of the world, with the greatest species diversity found in the Southern Hemisphere. The overwhelming majority of *Drosera* species that occur in the Southern Hemisphere do so within Australia, which is home to over 160 species.

Outside of Australia, most species of *Drosera* are generally considered to be plants of swamps and peat bogs. In Australia, this is far from the case for the majority of species. Australia is a vast continent that has many varied habitats and climatic conditions that have impacted the evolution and survival strategies employed by its flora. The southwest region of Western Australia has a Mediterranean climate, experiencing a hot, dry summer. It is in these almost desert-like conditions that many *Drosera* are able to survive and actually thrive, taking advantage of seasonal rainfall through a remarkable variety of means. The majority of all Australian *Drosera* are found in the southwest of Western Australia, however,



Drosera barbigera





Drosera exist in all Australian states and territories, and have evolved to thrive in a wide range of habitats and climates. The *Drosera* of Australia fall into a number of groups, as outlined below.

Pygmy *Drosera*

There are currently 53 species of Pygmy *Drosera* known to science, with 52 of these endemic to the south west corner of Western Australia, and *Drosera pygmaea* the exception. These amazing plants are the tiniest members of the genus *Drosera*, yet their diminutive size should not hide the sophistication of their ability to self propagate and their efficiency in catching prey. Pygmy *Drosera* differentiate themselves from other members of the *Drosera* family in two ways: firstly they reproduce asexually via gemmae, small buds produced in the centre of the plant that are an exact clone of the parent; and secondly they produce stipules at the base of each mature leaf, and these stipules form a tight bud that protects the plant during summer dormancy. The growth cycle of Pygmy *Drosera* revolves around the arrival of the first autumn rains. Most species spend the harsh summer in dormancy and with the arrival of rain send down fresh roots and start producing carnivorous leaves to replenish the plant with nutrients. As winter arrives, and with it cooler temperatures, the plant begins to form gemmae, which are dispersed by the rain. These gemmae in turn send out roots and form an identical clone of the parent plant. As spring arrives gemmae production ceases and the plants produce flowers, many of which are spectacular and large for the size of the plants. Seed is another means of reproduction, ensuring the survival of the plants.

Tuberous *Drosera*

Australia is home to the majority of species of Tuberous *Drosera*. These plants have adapted superbly to survive the extreme heat and lack of rainfall of the Australian summer by producing a fleshy tuber to which the entire plant dies back. The plants will break dormancy at the same time each year and this is timed to coincide with the first rains and a drop in temperature but is not dependent on it. The plants may emerge from the soil before any rain but the onset of the first winter rains causes the plants to begin to grow rapidly, sending out carnivorous leaves and trapping prey to replenish the plant with nutrients. Some species of Tuberous *Drosera* flower at the start of the season and others at the end of the season. In many cases the flowers have a delicate perfume like aroma. As the rains dry up and the temperatures start to increase the plants begin to dry out and turn black as they recede onto their tubers. There are four basic forms of Tuberous *Drosera*: climbing, erect, rosette forming and fan leaved.





Drosera purpurascens



Drosera falconeri

Petiolaris Complex *Drosera*

Across the far north of Australia ranging from the Kimberley in the west, across Darwin and through to Cape York, a most unusual group of *Drosera* have evolved. These are the *Drosera* of the Petiolaris Complex, so named as for many years the only known species was *Drosera petiolaris*. But in the past 30 years many more closely related species have been discovered as Australia's top end is explored. The climate in the north of Australia is quite different to that of southern Australia, as temperatures are on average much warmer, and there are two distinct seasons, the wet season and the dry season. The Petiolaris Complex have adapted their growth cycle to take advantage of the warm moist conditions of the wet season and to survive the harsh baking hot conditions of the dry season. Similar to Tuberous *Drosera*, the Petiolaris Complex die back during the dry season but their survival strategies are quite different. Some of the species develop a dormant bulb of old fleshy leaves that sit just below the soil, while others have petioles that are covered with dendritic hairs, the accumulation of which protects the growing bud, which is positioned at the soil level. These hairs also provide a mechanism for trapping precious moisture produced by morning dews.

Perennial *Drosera*

In coastal swamps, *Drosera* occur in open or semi-open, seasonally wet sand or silt amongst scrub and grasses, occupying the wetter areas in full sun to part-shade. Swamp habitats exist in parts of Australia, such as far northern coastal Queensland or the south west coast of Western Australia.





Alpine *Drosera*

Drosera are rare in true alpine habitats, but a number of species occur in sub-alpine wetlands, habitats that are characterised by a prevalence of water variably derived from rain or from the melt-waters of glaciers or snow in adjacent higher elevation zones. The elevations at which they occur are fairly close to sea level at high latitudes in southernmost Tasmania, or higher altitudes in the Victorian Highlands. Low temperatures for much of the year may limit periods of growth to the short summer months, and conditions year round can be harsh, with frequent inclement weather. Cushion plants like *Donatia* spp. are a common feature of sub-alpine and alpine bogs.



Drosera muretii, an alpine species endemic to Tasmania.

Fork leaved *Drosera*

Seepages and flushes are habitats where a seasonal or perennial water source fed by rain or springs steadily emerges to wash over an area of habitat, usually overlying impermeable rocky escarpments. The term 'seepage' generally refers to sloping sites associated with hill sides, cliffs and river banks, while the term 'flush' refers to more or less flat, valley-floor sites. Such water sources are vital to sustaining many species of *Drosera*. It is in these conditions that the fork leaved *Drosera*



have evolved and they can be found in the south west corner of Western Australia, the coastal areas from Adelaide through Victoria and right up the east coast to Fraser Island in Queensland.

Drosera schizandra





Rainforest *Drosera*

Few species of *Drosera* are found in rainforests, where the relatively low light conditions and high surface humidity are assumed to be sub-optimal for growth and the flypaper trapping mechanism employed by all *Drosera*. However, three species of *Drosera* from Australia are endemic to rainforest areas in the vicinity of Cairns in northern Queensland growing mainly in deep shade.



Drosera aquatica

Tropical annual *Drosera*

In the seasonally dry regions of northern Australia, a pronounced dry season occurs from approximately April through to November. There, annual *Drosera* species grow in open, seasonally wet savannah characterised by often sclerophyllous scrub including melaleucas. They grow in these scrublands amongst grasses on acidic, riverine silt often overlying sandstone at 10–20 m elevation. The annual species of *Drosera* have evolved a dramatic strategy to survive in areas of extreme climatic challenges without expending energy to produce specialised adaptations such as tubers or resting buds. Instead, the entire life cycle of the plant is condensed into one year; they grow rapidly, flower and quickly set often copious amounts of seed before the onset of dry conditions. In this way, they regenerate from year to year through seeds that lie dormant in the substrate and germinate when conditions improve.



Temperate annual *Drosera*

In southern Australia, the summers are harsh and one species of *Drosera* has evolved away from producing tubers or stipule buds to survive, and grows as an annual during the winter and spring months.

Drosera glanduligera





Pygmy Sundews – Dwarf Stars of the Genus *Drosera*

Alastair Robinson

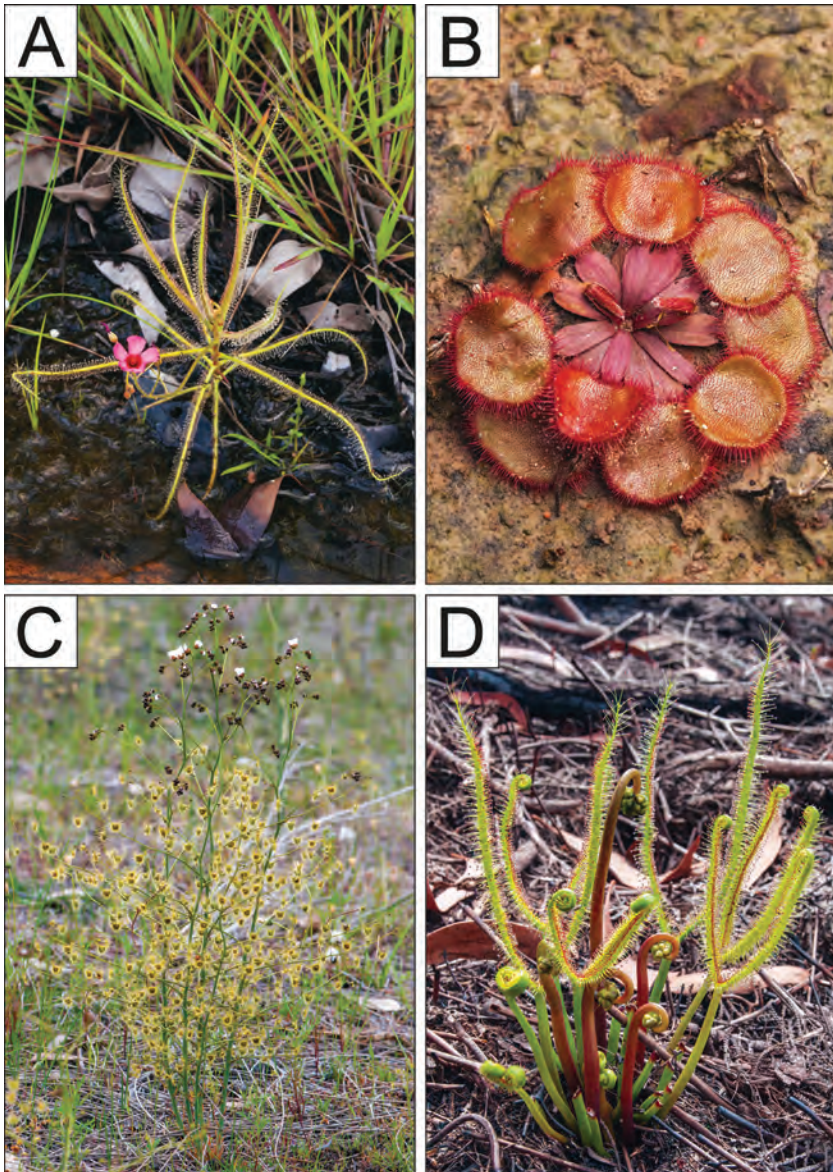
Alastair is a botanist and author specialising in the tropical pitcher plants (Nepenthes) and other carnivorous plant genera, including Drosera, as well as terrestrial orchids. Alastair has a BSc in plant pathology (University College London) and a PhD for his research into the molecular controls that govern plant development (University of Cambridge).

Known by the common name “sundew”, *Drosera* is a large and remarkably diverse genus of sticky-leaved insect-eating plants that lure, trap and digest insects via specialised mucilaginous glands present on their leaves. This genus of around 245 described species has a more or less cosmopolitan distribution, ranging from the sub-polar regions of both hemispheres to sub-alpine habitats and the tropics. However, it is in the harsh, seasonally-dry regions of the Southern Hemisphere where this genus is at its most diverse, being particularly abundant in the sub-tropical to temperate regions of Australia, South Africa and central eastern Brazil.

Australia is the centre of diversity of *Drosera*, with over 160 species documented from the country to date. They are found on various types of nutrient-poor, typically acidic soils that are invariably wet during the growing season. Given that *Drosera* occupy a diverse range of habitats across the country, subjecting the plants to very different seasonal conditions, adaptive specialisations are numerous and diverse, including annual and perennial life cycles, the production of resting tubers or asexual reproductive bodies, as well as myriad plant forms that range from upright or climbing stems – as much as 3 metres long – to ground-hugging rosettes, or even branching, tree-like sub-shrubs. Not surprisingly, given their widespread occurrence and striking appearance, *Drosera* were prominent in the first collections of botanical specimens made from Australia by western scientists, including the pre-eminent botanists Joseph Banks and Robert Brown, who sailed with Captain James Cook and Matthew Flinders, respectively.

Drosera are not simply fascinating because they are carnivorous – or, more accurately, insectivorous. They include some extraordinarily beautiful forms. This beauty may be reflected in their flowers, as in the large, *Cistus*-like blooms of some South African species, but is equally apparent in their foliage. This is particularly true of the substantial, upright or ground-hugging growths of many tuberous species; in the





Examples of morphological variation in *Drosera*. A: *Drosera fragrans* (A. Robinson); B: *D. falconeri* (A. Robinson); C: *D. gigantea* (R. Nunn); D: *D. binata* var. *dichotoma* (G. Bourke).

long, elegant leaves of Australia's sub-tropical and tropical 'spider-leaved' sundews; and in the tiny (about 1 cm in diameter), nonetheless deadly, perfectly formed rosettes of the pygmy sundews.





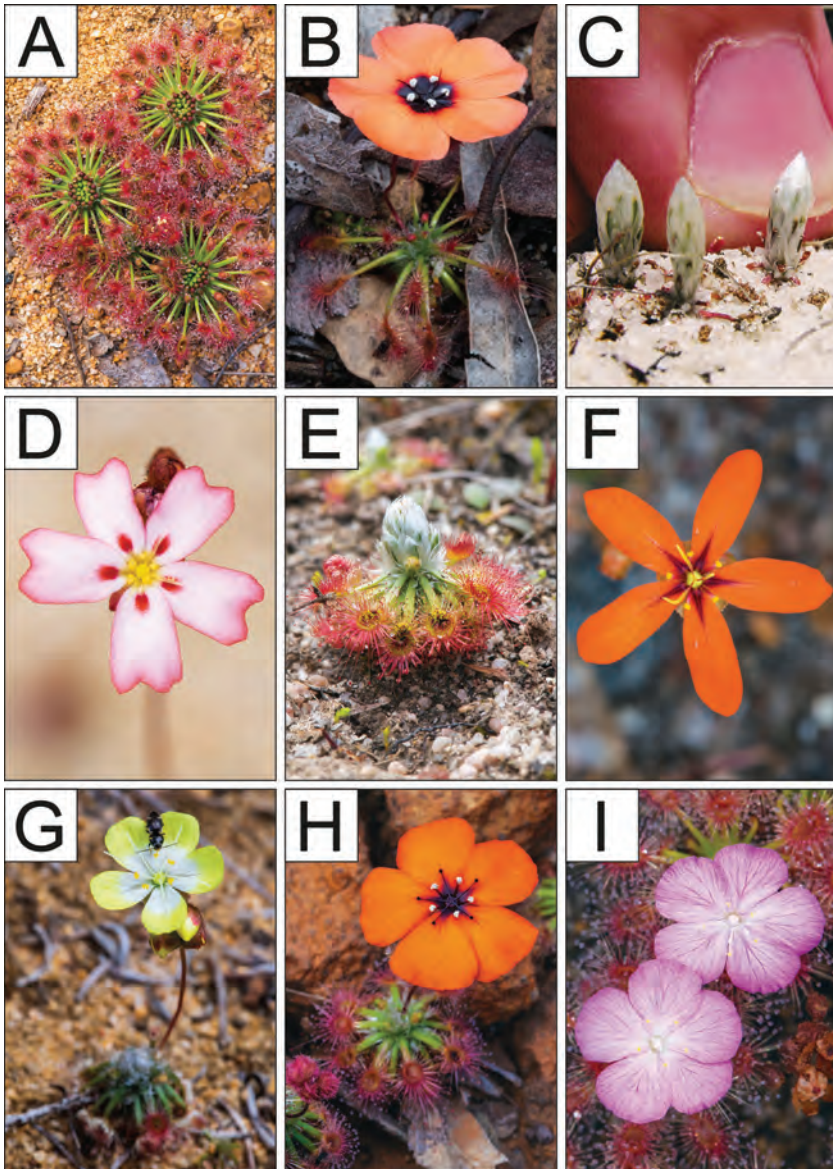
Pygmy *Drosera* evolved in the Kwongan shrublands of Western Australia, a region which supports the largest number of *Drosera* species in the world. This extensive, geologically and climatically stable zone of severely phosphorous-impoverished soils also accounts for one quarter of the area of the Southwest Australian Floristic Region, and hosts that region's most species-rich vegetation, including about 70% of the 8,000 species recorded there (in contrast with the 13,000 total native species recorded from all of Western Australia). The carnivorous plants that have evolved in the Kwongan are so specialised to nutrient-deficient soils that some species no longer even possess the enzymes required to take up soil-bound nitrates from the ground!

The pygmies form a taxonomic group known as *Drosera* section *Bryastrum* (referring to the starry, moss-like appearance of their rosettes, which can form dense colonies that give rise to impressive drifts of colour across the ground), a group well-supported by shared morphology and genetic data alike. The one exception is a curious, ancestral pygmy species from South America, *D. meristocaulis*, which is found on the summit of Pico da Neblina, Brazil's highest mountain, situated on the border of Brazil and Venezuela. This species, which forms its very own section, is basal to all other pygmies and is thought to be a relict of a common ancestor that arrived in South America via long-distance dispersal long ago. The remaining 'true' pygmy *Drosera* are virtually all endemic to southwestern Western Australia, again with one exception, *D. pygmaea*, which is found across the southern temperate coast of Australia as well as in New Zealand.

With 53 described species, the pygmy *Drosera* are the largest group of sundews in Australia, and therefore represent the majority of known sundew species worldwide. This group, like the tuberous *Drosera*, is specialised to survive pronounced summer droughts. This is achieved not through subterranean storage organs, but through the presence of large, desiccation-tolerant stipule buds in the centre of their rosettes. Moreover, they reproduce prodigiously through asexual means to maximise survival success. This occurs not through the production of offsets or stolons, but through the generation of gemmae, which are specialised, clonal, modified leaf propagules that are, each winter, dramatically catapulted by the springy stipules of their parent plants to germinate nearby, prior to the production of leaves and flowers.

What pygmy *Drosera* lack in terms of plant size, they more than make up for in terms of floral exuberance. Their plant to flower size ratio can be very large and, with respect to overall plant size, they produce what are proportionately the largest blooms in the genus, with many species





A: *Drosera barbigera* with gemmae (R. Nunn); B: *D. barbigera* (A. Robinson); C: *D. leioblastus* stipule buds (A. Fleischmann); D–E: *D. eneabba* (R. Nunn); F: *D. leucoblasta* (R. Nunn); G: *D. citrina* with pollinator (A. Robinson); H: *D. sewelliae* (A. Robinson); I: *D. gibsonii* in cultivation (G. Bourke).

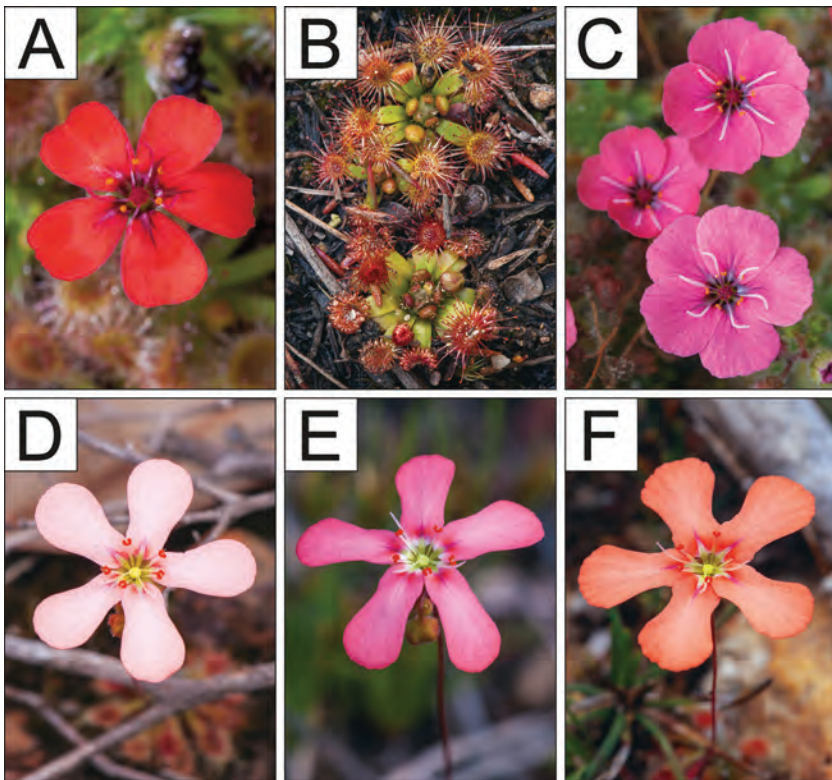
in nature forming extraordinary carpets of impossibly tiny, sparkling rosettes truly dwarfed by their massed flowers.





The largest blooms recorded amongst pygmy *Drosera* are produced by three different species found in the regions surrounding Perth, all coincidentally producing orange flowers: *D. leucoblata*, *D. albonotata* and *D. sewelliae* produce flowers of 2.5–3.5 cm in diameter, differing most obviously in petal proportions, colouration and shape. These species are part of a group of 12 known species that produce orange flowers, many of which have a metallic lustre when viewed beneath direct sunlight, not to mention the presence of eye spots or other unusual colouration.

The flowers of pygmy *Drosera* occur in the widest range of colours in the genus within Australia, the only comparable zone elsewhere being the Western Cape region of South Africa. In both areas, noted for their extraordinary displays of seasonal wildflowers, the evolution of diverse flower forms and colours within plant families is thought to have been driven by the competitive selection pressures of pollinator floral preference.



A–B: *Drosera pulchella* ‘red’ (A. Robinson); C: *D. pulchella* ‘pink’ (G. Bourke); D: (R. Nunn) and E–F (A. Robinson) *D. walyunga* colour forms.





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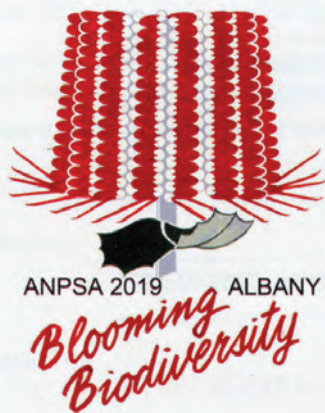
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ANPSA Biennial Conference Albany, Western Australia 29 September – 4 October 2019



Every two years the Australian Native Plants Association (Australia) (ANPSA) holds a national conference, which is organised by one of its member Societies, at a different location around Australia. These conferences afford members the opportunity to meet members from other states, and learn about the native flora of different regions of Australia. The program usually comprises a series of lectures by expert speakers relating to Australian native flora interspersed with field trips to gardens and natural areas.

Other features of the Conference program are guided pre- and post-Conference tours, which allow participants to experience the diversity of the flora of the host State and are usually 5 days duration.

The *Wildflower Society of Western Australia* is hosting the 2019 Biennial Conference in Albany, W.A., from 29 September to 4 October 2019. The theme of the conference is 'Blooming Biodiversity'.

Blooming Biodiversity will feature lectures and workshops delivered by leading botanists. Keynote speaker Greg Keighery will head a panel of experts in their field. Professor Stephen Hopper will present the AJ Swaby Address. The conference also offers a range of guided tours before and after the conference, giving you the opportunity to experience the flora and scenery of Western Australia up close.

Further information about the conference can be found on the Wildflower Society of Western Australia's website at:

www.wildflowersocietywa.org.au





of all carnivorous plants, with a natural diversity of flower colour and form that rivals many horticulturally desirable plant genera. Though most pygmy *Drosera* hybrids are sterile, preventing the creation of novel colour forms, the sheer diversity presented by this group would satisfy many specialist gardeners. That said, one species, *D. pulchella*, may produce flowers of pink, lilac, red, white or orange, often with maroon or black colouration at the base. The fertile crosses of this easy to grow pygmy present a tantalising starting point for experiments in hybridisation for ornamental purposes.

Pygmy *Drosera* are popular subjects amongst growers of carnivorous plants and, though some species are challenging and very exacting in their requirements (none of which are more challenging to grow than any intermediate-difficulty Australian native orchids), many are very forgiving in cultivation, flowering freely and making impressive displays in pots that rival any potted alpine flower display.

The cultivation of pygmy *Drosera* is by no means the sole domain of gardeners with a taste for novelty; responsibly sourcing and cultivating species of known provenance serves to increase the resilience of *ex situ* populations, maintaining the biodiversity of a group of native species that are naturally very rare in nature, whether historically or as a result of anthropogenic changes to the environment.



A pot of *Drosera lasiantha* in flower (G. Bourke).





The substantial flower of *Drosera albonotata* (A. Robinson).

An example is the widespread cultivation of *Drosera oreopodion*, known from just one population of plants scattered across just 20 square metres of a small reserve in the Perth suburbs. Half a dozen other species are known from just two or three small sites, and *D. albonotata* – described only in April 2018 despite being one of the largest-flowered species – is now known from just six sites, two previous collection sites having been lost to farming and residential development. Trends of clearing in the Avon wheatbelt region have made it one of the most cleared regions in the southwest of Western Australia, with about 97% of all native vegetation now cleared. Ongoing habitat loss and degradation therefore represent very real threats to many of the species endemic to the region.





***Drosera binata*: The Forked-leaved Sundew**

Robert Gibson

Robert has been growing and studying carnivorous plants for more than 35 years and has a particular interest in the genus Drosera, a cosmopolitan genus that is most abundant and diverse in Australia.

The Forked-leaved Sundew (*Drosera binata*: Droseraceae) is a robust and distinctive sundew with semi-erect linear petiolate leaves in which the linear leaf branches dichotomously at the junction with the petiole. Each leaf blade may dichotomously divide several more times (like the leaves of *Gleichenia* ferns, with which it often grows). It is native to wetlands and seeps of the coast and tablelands of south-eastern Australia (Rockhampton to Kangaroo Island), much of Tasmania, a few peaty wetlands on the south coast of Western Australia, and throughout New Zealand.

Drosera binata grows during the warmer months of the year. The leaves are arranged loosely in a rosette and arise from a growing point at the ground surface from which a network of a few thickened roots extend into the substrate. One or sometimes a few scapes emerge from some growing points during the summer. The scapes are erect and have a cymose arrangement of up to 50 white, rarely pink-blush flowers to 3 cm



Drosera binata 'T-form' plants backlit in the wild near Glenelg, Victoria.





across. Each flower is open for a few hours during a single day. Leaf production finishes by late autumn when plants experience a period of dormancy.

Three informal forms of the Forked-leaved Sundew have been recognised based on plant stature, habit, plant colour and typical leaf division. They are native to different parts of Australia.

Drosera binata 'T-form' is the smallest variant. It has semi-erect leaves to about 20 cm tall with a leaf blade that usually forks once; but may occasional fork two or three times to produce leaves with up to 8 terminal lobes. The leaf blade at the junction with the petiole is up to 2 mm wide. Most parts of the plant may develop a deep red colouration. The flowers have white petals and glabrous sepals. This taxon is self-compatible and readily sets a lot of seed.

This variant is native to coastal peaty wetlands of south-eastern Australia, particularly from Kangaroo Island to the south coast of New South Wales. It occurs throughout Tasmania and is found in a few wetlands on the south coast of Western Australia where it is listed as a 'Priority Two' threatened plant.

Drosera binata 'var. *multifida*' has leaves typically to 40 cm. The leaf blade at the junction with the petiole is no more than 2 mm wide and can



Drosera binata var. *multifida* with leaves with up to 10 terminal lobes.





span 30 cm across. It may divide many times; although not always uniformly, and can have up to 56 terminal lobes – although most have between 8 and 20. The leaves tend to flop, and require other plants to support them.

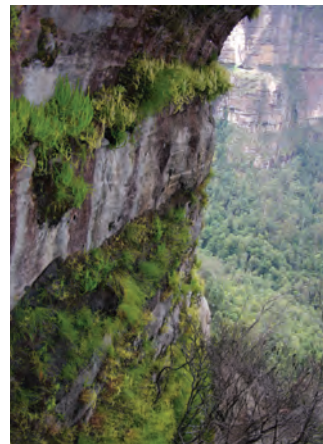
Thus the leaves tend to grow through the mass of other plants and open their blade on the surface of the vegetation. The flowers in this form are up to 2 cm across, have glabrous sepals, and typically have white



Pink-flowered forms of *D. binata* 'var. *multifida*' are rare in nature, but readily available in cultivation. Pigment colour is strongest when the flowers are in bud.

petals, but plants with pink-blush petals occasionally occur. The flowers of this variant tend to be self-incompatible, and they tend to set seed after mass flowering events that usually follow disturbance, such as bushfires, in their native habitat. This variant is found on the coast and tablelands between about Taree in New South Wales and Rockhampton in Queensland. It commonly grows in wetlands in wallum heathland.

Drosera binata 'var. *dichotoma*' is found in sandstone seepages on sandstones of the Sydney Basin, and in wallum heathland on the mid north coast of New South Wales. Plants of this variety typically have a bright yellow-green pigmentation, leaves that are usually 2 to 4 mm wide at the junction with the petiole. They have fragrant flowers with white petals and hairy sepals.

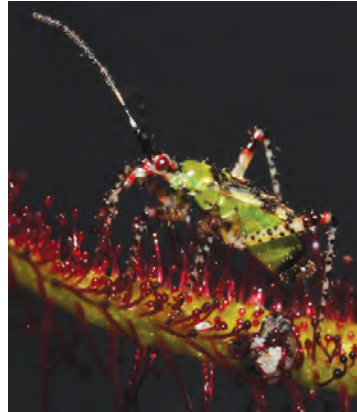


Drosera binata 'var. *dichotoma*' unfolding leaf, and in habitat in seeping sections at Blackheath, New South Wales.





Flowers of *D. binata* 'var. *dichotoma*' are large and sweetly scented.



Drosera Bug (*Setocoris* species) on a leaf of *D. binata* 'var. *multifida*' from a plant grown at Coffs Harbour, New South Wales.

The petioles grow to 30 cm long, and the leaf blade is variably dichotomously divided usually with between two to eight terminal lobes. Some of the larger leaves are up to 30 cm across, and may have up to 18 terminal lobes. Plants of this taxon are self-incompatible, and usually flower en masse after bushfires. This sundew is a spectacular element of wet cliff faces in the upper Blue Mountains where it can contribute to over 50% of the vegetated surface.

Leaves of *D. binata* are often home to Drosera bugs (genus *Setocoris*: *Hemiptera*). These omnivorous insects walk with impunity over the sticky leaves and feed on trapped prey – often while they are still alive and rendered immobile on the leaf. They are also known to feed on sap of the leaf.

Drosera binata is easy to grow in temperate and sub-tropical Australia. The main requirements for this sundew are for a low nutrient, acid growing medium that is permanently wet; high humidity; and for exposure to bright light. Plants do well in an equal mix of sphagnum peat moss and quart sand, in a pot at least 15 cm in diameter and width, which sits in a saucer of water, and is exposed to several hours of direct sunlight. Rainwater is ideal to use on these plants, but the low salt content of water in most major cities will also work, so long as the pots are flushed periodically to remove salt build up.

This sundew grows readily from seed, particularly if started in spring and it is possible to raise plants of *D. binata* 'T-form' to flowering in less than one year. Over time plants produce multiple growing points and they may be divided and placed in their own pots. This process may

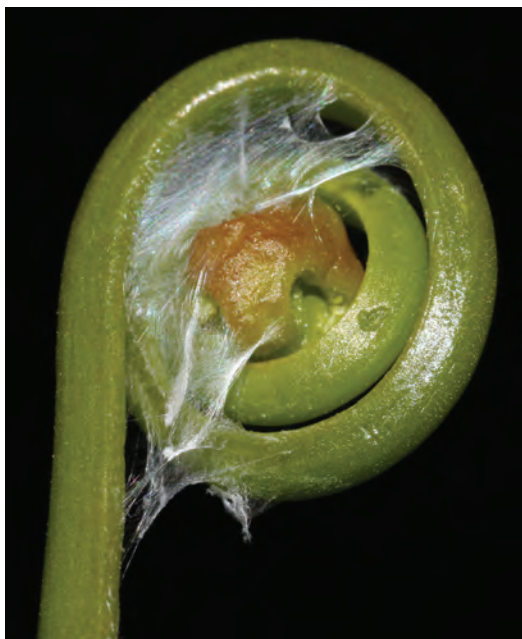




be enhanced by harvesting sections of root, which are cut into sections about 3 cm long that are buried just below the surface of a part-sand mix. New plants may also be raised from leaf cuttings – where leaf sections about 3 cm long are floated on the surface of clear fresh water, or where the segments are partially buried in sphagnum moss – all in a well-lit environment.

Caterpillars and aphids may trouble plants at times. Small numbers of these pests can be controlled by wiping the affected areas with the surface of active leaves of the same plant – to turn herbivores into prey. Bad infestations of pests may be treated by submerging the plant fully in water for several hours, or complete defoliation of affected leaves as these vigorous sundews will readily produce new leaves. Persistent attack by pests suggests that the plants are not in optimum conditions, and so they would probably benefit from a move, particularly to sunnier, or more humid, or both, conditions.

The pendulous to semi-erect nature of the leaves of *D. binata* 'var. *dichotoma*' and 'var. *multifida*' make them great subjects for hanging pots. In late spring they send out a large number of leaves to quickly fill the space around the pot. This means that in autumn most of those leaves will die and these dead leaves can be removed to help tidy up the pot.



In summary, the Forked-leaved Sundew is a wonderful native carnivorous plant that is robust and attractive. There are three basic types, all of which are worth growing and add interest to a garden collection. They are also beautiful and captivating to see in the wild.

Caterpillar predation of an unfurling leaf of *D. binata* 'var. *dichotoma*' in cultivation. The caterpillar on the leaf became plant food shortly after the photo was taken.





Australia's tropical pitcher plants

Charles Clarke, Adjunct Senior Research Associate, James Cook University

The tropical pitcher plant genus *Nepenthes* comprises 100–160 species, most of which occur in Southeast Asia, with outlying species occurring on several Indian Ocean islands, India, New Caledonia, Palau and Australia. They are almost exclusively tropical plants, but many species occur on high mountains which, despite being close to the equator, experience relatively cool temperatures throughout the year. *Nepenthes* plants are typically vines which climb or scramble through adjacent vegetation, or occasionally small shrubs. The leaves have tendrils at their tips, which curl around objects to provide support for the climbing stem. The pitchers that make these plants so distinctive are produced at the tips of the tendrils. The role of the pitchers is to attract, trap, retain and digest animal prey to provide supplementary nutrition to the plant.

The size, shape and colour of the pitchers varies greatly among species, but all pitchers share the same basic components. The main part of the pitcher is a fluid-filled, bladder-like cup with an opening at the top, called the mouth. The edge of the mouth is typically lined with a ridge of hardened tissue called the peristome. Above the mouth is a lid, which is often brightly coloured and has many nectar glands. The lid typically plays two roles: excluding rainfall, and attracting potential prey animals to the pitcher. The peristome has a very complicated structure that renders it easy for insects to walk on when it is dry, but extremely slippery when wet. Visiting insects can never tell whether the surface is slippery or not until they are upon it, which makes the traps very effective at trapping prey (particularly social insects, such as ants), but only some of the time. This prevents animals from learning to avoid moving onto this structure and ensures that the trap mechanism – when active – cannot be bypassed. The inner surfaces of the pitcher are lined with fragile wax plates in the upper parts, which hinders the ability of trapped insects to escape, while the lower surfaces, which are often below the surface of the pitcher fluid, are lined with digestive glands.

Most *Nepenthes* plants are unimpressive and often rather ugly in appearance, but this deficiency is more than made up for by the incredible form and function of their pitchers, and this is why the genus has so many enthusiasts worldwide.

In Australia, *Nepenthes* occur only in Queensland, in the northern parts of Cape York Peninsula, and near Cairns. A large number of





Nepenthes mirabilis is usually quite dull but occasionally colourful pitchers can be found. Bamaga, Cape York.
Photo: Greg Bourke

species from Cape York were described by the government botanist, F. M. Bailey, in the late 1800s and early 1900s, but in 1928 these were all reduced to synonyms of *Nepenthes mirabilis* – a very widespread species in Southeast Asia – by the eminent Dutch botanist, B. H. Danser. That is how things stayed until the early 2000s, when Clarke and Kruger (2005, 2006) reinstated one of Bailey's species (*N. rowaniae*) and described a new species, *N. tenax*. More recently, Wilson and Venter (2016) described an additional Australian species, *N. parvula*. *Nepenthes rowaniae*, *N. tenax* and *N. parvula* are all endemic to Cape York Peninsula, and the taxonomic status of all of them is controversial. Each of these three species is distinguished from *N. mirabilis* on the basis

of minor morphological characteristics, the importance and stability of which is difficult to determine. In the field, the type forms of *N. rowaniae*, *N. tenax* and *N. mirabilis* may be quite easy to distinguish, but plants of intermediate appearance may also be abundant in some places. Whether these plants represent natural hybrids of two to three distinct parent species, or a continuum of morphological variation in a single, highly variable species is open to interpretation. More information about the differences among these three species can be found in Clarke and Kruger (2006). The status of *N. parvula* is highly controversial – it appears to be simply a small form of *N. tenax*, with no other clearly distinctive characteristics (Wilson & Venter 2016).

The taxonomic controversy that currently afflicts *Nepenthes* in Australia is a global problem. After decades of taxonomic conservatism, where minor morphological variations were not considered taxonomically informative, a major shift in approach has taken place over the last 15–20 years, and now almost any evidence of morphological variation can





be used to distinguish two or more geographically disjunct populations of *Nepenthes* as different species. An ongoing reliance upon qualitative morphological characteristics by taxonomists working on *Nepenthes* means that there is no firm support for the majority of recently-described taxa. Until a more objective and quantitative approach is adopted, this situation will persist. In the case of the Australian taxa, the best approach is to adopt whatever interpretation you are most at ease with – there is no ‘right’ or ‘wrong’.

All of the Australian *Nepenthes* taxa are in cultivation, but are rarely available for sale. They all grow in permanently wet, humid lowland swamplands in Far North Queensland and Cape York Peninsula. They will only succeed in cultivation if the physical aspects of their environment are accurately replicated. Meeting these requirements is not negotiable – the plants will quickly die in environments that are substantially different from their natural ones, and even in conditions that are only slightly sub-optimal, many are likely to slowly decline and die. They will not acclimatise to sub-optimal conditions over time. *Nepenthes rowaniae* is particularly fastidious and even in tropical climates it can be difficult to maintain in cultivation for more than a couple of years.



Nepenthes rowaniae upper pitcher left and lower pitcher right. Photos: Greg Bourke





Nepenthes tenax growing in swampy conditions north of the Jardine River, Cape York. Photo: Greg Bourke

Pots should be stood in saucers that are filled with water throughout the year, and this water should be changed regularly to keep it fresh, and to ensure that mosquitoes and midges do not breed in it. Pot size should be correlated with the depth of the root system – when the plant is removed from its previous pot, wash off most of the old mix to expose the delicate roots (try not to damage them too much), and select a new pot that is about 15–25% deeper than the longest roots. If the new pot you require is taller than 250 mm, consider placing a smaller, upturned pot in the bottom, to create a large air pocket inside the compost. If you choose to do this, you should ensure that the upturned pot is as large as possible, but simultaneously small enough to allow the rhizome and root system of the plant to sit stably in the mix above it. The space between the walls of the upturned pot and the main pot should be filled with coarse material, such as pebbles or large expanded clay pearls, along with three to four columns of sphagnum moss, which run from the base of the pot up to the main bed of potting mix. These provide a ‘wicking effect’, conducting water from the saucer below to the potting mix, while the coarse material enhances drainage and provides additional air pockets. The root systems of *Nepenthes* appreciate very moist air spaces in their mix, but they quickly die in saturated mixes that lack air spaces.

The best medium for growing these plants is a mixture of peat and coarse sand, to which additional larger objects, such as coarse perlite and/or





expanded clay pearls, may be added to improve drainage and create air pockets in the mix. Sphagnum can be integrated into the mix in small quantities, but it rarely grows well in lowland tropical environments, and often decays quickly. Large orchid bark chips can also be used in limited quantities, but it is best to avoid chips derived from coconut, as these also decay quickly. I prefer to avoid using charcoal, as it tends to accumulate salts and other chemicals, although most *Nepenthes* do not seem to be too fussy about this.

Pots should be stood in saucers that are filled with water throughout the year, and this water should be changed regularly (to keep it fresh, and to ensure that mosquitoes and midges do not breed in it). Pot size should be correlated with the depth of the root system – when the plant is removed from its previous pot, wash off most of the old mix to expose the delicate roots (try not to damage them too much), and select a new pot that is about 15-25% deeper than the longest roots. If the new pot you require is greater than 250 mm, consider placing a smaller, upturned pot in the bottom, to create a large air pocket inside the compost. If you choose to do this, you should ensure that the upturned pot is as large as possible, but simultaneously small enough to allow the rhizome and root system of the plant to sit stably in the mix above it. The space between the walls of the upturned pot and the main pot should be filled with coarse material, such as pebbles or large expanded clay pearls, along with 3-4 columns of sphagnum moss, which run up from the base of the pot up to the main bed of potting mix. These provide a ‘wicking effect’, conducting water from the saucer below to the potting mix, while the coarse material enhances drainage and provides additional air pockets. The root systems of *Nepenthes* appreciate very moist air spaces in their mix, but they quickly die in saturated mixes that lack air spaces.

The best medium for growing these plants is a mixture of peat and coarse sand, to which additional larger objects, such as coarse perlite and/or expanded clay pearls may be added to improve drainage and create air pockets in the mix. Sphagnum can be integrated into the mix in small quantities, but it rarely grows well in lowland tropical environments, and often decays quickly. Large orchid bark chips can also be used in limited quantities, but it is best to avoid chips derived from coconut, as these also decay quickly. I prefer to avoid using charcoal, as it tends to accumulate salts and other chemicals, although most *Nepenthes* do not seem to be too fussy in this respect.

The habitats of Australian *Nepenthes* tend to be at least breezy, and often windy, and excellent air movement is another essential requirement





Nepenthes tenax in the Jardine River catchment.

for successful cultivation. Thus, if they are grown in an enclosure, it is necessary to circulate the air rapidly using a strong fan. Indeed, plants of *N. rowaniae* and *N. tenax* grow best when subjected to consistent breezes. The air also needs to be humid: humidity levels should not be allowed to drop below 50% for extended periods, and ideally should be kept above 70%.

The vast majority of wild *Nepenthes* in Australia grow in full sun all day. For cultivated plants to regularly produce good pitchers and strong stems and leaves, they should not receive any shade – 25% shade cloth is

the maximum level of shade that should be provided, and avoid using black or green material.

Outside the tropics, this combination of environmental conditions can be difficult and costly to provide. For this reason, anyone who intends to grow these plants well should either move to the tropics (if they haven't already), or instead consider growing exotic *Nepenthes* species and hybrids that originate from the highlands of Southeast Asia. Many of these will tolerate lower temperatures and are much more forgiving in sub-optimal environments. Many are readily available from reputable nurseries and are also easier to grow, and growing them reduces pressure on wild populations of *Nepenthes* in Australia.

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The Albany Pitcher Plant, *Cephalotus follicularis*

Richard Nunn

Richard Nunn is a senior executive in the financial services sector. He has been a passionate naturalist for over 40 years, since growing up in the bushland of the Adelaide Hills. His primary interests are carnivorous plants and Triggerplants and this hobby has taken him around Australia and the world to photograph and record these amazing plants in their natural habitat. Richard has co-authored several books on carnivorous plants and has been published in many journals. He is the Vice President of the International Carnivorous Plant Society.

Cephalotus follicularis, or as it is commonly known, the Albany Pitcher Plant, is a monotypic genus and is endemic to Australia. This extraordinary little plant is perhaps the most unique of all the world's carnivorous pitcher plants. It is the only monotypic family and genus of pitcher plant, and the only carnivorous plant in the rosoid clade of flowering plants. It is thus entirely unrelated to the pitcher plants of Nepenthaceae or Sarraceniaceae, and is indeed more closely related to cabbages, roses and pumpkins than it is to other carnivorous plants.



Cephalotus follicularis in its natural habitat near Albany. Plants form large rosettes, often at the base of shrubs or clumping sedges.





Cephalotus follicularis pitcher.

As such, the pitchers of the Albany Pitcher Plant represent perhaps the most astonishing example of convergent evolution amongst carnivorous plants, and one of the most interesting cases of evolution in the plant kingdom. This example of convergent evolution has arisen as a result of similar ecological limitations. The Albany Pitcher Plant inhabits coastal swamps with nutrient poor soils and thus has evolved to supplement its nutrient requirements with insect prey.

Botanical history

Specimens of *Cephalotus follicularis* were first collected in 1802 at King George Sound by naturalists, including the great botanist Robert Brown, on board Matthew Flinders' HMS Investigator. This plant was formally described in 1806 by French naturalist Jacques de Labillardiere.

Distribution

Only growing on the south west tip of Western Australia, the Albany Pitcher Plant inhabits a strip of coastal swamp land never more than 50 km inland and extending from Augusta at the easternmost point of its range to Cheynes Beach at its westernmost point.

Plant structure

The Albany Pitcher Plant is a low growing, perennial, rosette forming plant. The plant has a main woody tap-root that, over time, forms





Flowers of the Albany Pitcher plant are unimpressive but presented well above the plant.

branching rhizome-like structures from which new growth can be produced. This explains the dense clumps of older plants that are found in the field. It has two types of leaves: oval shaped green non-carnivorous leaves clustered at the centre of the plant and the pitchers themselves. When the plant regenerates from fire non-carnivorous leaves are the first produced followed by the pitchers. This tends to be the case with the normal growth cycle of the plant, with each new growing season commencing with the non-carnivorous leaves. The flowers of the Albany Pitcher Plant are small and unimpressive and are borne on a relatively tall scape, up to 60 cm, to get above the surrounding low lying vegetation.

Trapping mechanism

The Albany Pitcher Plant has a pitcher or pit-fall trapping mechanism, where prey falls into the pitchers that contain fluid, drowns and is absorbed by the plant. The pitcher mouth has a ring of sharp downward pointing teeth, below which is a collar overhanging the pitcher chamber. Prey is attracted to the nectar glands on the outer surface of the plant, peristome and underside of the lid. Once inside the pitcher there is no escape and the prey falls into the pitcher fluid and is broken down and absorbed by the numerous enzyme producing glands.

Habitat

The preferred habitat of the Albany Pitcher Plant is peaty swamps where it grows slightly elevated often at the base of tea trees or on small tussocks. The tea tree affords protection to the plants and its roots and the slight elevation ensures that the plant is not too wet. the Albany Pitcher Plant does not grow in all parts of the swamp and is generally found about half way between the highest part of the swamp and the lowest, which in some cases is a creek. The substrate may appear very dry, but at all times there is a constant seep of water not far below the surface and this gives the feeling of walking on a sponge. The Albany Pitcher Plant is a very successful plant in its range, growing





in great numbers and many sites. It is capable of withstanding fires and thrives in the direct light provided by the clearing effect of the fire, often being the first plant to reshoot. It can also survive for many years in deep shade covered by dense vegetation.

Cultivation

The following is a general guide only to cultivation of the Albany Pitcher Plant, which can be tricky to cultivate, but well worth the effort. In its natural habitat Albany Pitcher Plants can tolerate temperatures ranging from lows of 2°C with occasional frosts in winter and highs of 40°C in summer. They perform best in cultivation with more moderate temperatures between 5°C and 32°C. The Albany Pitcher Plant is native to coastal areas and, as such, experiences cooler nights and overall cooler conditions during the winter rest period. Extended periods of heat without a temperature drop will almost certainly result in the plant perishing.

The Albany Pitcher Plant is extremely sensitive to hard water, and using mains water with high mineral levels will likely kill the plant. Rain water or reverse osmosis water are recommended. Since the Albany Pitcher Plant has been in culture, over watering has been regarded as the main contributor to poor performance or death. The pot is best placed in a water tray in summer, but in autumn, winter and spring excessive moisture easily leads to rot, hence the plant should be watered from the top in those seasons and the media kept just damp.

Albany Pitcher Plants perform well in a variety of light conditions, from bright indirect light to full sun. The pitchers tend to be smaller and more brightly coloured in full sun while in shadier positions, the pitchers will grow larger and attain less colour. Albany Pitcher Plants grow well under artificial lighting in a tank or terrarium and the lights should be kept on for 14 hours during growth and 10–12 hours during the cooler rest period.

Albany Pitcher Plants require a well-drained media, poor in nutrients, and there is considerable variation in the substrate that growers use, ranging from the simple to the complex. This is an area that raises much debate amongst experienced growers. Some examples of media are pure sphagnum peat, one part peat to two parts sand, or half sphagnum and half peat with some sand added.

Albany Pitcher Plants can be subject to fungal attacks and at the first sign of this, treatment with a good quality fungicide is necessary. Air movement and good ventilation, combined with following the correct watering regime, will help prevent fungal attacks.





Capturing prey and imaginations: could carnivorous plants help us “prevent plant blindness”?

Laura Skates, Laura is a PhD candidate and science communicator

On reading the title of this article, you might be wondering: what is plant blindness and why do we need to prevent it? To answer that question, let me start by asking you a few: Are plants important? Are they interesting? Do they deserve conservation attention?

As a reader of the *Australian Plants* journal, I would guess that you answered yes, yes and yes. Unfortunately, it seems that not everyone would agree. Even though plants provide important habitat, food resources, ecosystem functions and human health benefits, they are often considered to be less interesting (Baird et al., 1984, Wandersee, 1986) and given less conservation attention (Martín-López et al., 2009, Havens et al., 2013) than animals. This bias against plants can have serious consequences not only for plants but for everything that relies on plants too. In order to begin addressing this issue, Wandersee and Schussler (1999) coined the phrase “plant blindness”, which they defined as:

- a) “the inability to see or notice the plants in one’s environment;
- b) the inability to recognise the importance of plants in the biosphere and in human affairs;
- c) the inability to appreciate the aesthetic and unique biological features of the life forms that belong to the plant kingdom; and
- d) the misguided anthropocentric ranking of plants as inferior to animals and thus as unworthy of consideration”.

Their call to “prevent plant blindness” (Wandersee and Schussler, 1999) has led many researchers, educators and conservationists to contemplate approaches to improve public perceptions and knowledge of plants (e.g. Lindemann-Matthies, 2005; Lally et al., 2007; Sanders, 2007; Strgar, 2007; Frisch et al., 2010; Fančovičová and Prokop, 2011; Nyberg and Sanders, 2014) and to increase consideration of plants in conservation programs (e.g. Havens et al., 2013; Balding and Williams, 2016). With the ongoing threats of climate change, habitat loss, pollution and illegal wildlife trade (Kew Royal Botanic Gardens, 2017), counteracting “plant blindness” is becoming increasingly important.

As a carnivorous plant researcher and science communicator, I’ve often contemplated the role that carnivorous plants can play in engaging





the wider public in botanical sciences and promoting conservation. However, alongside the benefits of using carnivorous plants to “prevent plant blindness”, there are also a number of challenges. In this article, I present some benefits and challenges, in the hope of opening up further discussion and assisting others who may wish to use carnivorous plants in their education or conservation programs.

Benefits of using carnivorous plants to prevent plant blindness

1) Carnivorous plants are highly revered by the public

Carnivorous plants have long been appreciated for their unusual trapping leaves and peculiar symbiotic relationships with other organisms. We know Charles Darwin from his theories on natural selection and evolution, but he also had a particular fascination with carnivorous plants. Through a series of elegant experiments in his personal glasshouse in Down House, England (Figure 1), Darwin was able to provide the first scientific evidence that some plants are capable of capturing and digesting insect prey. In his treatise *Insectivorous Plants*, Darwin (1875) described the Venus flytrap *Dionaea muscipula* as “one of the most wonderful [plants] in the world”. These days, carnivorous plants bring together many people who share Darwin’s fascination and curiosity, including researchers, naturalists, horticulturalists, cultivators, collectors, artists and members of the wider public. A global community meets every two years at the International Carnivorous Plants Society conference, and discussions are continued via online forums, social



Figure 1: The glasshouse at Down House, England, where Charles Darwin conducted his experiments on carnivorous plants.





media, local society meetings, and the *Carnivorous Plant Newsletter*. Such widespread interest shows how passionate and excited people can be about carnivorous plants.

2) Carnivorous plants are often easily recognisable thanks to their representations in popular culture

Carnivorous plants have permeated throughout popular culture, from the Victorian Gothic era tales of explorers finding an “atrocious cannibal tree” (Chase et al., 2009), to the sci-fi horrors in *Day of the Triffids* and Audrey II in *Little Shop of Horrors*, to the piranha plants in Super Mario games and even a few modern-day memes. Carnivorous plants are also featured in several documentary-style formats, from “Life of Plants” narrated by Sir David Attenborough, to the “Plants Are Cool Too” YouTube series hosted by Dr Chris Martine, the “In Defense of Plants” podcast hosted by Matt Candeias, and even the “True Facts: Carnivorous Plants”



Figure 2: Victreebel from Pokémon making a meal out of Team Rocket.

video by YouTube user ZeFrank (warning: this one contains some swear words). These portrayals and digital resources can appeal to a broad range of audiences and can be a useful conversation starter to begin talking about real-life carnivorous plants. For example, kids might not be familiar with *Nepenthes* pitcher plants, but as soon as I mention Victreebel from Pokémon (Figure 2) they want to know more!

3) There are many ways to experience, enjoy and admire real-life carnivorous plants

To begin with, many botanic gardens have a section dedicated to displaying carnivorous plants or have exhibits inspired by these plants, such as the Lego carnivorous plant sculptures at Gardens by the Bay in Singapore (Figure 3). Closer to home, the Royal Botanic Garden Sydney currently has an amazing display of carnivorous plants at the “Plants With Bite” exhibit in the Calyx – definitely worth checking out!

For a more hands-on experience, growing carnivorous plants at home can be a lot of fun (and sometimes a challenge), and there are plenty of great resources both online and in print to help. Once you have some plants of your own, you could even follow in Darwin’s footsteps by trying out some of the same experiments he did way back in the 1800s!





Finally, seeing carnivorous plants in the wild can provide an immersive experience in nature and highlight the ecological value of carnivorous plants. In Australia, we are lucky to have an incredible diversity of native carnivorous plants to admire, including sticky-leaved *Drosera spp* and *Byblis spp*, suction-trapping *Utricularia spp*, the aquatic *Aldrovanda vesiculosa*, the tropical *Nepenthes spp* pitcher plants, and the endemic Albany pitcher plant *Cephalotus follicularis*. Many of these carnivorous plants have symbiotic relationships with other organisms, including digestive-mutualisms and pollinator-prey interactions. The next time you go for a bush walk, watch out for these native carnivores and take a moment to appreciate their incredible colours and shapes, observe their interactions with other organisms in their natural environment, and consider their role in the surrounding ecosystem.

Challenges of using carnivorous plants to prevent plant blindness

1) Issue of anthropomorphising plants

In a letter to Charles Lyell, Darwin wrote “at this present moment I care more about *Drosera* than the origin of all the species in the world. It is a wonderful plant, or rather a most sagacious animal” (Darwin, 2002). This statement shows not only a deep fascination with carnivorous plants, but also an acknowledgment that these plants are rather animal-like in the ways they move and get food. Such comparisons could serve to make carnivorous plants one of the more relatable plant groups, however there can be risks of misconceptions and negative conservation outcomes when anthropomorphising species (Balding and Williams, 2016), so care must be taken.



Figure 3: Lego carnivorous plants on display at Gardens by the Bay, Singapore.

2) Perpetuating the man-eating monster myth

Given all the popular culture references, it's perhaps not surprising that when googling “can carnivorous plants...”, the first two autocomplete suggestions are “harm humans” and “eat humans” (Figure 4).





Many of the fictional portrayals listed previously perpetuate the “man-eating monster” myth surrounding carnivorous plants, and may contribute towards the wider public’s understanding of what carnivorous plants really are. If we use these portrayals of carnivorous plants in education or conservation programs, it’s important to dispel the associated myths and provide the scientific truth.

3) Conserving wild species and populations

Unfortunately, many carnivorous plants around the world are rare and/or threatened, and Australia is no exception (Jennings and Rohr, 2011; Kew Royal Botanic Gardens, 2017; Clarke et al., 2018). Our fascination with these plants can sometimes contribute (either intentionally or unintentionally) to the issues of poaching, illegal trade and habitat disturbance. In order to help protect carnivorous plants and the ecosystems they belong to, we must ensure that conservation is a fundamental component of educational activities involving carnivorous plants. We can all take simple steps to help protect wild carnivorous plants, by being careful not to disturb their natural habitats, disposing of rubbish properly, following the instructions of any signs, and ensuring any purchases of carnivorous plants are from a reputable source. With people and the fate of carnivorous plants so intertwined, there is clearly a need for open and effective communication between ecologists, conservationists, cultivators, collectors and the wider public.

Conclusion

Carnivorous plants can spark curiosity in the plant kingdom, and open conversations up to broader scientific topics including botany, ecology, evolution, biodiversity, symbiotic interactions, threatening processes and conservation. Done with care, these conversations could have many positive impacts, from improving public perceptions of plants, to positively influencing public policy and decision-making around threatened species, to inspiring the next generation of plant scientists and conservationists. However, further research is certainly needed to better understand the many ways in which humans and carnivorous plants interact, to determine the most effective frames for promoting conservation of carnivorous plants and their ecosystems, and to vigorously evaluate the role that carnivorous plants could play in helping to “prevent plant blindness”.

If you have any thoughts on this or would like to discuss further, please feel free to get in touch. You can find me on Twitter @floraskates





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