CALEYI

Australian Plants SOCIETY NSW


pic Andre Porteners

NORTHERN BEACHES GROUP

austplants.com.au/northern-beaches

January/February 2019

Australian Plants Society Northern Beaches
Contact us at
northernbeaches@austplants.com.au

President
Dr Conny Harris (02) 9451 3231
Vice-President
David Drage (02) 9949 5179
Secretary
Julia Tomkinson (02) 9949 5179
Treasurer
Lindy Monson (02) 9953 7498
Regional Delegate
Harry Loots (02) 9953 7498
Librarian
Jennifer McLean (02) 9970 6528
Talks Co-ordinator
Russell Beardmore 0404 023 223
Walks Co-ordinator
Penny Hunstead (02) 9999 1847
Catering Officer
Georgine Jakobi (02) 9981 7471
Editor
Jane March 0407 220 380

CALENDAR

APS Northern Beaches meeting Thursday February 7, 2019 at Stony Range Regional Botanic Garden, Dee Why. **NB changed times**.
7 pm Committee meeting.
7.30 pm Plant family time. Acanthaceae.genus: Brunoniella: species B.australis.
7.45 pm Presentation: Conny Harris Bush regeneration..
Supper: Georgine & Jane

APS Northern Beaches visit **'Plants with bite' at The Calyx, Royal Botanic Garden, 11 am Sunday February 17 , 2019**. " Plants with Bite" The story of the captivating and bizarre world of carnivorous plants, with displays of plants, from all over the world. Penny will email details.

From the Editor
I wish you all a wonderful 2019 and look forward to all the great photographs, reports, and stories you will send me for Caleyi. march@ozemail.com.au

MESSAGE FROM OUR PRESIDENT

Conny Harris

Who would like to join me in doing a little memory training on our favourite subject?

For the next year I suggest we review at each meeting one genus of our 'lesser families'

I envisage this to be done by choosing one species of that genus and saying a few words about it and perhaps if other interesting members of that species exist, mention those to spark our memory.

I suggest we set aside 5-10 min at the beginning at each meeting (7.05 - 7.15pm) to do this and either someone has read up on that genus or we all do it together by consulting our library right there and than. (When there is a committee meeting the plant subject will be at c. 7.30 pm. Ed.)

For our first meeting in 2019 let's look at A..... family: Acanthaceae..genus: *Brunoniella* species *B.australis*. Hope to see you all participating in this activity, Conny

2018 CHRISTMAS LUNCH


pic: Georgine Jakobi.

Saturday December 8th was a glorious summer day. The many members gathered for this celebration enjoyed the wonderful array of home made treats accompanying the barbecued chickens.

My photos of the day disappeared into the ether but fortunately Georgine took these beauties to remind us of the wonderful company we shared.

Once in the tube flannel flowers can be placed in the full sun and watered daily. After a few months they should reach eight centimetres in height although quite a few will die off while maturing. At this stage plants can be take out of their tubes placed in the garden and neglected. There will come a time when flannel flowers will start self seeding in the garden and then they will be seen as yet another common garden plant that flowers from Spring through to Summer.

WHEN YOU MIGHT THINK THAT FLANNEL FLOWERS ARE WEEDS.

Harry Loots

Who has not been delighted by the sight of a field of white flannel flowers decorating a fire-blackened bush? In the wild they appear as thick groves that Europeans will call edelweiss and less educated Australians call daisies. It will not surprise Australian Plant growers that Flannel flowers, *Actinotus helianthi*, are easy to propagate and grow in the garden.

I have a propagation bin that has been used to germinate a number of different species. The bin is particularly successful with flannel flowers. It is a large deep plastic basin, an old council recycling container in which is placed a layer of blue metal then two layers of commercial germinating mix topped off with a thin layer of ash collected after a bushfire. Old flannel flower heads are thrown on top of the charcoal.

Within a few months juvenile flannel flowers will appear. When these juveniles are at least two centimetres high they are carefully dug out and placed into a tube containing an ordinary commercial potting mix. The roots must be disturbed as little as possible. At this stage there will be a high attrition rate due to mechanical damage or rot of the roots. Flannel flowers do not like to be too wet all the time, just damp. It is important that tubes should drain well.

BANKSIAS A WORTHWHILE CHALLENGE FOR CURATORS OF NEW DISPLAY AT NATIONAL BOTANIC GARDENS

ABC Radio Canberra November 21, 2018 Louise Maher

Photo: Waratah banksia in bloom at the Australian National Botanic Gardens. (ABC Radio Canberra: Louise Maher)

In the early 20th century, May Gibbs gave banksias a bad rap — the Big Bad Banksia Men in her Gumnut stories have terrified generations of Australian children.

A decade later, Margaret Preston focused her artistic eye on the plant's spectacular spikes; her 1927 painting of banksias in a black vase is regarded as her masterwork. Banksias are one of Australia's most distinctive wildflowers.

They were first planted on the site of the Australian National Botanic Gardens (ANBG) in Canberra in 1947.

Soon they'll play a starring role in a new garden currently under construction to celebrate the ANBG's 50th anniversary in 2020.

Photo: David Taylor with some of the dozens of banksias being cultivated. (ABC Radio Canberra: Louise Maher)

David Taylor, ANBG's curator of living collections, said the garden would showcase the variety of banksias while telling the story of their place in our landscape.

Indigenous Australians soaked the flower cones in water to extract nectar for sweet drinks and used dry flowers to strain water.

Some banksia flowers open to the north, providing a handy compass in the bush.

"They're such a tactile and engaging group of plants," Mr Taylor said. "The incredible diversity of foliage, fruit, flower and all the mammals, birds, insects that they attract — it's almost like biodiversity in one group of plants."

West to east challenge

Photo: Tennis ball banksia grows naturally in Western Australia. (ABC Radio Canberra: Louise Maher)

Banksias range in size from small shrubs that grow across the ground to trees that can be up to 30 metres tall. They occur in most Australian landscapes including rainforests — though not deserts.

Of the 170 or so different species, 90 per cent occur only in south-west Western Australia, often in sandy, gravelly soils, and many are susceptible to fungus disease.

This can make them particularly difficult to grow on the east coast.

Horticulturalists at the ANBG have built test plots to trial banksias in different mixes of sandstone and organic matter before they're planted out in the new garden.

They're also grafting some West Australian species onto the roots of banksias which thrive in eastern Australia.

"A lot of the West Australian species are very difficult [to grow] on their own roots, so grafting them gives them that durability below ground," Mr Taylor said.

A banksia blooming every day

Photo: Hairpin banksia is native to the eastern states of Australia. (ABC Radio Canberra: Louise Maher)

The new garden is due to open in April 2020, when many species will be in bloom.

It's hoped that on each day of the year, at least one of the 50 or so species in the garden will be flowering.

The garden will feature artistic elements as well as information and tips for home gardeners.

Mr Taylor said the ANBG was keen to pass on the results of its experiments with banksia grafting to home gardeners.

"We'll have success and failures with them because they're very difficult," he said.

"But it's an idea for people who want to grow some of those tricky but wonderful species you don't often see over this side of the country."

Seed-bearing cones from Banksia violacea (left) and Banksia lemmanniana (right)

Photo: Banksia cones are as varied as their flowers and foliage. (ABC Radio Canberra: Louise Maher)

This fossilized twig of a podocarp conifer dates back to the Permian, much earlier than expected. P. BLOMENKEMPER ET AL., SCIENCE, 362/1414 (2018)

MIDDLE EAST FOSSILS PUSH BACK ORIGIN OF KEY PLANT GROUPS MILLIONS OF YEARS

sciencemag.org December 20, 2018 Elizabeth Pennisi

Paleobotanists exploring a site near the Dead Sea have unearthed a startling connection between today's conifer forests in the Southern Hemisphere and an unimaginably distant time torn apart by a global cataclysm. Exquisitely preserved plant fossils show the podocarps, a group of ancient evergreens that includes the massive yellowwood of South Africa and the red pine of New Zealand, thrived in the Permian period, more than 250 million years ago. That's tens of millions of years earlier than thought, and it shows that early podocarps survived the "great dying" at the end of the Permian, the worst mass extinction the planet has ever known.

Reported in this week's issue of Science, the fossils push back the origins not just of podocarps, but also of groups of seed ferns and cycadlike plants. Beyond altering notions of plant evolution, the discoveries lend support to a 45-year-old idea that the tropics serve as a "cradle" of evolution. "This is an exciting paper," says Douglas Soltis, a plant evolutionary biologist at the University of Florida (UF) in Gainesville. By revealing the richness of the Permian tropics, he adds, "The findings may also help researchers decide where to look for crucial fossil discoveries."

During the Permian, from 299 million to 251 million years ago, Earth's landmasses had merged to form a supercontinent, bringing a cooler, drier climate. Synapsids, thought to be ancient predecessors of mammals, and sauropsids, ancestors to reptiles and birds, roamed the landscape. Simple seed-bearing plants had already appeared on the scene. Family trees reconstructed from the genomes of living plants suggest more sophisticated plant groups might also have evolved during the Permian, but finding well-preserved plant fossils from that time has been difficult.

About 50 years ago, a German geologist described the Umm Irna formation, a series of sedimentary layers exposed along the Jordanian coast of the Dead Sea. Working at the site in the early 2000s, paleontologist Abdalla Abu Hamad, now with the University of Jordan in Amman, discovered some exquisitely preserved plants from Permian swamps and drier lowlands.

After moving to the University of Münster in Germany for a Ph.D., he teamed up with paleobotanists there to analyze hundreds of newly collected plant fossils, including leaves, stems, and reproductive organs. Many of the fossils preserve the ancient plants' cuticle, a waxy surface layer that captures fine features, such as the leaf pores called stomata. That made it possible for the team to positively identify many of the plants.

"At first, we couldn't really believe our eyes," Benjamin Bomfleur, a study co-author at the University of Münster, recalls. Many were plants thought have gotten their start later in the Mesozoic, the period when dinosaurs

Freed from rock by a strong acid, this fossilized frond preserves enough detail to identify it as a seed fern. P. BLOMENKEMPER ET AL., SCIENCE, 362/1414 (2018)

ruled. Along with the podocarps, they identified corystosperms, seed ferns common in the dinosaur age but extinct now, and cycadlike Bennettitales, another extinct group that had flowerlike reproductive structures.

Such finds could help resolve an ongoing debate about why the tropics have more species than colder latitudes do. Some have suggested that species originate at many latitudes but are more likely to diversify in the tropics, with its longer growing seasons, higher rainfall and temperatures, and other features. But another theory proposes that most plant—and animal—species actually got their start near the equator, making the low latitudes an evolutionary "cradle" from which some species migrate north and south. The new work "supports the idea of the evolution cradle," Bomfleur says. Philip Mannion, a paleontologist at Imperial College London agrees, but says the case is not fully settled. "Our sampling of the fossil record is extremely patchy throughout geological time and space," he cautions.

It's not clear how the newfound Permian plants made it through the great dying, a 100,000-year period when, for reasons that are still unclear, 90% of marine life and 70% of life on land disappeared. But their presence in the Permian raises the possibility that other plant groups thought to have later origins actually emerged then in the tropics, says UF plant evolutionary biologist Pamela Soltis. If these select plants survived the mass extinction, she says,

"Perhaps the communities they supported may have been more stable as well."

INTRIGUING NATIVE SEEDS SPROUT NATIONAL DIGITISATION PROJECT

Atlas of Living Australia December 4, 2018

Images and traits of 1000 seeds of Australia's native plants are now available on the Atlas of Living Australia and free to use for species verification, conservation management, education, art and more.

Seeds come in all different sizes, from microscopic orchid seeds to tropical coconuts. Seed traits like size, shape and appendages affect how they disperse and germinate, but surprisingly little is known about the traits of Australia's diverse seeds.

Digitising 1000 seed species

Scientists and volunteers from the Centre for Australian National Biodiversity Research (CANBR) have been busily working to change this. They have captured digital images and associated trait data for 1000 species from the National Seed Bank at the Australian National Botanic Gardens – over a quarter of the species held in the seed bank's collection. The images cover expertly identified, verified seeds from

across the entire country, including Christmas and Norfolk Islands.

These images and data are now freely available on the Australian Plant Image Index (search Class 'nsb' in lower case) and displayed with the species records in the Atlas of Living Australia, opening the door for scientific research, education and practical applications such as plant and seed identification guides.

"The images have been captured from verified seed specimens that are linked to plant specimens and records at the Australian National Herbarium. This is important because identifying plants from seeds and fruits alone may not be possible without also considering flowers, leaves and other plant parts," said seed conservation biologist Dr Lydia Guja of the CANBR.

Seed diversity. The key of names for seed images is available on the Australian National Herbarium facebook page.

"Seed diversity is a relatively unexplored aspect of Australia's native plants. In many cases we don't yet know the range of variation in characteristics like texture or appendages. This is the first step in documenting trait variation so that we can begin to understand seed trait evolution, ecological function and environmental interactions," she said.

Uncovering seed secrets

The work has uncovered some intriguing features of native seeds that prompt new ecological questions.

Noticing that seeds of some hibiscus species have a dense covering of long hairs, while other species have only residual hairs that look more like scales, the researchers speculated that extra hairs may help seeds in arid environments to collect and retain water to facilitate germination.

"We observed that species with hairier seeds occur in arid environments and those with fewer seed hairs occur in the tropics, suggesting potentially different evolutionary pathways for these species and adaptations that may allow them to survive under different environmental conditions," said Dr Brooke Clinton of the CANBR.

The scales on seed from threatened species Hibiscus brennanii contrast strongly with the silky hairs of Hibiscus brachysiphonius. The differences may be a result of adaptation to different climatic conditions.

Understanding seeds also has practical applications in conservation biology. "If seed traits can help us understand the requirements of seeds, such as whether they need to be buried under the soil to germinate or will germinate successfully nearer the surface, this could help to increase the success of restoration programs and expand the number of species that can be used in such programs," Dr Clinton said.

Inspiring scientists, teachers and artists

The team has received many requests for their seed images, including for images of edible grains used by Aboriginal people and from conservationists seeking images of threatened species to use for identification and awareness-raising. Bush Blitz is using seed images in school education programs, teachers are using the free downloadable poster A Handful of Acacia Seeds and researchers are uploading images and trait data like these into national and international plant trait databases.

The team behind the 1000 seeds project has dreamed up many possible additional uses of the images and trait data, including inspiring artists and jewellers, or searching for useful biochemicals in arils – the fleshy appendages containing proteins and oils that attract ants and birds who disperse the seeds.

Where to from here?

Volunteers at the National Seed Bank are continuing to digitise the more than 3500 species in the collection. CANBR researchers are working to uncover ecological functions and evolutionary signals from the measured seed traits and using artificial intelligence (AI) to analyse images for more rapid trait extraction.

Australian native seeds: a digital image library was supported by funding from Bush Blitz. The Centre for Australian National Biodiversity Research is a joint venture between Parks Australia's Australian National Botanic Gardens and CSIRO.

WARTY HAMMER ORCHIDS ARE SEXUAL DECEIVERS

The Conversation November 30, 2018 Ryan Phillips, Senior Lecturer in Ecology, Environment & Evolution, La Trobe University

Orchids are famed for their beautiful and alluring flowers – and the great lengths to which people will go to experience them in the wild. Among Australian orchids, evocative names such as The Butterfly Orchid, The Queen of Sheeba, and Cleopatra's Needles conjure up images of rare and beautiful flowers.

Yet there is a rich diversity of our orchids. Some are diminutive, warty, and unpleasant-smelling, bearing little resemblance to a typical flower. While many orchid enthusiasts have a soft spot for these quirky members of the Australian flora, what has brought them international recognition is their flair for using some of the most bizarre reproductive strategies on Earth.

Sexual mimicry

The King-in-his-carriage, Drakaea glyptodon, is the most common species of hammer orchid. Here the flower is pictured next to the female of its pollinating thynnine wasp, Zaspilothynnus trilobatus. Rod Peakall, Author provided

From the very beginnings of pollination research in Australia there were signs that something unusual was going on in the Australian orchid flora. In the 1920s Edith Coleman from Victoria made the sensational discovery that the Australian tongue and bonnet orchids (Cryptostylis) were pollinated by males of a particular species of ichneumonid wasp attempting to mate with the flower.

But this was just the beginning.

We now know that while the insect species involved may vary, many of our orchid species use this strategy. Australia is the world centre for sexual deception in plants.

Perhaps the most sophisticated flower of all sexually deceptive plants is seen in the hammer orchids, a diminutive genus that only grows in southwestern Australia. Their solitary stem reaches a height of around 40cm, and each stem produces a single flower no more than 4cm in length.

Even among sexually deceptive orchids, hammer orchids stand out from the crowd. They have a single heart-shaped leaf that sits flush with the soil surface, and grow in areas of dry inhospitable sand – an unusual choice for an orchid.

And then there is the flower. Not only does the lip of the flower more closely resemble an insect than a petal, but it is hinged partway along. All of which starts to makes sense once you see the pollinators in action. Like many other Australian sexually deceptive orchids, they are pollinated by thynnine wasps – a unique group in which the male picks up the flightless female and they mate in flight. In the case of hammer orchids, the male grasps the insect-like lip and attempts to fly off with "her". The combination of his momentum and the hinge mechanism swings him upside down and onto the orchid's reproductive structures.

It's not me, it's you (you're a flower)
So, how do you trick a wasp?

Accurate visual mimicry of the female insect does not appear to be essential, as there are some sexually deceptive orchids that are brightly coloured like a regular flower. Instead, the key ingredient for attracting pollinators to the flower is mimicking the sex pheromone of the female insect. And boy, is this pheromone potent.

Indeed, one of the strangest fieldwork experiences I've had was wasps flying through my open car window while stopped at traffic lights, irresistibly drawn to make love to the hammer orchids sitting on the passenger seat!

Pollination of the Warty hammer orchid by a male of the thynnine wasp Zaspilothynnus nigripes. Suzi Bond, Author provided

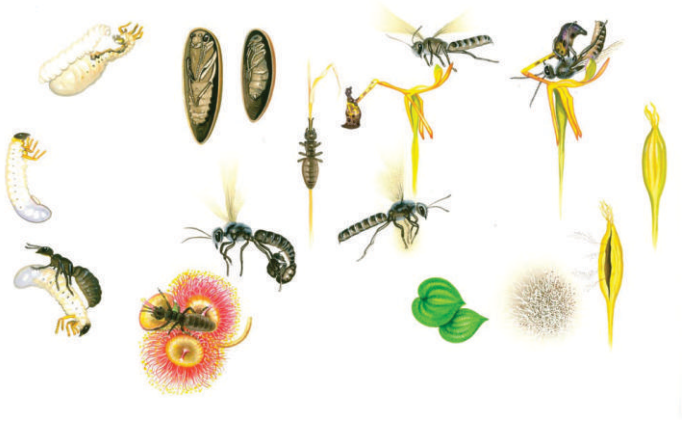
While determining the chemicals responsible for attraction of sexually deceived pollinators is a laborious process, we now know that multiple classes of chemicals are involved, several of which were new to science or had no previously known function in plants.

What's more, we are still discovering new and unexpected cases of sexual deception in orchids that don't conform to the insect-like appearance of many sexually deceptive orchids.

A classic example is the case of the Warty hammer orchid and the Kings spider orchid – these two species have totally different-looking flowers, yet both are pollinated by the same wasp species through sexual deception.

While the ability to attract sexually excited males without closely resembling a female insect may partly explain the evolution of sexual deception, it does not explain the benefit of evolving this strategy in the first place.

A leading hypothesis for the evolution of sexual deception is that mate-seeking males be more efficient at finding orchid flowers than food-foraging pollinators – but this remains a work in progress.



The life cycle of the Warty hammer orchid and its pollinator species, highlighting the complex ecological requirements needed to support a population of. the orchid. Martin Thompson, Author provided

From a conservation point of view, pollination by sexual deception has some interesting challenges. Female animals produce sex pheromones that only attract males of their own species. This means an orchid that mimics a sex pheromone typically relies on a single pollinator species. As such, conservation of any given orchid species requires the presence of a viable population of a particular pollinator.

Further, an interesting quirk of these sexually deceptive systems is the potential for cryptic forms of the orchid: where populations of orchids that appear identical to human observers actually attract different pollinator species through shifts in pheromone chemistry. Indeed, of the ten known species of hammer orchid, three contain cryptic forms.

Not only does this create a major challenge for managing rare species, it raises the possibility that – should these forms prove to be separate species – the true diversity of sexually deceptive orchids could be greatly underestimated.

THE PLANTS THAT SAVED THE NUMBAT

Australian Geographic October 4, 2016 Tim Low

IT LOOKED NERVOUS, as well it might. Numbats were nearly wiped out by foxes and cats, and the one I was watching in Western Australia's Dryandra Woodland needed to be alert to survive. After scratching at one patch of ground for termites to eat, the numbat would listen carefully before scampering to another, often passing shrubs with yellow and red pea flowers. Odd as it may seem, these plants, known as sandplain poison (*Gastrolobium microcarpum*), have been central to the numbat's survival.

Heart-leaf poison (Gastrolobium bilobum) is the most toxic of all the 1080 bushes tested. IMAGE CREDIT: MurielBendel/commons.wikimedia.org

Many pea bushes in the genus Gastrolobium are highly toxic, containing the active ingredient in dingo, fox and rabbit bait, namely sodium monofluoroacetate, known as 1080. These plants are concentrated in south-western Australia, where with long exposure to the plants, many animals have evolved high 1080 tolerance.

Brushtail possums in this region can survive 150 times as much 1080 as brushtails in the east. Predators such as goannas have also evolved resistance, presumably by feeding on insects and other prey that browse these plants. Ingested 1080 may take a day or two to be eliminated, which means that a fox or cat dining on possum in south-western Australia runs a risk of being poisoned.

Female numbat. (Photo credit: Gnangarra/commons.wikimedia.org)

This toxin has apparently limited foxes in the south-west, explaining why numbats, woylies, western quolls and red-tailed phascogales survived there and nowhere else. These mammals once lived as far east as inland New South Wales, but hung on only in the corner of Australia where 1080 plants abound. At their low point, numbats survived only at Dryandra and Western Australia's Perup Nature Reserve. Sandplain poison is Dryandra's main shrub.

Today, under the Western Shield program, national parks and other south-west reserves are baited with 1080, upping the aid conferred by the plants. While elsewhere in Australia the baits are dangerous to fauna, 1080 baits are safe for feral animal control in this region because native animals are so tolerant – quolls and goannas won't die if they gulp down a bait. The plants have helped wildlife in another vital way. As they're lethal to cattle and sheep, places with high densities were quickly found to be useless for grazing. Many of these high-density areas became reserves – which are often rich in rare wildflowers – as a result.

Unfortunately, the benefit these plants bestow is weakening. When I re-visited Dryandra last year, I was told that numbat and woylie numbers have plummeted due to cats. Less inclined than foxes to take baits, feral cats have taken over as the main numbat enemy. What Australia desperately needs is an effective way to curb cats. 1080 plants provided numbats with a lifeline, but much more is needed if they are to have a secure future.

HOW A SPIDER AND A PITCHER PLANT CAN BENEFIT FROM COLLABORATION

Sciencedaily.com November 12, 2018 Robyn Jing Ying Lim, Weng Ngai Lam, Hugh Tiang Wah Tan, National University of Singapore.

Ecologists have shed light on the relationship between the slender pitcher plant and its 'tenant', the crab spider *Thomisus nepenthiphilus*, providing insights to the little known foraging behaviors of the spider.

Although the crab spider Thomisus nepenthiphilus 'steals' prey from its host, the slender pitcher plant Nepenthes gracilis, a study by ecologists from the National University of Singapore found that the net effect of this 'burglary' can still be beneficial to the pitcher plant as it gets the residual nutrients from the prey discarded by the crab spider.

Credit: Lam Weng Ngai, NUS Department of Biological Sciences

Two recent studies by ecologists from the National University of Singapore (NUS) have shed light on the relationship between the slender pitcher plant and its 'tenant', the crab spider Thomisus nepenthiphilus, providing insights to the little known foraging behaviours of the spider.

Thomisus nepenthiphilus is found only in the slender pitcher plant Nepenthes gracilis, which is native to Singapore and can also be found in Indonesia, Borneo, and Malaysia. Although the pitcher plant is a carnivore that traps and devours insects to supplement its nutrient requirements, the crab spider Thomisus nepenthiphilus is able to exploit the pitcher plant's sweet-smelling nectar to catch its prey while at the same time, provide supplementary nutrients for its host.

"Our two studies provide important insights into the circumstances that favour cooperation over parasitism, and the results are pivotal in attaining a better understanding of these interactions," said research supervisor Associate Professor Hugh Tan, who is from the Department of Biological Sciences at the NUS Faculty of Science.

The benefit of being 'robbed'

In the first study, Assoc Prof Tan, together with doctoral student Mr Lam Weng Ngai and former undergraduate student Miss Robyn Lim, found that pitchers that are without any crab spider get more nutrients out of each prey, while those inhabited by 'tenants' trap more prey but get less nutrients from each prey.

Their laboratory experiments found that the crab spider ambushes flies that feed at the pitcher plant and sucks the body fluids of the insect prey. The crab spider subsequently drops the carcasses of the prey, which still contain some nutrients, into the fluids in the pitcher for it to digest. As such, although the crab spider 'steals' from the pitcher plant and gets the first taste of the prey, the net effect of this 'burglary' can still be beneficial to the pitcher plant as it gets the residual nutrients from the prey.

The findings suggest that when resources are scarce, this partnership between the crab spider and the pitcher plant is beneficial. However, when resources are abundant, this partnership is not favourable.

.

"A trend that has been observed in recent mutualism research is that under more stressful conditions, the frequency and intensity of mutualism between the different organisms increases. Our findings support this observation. In other words, the age-old adage 'a friend in need is a friend indeed' is true not just for humans, but also for plants and animals," said Assoc Prof Tan.

Big prey, big gains
Assoc Prof Tan and Mr Lam also conducted additional experiments in the natural habitat of the plants. Through field surveys, the researchers identified the species of prey that were found to be in greater numbers in pitchers that were inhabited by spiders, and those that were not.

Laboratory experiments were conducted to measure the nutrient contents of these prey species to estimate how much nutrients the pitchers would obtain if the prey had been trapped with, and without, the help of the crab spiders.

"Our results confirm the findings of our earlier study -- the T. nepenthiphilus crab spider does indeed help the N. gracilis pitcher plant catch many different species of prey. More importantly, the net contribution of T. nepenthiphilus to N. gracilis' nutrition appears to be proportional to the size of prey that T. nepenthiphilus catches," explained Mr Lam.

He elaborated, "If the crab spider only catches small prey, such as mosquitoes or scuttle flies, the net benefit to the pitcher plant will be negative -- it will be 'stealing' nutrients from the pitcher plant. However, when the crab spider catches large insects like cockroaches or large bugs, the pitcher plant will benefit, as the 'service charge' paid to the crab spider becomes small compared to the total amount of nutrients gained through the interaction. As such, the residual nutrients that the pitcher plant receives from the carcasses discarded by the crab spider is a good trade-off."

Theoretical model to be constructed
Based on the insights gained from these two studies, the research team is now constructing a theoretical model on mutualisms that involve the provision of nutrients by one species to another. Such a model will allow scientists to examine the factors that make mutualisms stable, and monitor how changes in the environment, such as global warming or habitat modification, will alter the ecological outcomes.

FOR THE FIRST TIME WE'VE LOOKED AT EVERY THREATENED BIRD IN AUSTRALIA SIDE-BY-SIDE

Theconversation November 27, 2018 Stephen Garnett,
Professor of Conservation and Sustainable Livelihoods, Charles Darwin University et al.

Glossy Black-Cockatoos used to be common on South Australia's Kangaroo Island until possums started eating their eggs and chicks. After volunteers helped protect nest hollows and erect safe nest boxes, the population more than doubled.

But how do you measure such success? How do you compare cockatoo nest protection with any other investment in conservation? Unfortunately, we have few ways to compare and track the different efforts many people may be making to help conserve our natural treasures.

That's why a group of us from a dozen Australian universities along with scientists and private researchers around the world have created metrics of progress for both our understanding of how to manage threats of different intensity, and how well that management has been implemented. We also provide guidance on what still needs doing before a threat no longer needs active management.

For the first time, we looked at every threatened bird in Australia to see how well – or not – they are managed. Hopefully, we can use this to avoid compounding our disastrous recent track record of extinctions in Australia.

The state of Australian birds
What we did differently was collect the same data across different species, which meant we could compare conservation efforts across all birds.

When we applied these metrics to Australia's 238 threatened bird species, the results were both encouraging and daunting. The good news is that we understand how to reduce the impact of about 52% of the threats – although of course that means we know little about how to deal with the other 48%. But the situation is decidedly worse when we consider how effectively we are putting that research into practice. Only 43% of threats are being managed in any way at all – and just a third of the worst threats – and we are achieving good outcomes for just 20%.

But at least we now know where we are. We can celebrate what we have accomplished, appreciate how much needs doing, and direct our efforts where they will have the greatest benefit.

The threats to our birds
Introduced mammals, particularly cats, have been (and continue to be) a significant threat to Australian birds. Although we have successfully eradicated feral animals on many islands, saving many species, they remain a grave threat on the mainland.

The effect of climate change is becoming the top priority threat for the future. About half of all threatened birds are likely to be affected by increases in drought, fire, heat or sea level. Given the policy prevarication at a global level, targeted research is essential if birds are to be helped to cope.

By looking at multiple species, we can also identify what helps successful conservation. Monitoring, for instance, has a big impact on threat alleviation – better monitored species receive more attention.

The orange-bellied parrot is amongst Australia's most critically endangered birds. sompreaw/Shutterstock

There is also – unsurprisingly – a strong connection between knowledge of how to manage a threat and successful application of that knowledge. Often policy people want instant action, but our work suggests that action before knowledge will squander money.

Where to from here?
So what can we use this analysis for? One use is helping species close to extinction. Using the same approach for multiple species groups, it is apparent that, while birds and mammals are in a parlous state, the most threatened fish are far worse off. We can also identify some clear priorities for action.

Finally, we must acknowledge this work emerged not from a government research grant, but from a non-government organisation (NGO). BirdLife Australia needed an overview of the country's performance with threatened birds and was able to draw on the volunteered skills of biologists and mathematicians from around the country, and then the world.

Indeed, one of the future projects will be using the new assessment tool to see just how much of the conservation action around the country is being driven by volunteers, from the many people who contributed their knowledge and skills to this paper through to those keeping glossy black-cockatoo chicks safe on Kangaroo Island.