



# Carnarvon Station Reserve Queensland

7 – 17 October 2014

Bush Blitz species discovery program



Australian Government

Department of the Environment and Energy



**bhpbilliton**

Sustainable Communities



**EARTHWATCH**  
INSTITUTE



Australian  
Biological  
Resources  
Study

# What is Bush Blitz?

Bush Blitz is a multi-million dollar partnership between the Australian Government, BHP Billiton Sustainable Communities and Earthwatch Australia to document plants and animals in selected properties across Australia.

This innovative partnership harnesses the expertise of many of Australia's top scientists from museums, herbaria, universities, and other institutions and organisations across the country.

## Abbreviations

**ABRS**

Australian Biological Resources Study

**ALA**

Atlas of Living Australia

**ANH**

Australian National Herbarium

**ANIC**

Australian National Insect Collection

**CANBR**

Centre for Australian National Biodiversity Research (Australian National Herbarium)

**EPBC Act**

Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth)

**NCA**

Nature Conservation Act 1992 (Queensland)

**QM**

Queensland Museum

## Summary

A Bush Blitz survey was conducted at Carnarvon Station Reserve in Central Queensland between 7 and 17 October 2014.

The reserve sits within the Brigalow Belt bioregion, which is one of the most extensive, fertile and well-watered areas in Northern Australia. The vast majority of this bioregion has been cleared of vegetation for agriculture. This former cattle station has been a Bush Heritage property since 2001 and encompasses a valley flanked by mountains. Past grazing has impacted the vegetation of the valleys and plains but not the rugged hills.

The reserve protects a wide range of habitats and at least 10 threatened species. The lowland woodlands and bluegrass downs that cover much of the valley floor are important additions to the rugged ranges protected in neighbouring Carnarvon National Park. Management by Bush Heritage, including control of invasive species, has improved the quality of springs and surrounding areas, resulting in an increase in ground-nesting birds and small mammals.

Carnarvon National Park has been well surveyed however there have been fewer surveys within Carnarvon Station Reserve. While the Queensland Museum (QM) Entomology team undertook surveys in 2010, 2012, and 2013, the reserve had not been surveyed for other invertebrate groups. A small number of spider and thrips species had been collected as bycatch during the entomology surveys but there were no previous records of stygofauna or native bees from the reserve. Reptiles had only been collected during a 2005 survey and as bycatch in pitfall traps during the 2010 entomology survey.

This Bush Blitz survey recorded 1125 species, of which 705 had not been recorded previously for the reserve (28 vertebrates, 635 invertebrates and 42 vascular plants) and 127 may be new to science (37 true bugs, 34 spiders, 31 thrips, 10 beetles, five crustacea, five snails, a bee, a fly, a cicada, a segmented worm and a flatworm). Two threatened plant taxa were collected: Austral Cornflower or Native Thistle (*Rhaponticum australe*) is listed as Vulnerable (EPBC Act and NCA) and Hairy Anchor Plant or Australian Anchor Plant (*Discaria pubescens*) is listed as Near Threatened under the NCA. Four threatened vertebrate taxa were identified: Koala (*Phascolarctos cinereus*), South-eastern Long-eared Bat (*Nyctophilus corbeni*), Squatter Pigeon (southern) (*Geophaps scripta scripta*) and Adorned Delma (*Delma torquata*) are all listed as Vulnerable (EPBC and NCA).

Some highlights of the survey included:

- a significant increase in bat species recorded for the region
- documenting two more stygobitic (groundwater-adapted) amphipod species for Queensland—previously only a single stygobitic amphipod species was known from the state
- significant range extensions for a wide range of insect species
- the collection of the flies *Neoconops glaber* and *Neorhaphiomidas queenslandensis*, previously known only from Mt Moffatt, and specimens of a number of invertebrate taxa from groups currently under revision
- the great diversity and abundance of thrips species—the 81 described thrips species collected represent approximately 10% of the known Australian thrips fauna
- the 205 plant taxa collected have significantly increased the Australian National Herbarium (ANH) holdings of taxa from this area of Queensland and, in some cases, of taxa from Australia.

Seven vertebrate and six invertebrate pest species were recorded. Of the 17 introduced plant species collected, none are currently listed under Commonwealth or State legislation; however, seven taxa are considered potential environmental weeds in Queensland.

Management recommendations include the continued conservation, management, and monitoring of vine thickets, hilltops, ridge lines, and stands of *Leptospermum*; and further survey work for species such as the Adorned Delma.

# Contents

<b>What is Bush Blitz?</b>	<b>2</b>
<b>Summary</b>	<b>3</b>
<b>Introduction</b>	<b>6</b>
The Carnarvon Station Reserve Bush Blitz	6
Acknowledgements	6
<b>Reserve overview</b>	<b>7</b>
Description	7
Conservation values	7
<b>Methods</b>	<b>9</b>
Taxonomic groups studied and personnel	9
Site selection	10
Survey techniques	11
Identification	12
<b>Results</b>	<b>13</b>
Species lists	14
<b>Discussion</b>	<b>15</b>
Putative new species	15
Threatened species	22
Exotic and pest species	24
Range extensions	29
Other points of interest	34
<b>Glossary</b>	<b>41</b>

# Introduction

This is a report for the Bush Blitz program, which aims to improve our knowledge of Australia's biodiversity. Bush Blitz is an initiative of the Australian Government, through the Australian Biological Resources Study (ABRS), in partnership with BHP Billiton Sustainable Communities and Earthwatch Australia. Bush Blitz aims to:

- promote, publicise and demonstrate the importance of taxonomy through species discovery
- undertake a national species discovery program
- support the science of taxonomy in Australia through training students and early career researchers, and by providing grants for species description and resolution of taxonomically problematic, nationally important groups
- promote partnerships between scientific institutions, government, industry and non-government organisations
- inform reserve managers and other stakeholders of the results of Bush Blitz projects.

## The Carnarvon Station Reserve Bush Blitz

The survey took place between 7 and 17 October 2014. Therefore, the results are representative of spring activity in the area. A large area of Carnarvon Station had been burnt to control bush fires early in 2014; however, the flora had recovered quickly. Approximately 40 mm of rain fell a few weeks before the survey and a significant amount in the middle of the survey period, bringing on a high level of insect activity.

Eight BHP Billiton employees participated in this Bush Blitz as field assistants to the scientists. They were coordinated by Bruce Paton from Earthwatch Australia. This professional development opportunity is available to BHP Billiton employees twice a year, and their involvement is highly regarded by the Bush Blitz team.

The ABRS provided the logistical coordination and overall leadership of the survey while experts from the following organisations conducted the field and laboratory work:

- Queensland Museum (QM)
- CANBR (Australian National Herbarium)
- Queensland Department of Primary Industries
- South Australian Museum
- University of New South Wales

## Acknowledgements

The Bush Blitz team consisted of Mim Jambrecina, Beth Tully and Brian Hawkins. They would like to thank Chris Wilson and Murray Haseler from Bush Heritage for facilitating access to the reserve and providing advice and assistance. They would also like to thank the Wilson family and all Bush Blitz participants. A big thank you to Robbie and Stan Bayliss for their excellent hospitality and keeping everyone well fed.

## Reserve overview

**Reserve name:** Carnarvon Station Reserve

**Area:** approximately 56,000 ha

**Land manager/owner:** Bush Heritage

### Description

Carnarvon Station was acquired by Bush Heritage in 2001. The reserve is located in the Brigalow Belt South bioregion at the southern end of Queensland's Central Highlands, about 600 km west of Bundaberg. It lies within one of the most extensive, fertile and well-watered areas in northern Australia, of which the vast majority has been cleared of vegetation for agriculture. Immediately north of Carnarvon Station lies the Ka Ka Mundi section of Carnarvon National Park, and to the east is the Mt Moffatt section of the park.

The reserve encompasses a valley flanked by mountains. Typically, dry cold winters and hot wet summers oscillate in a decadal pattern of a few dry years followed by a series of wetter years. The vegetation varies from grasslands, grassy woodlands, Brigalow and casuarina shrubland to extensive vine thickets on the surrounding hillsides. Geology is mainly quartz sandstone in the south-western portion with basaltic strata in the north-east, while the valley floor is mostly blacksoil alluvium.

The property had been a cattle station for 150 years prior to its purchase by Bush Heritage. Sunflower crops were also grown in its fertile valleys. Grazing by cattle has impacted the vegetation of the valleys and plains but not the rugged hills. The vegetation communities on the hills and ranges have been adversely affected by fire mainly started by lightning strikes but also from escaped controlled burns.

The Bidjara people are the traditional custodians of Carnarvon Station, with a historical connection to the land stretching back at least 18,000 years before European settlement. Bush Heritage has undertaken cultural site surveys with Bidjara. The reserve holds many sites of cultural importance including rock art, burial places and quarry sites.

### Conservation values

The reserve protects an impressive diversity of habitats in a biogeographically significant area of Queensland. Carnarvon Station's most productive ecosystems are distinctive on a national scale. The reserve protects at least 10 threatened species including the nationally endangered Northern Quoll (*Dasyurus hallucatus*) and conserves a number of vegetation communities from grassland to vine thickets.

The lowland woodlands and grasslands (bluegrass downs) that cover much of Carnarvon Station's valley floor are important additions to the rugged ranges protected in the neighbouring Carnarvon National Park.

Bush Heritage has identified the following management priorities for Carnarvon Station:

- Bluegrass grasslands and grassy woodlands on clay loam flats
- Brigalow (*Acacia harpophylla*), Belah (*Casuarina cristata*) shrublands, and vine thicket
- Aquatic and littoral ecology at permanent freshwater springs
- Populations of small and Critical Weight Range mammals
- Open forests and associated riparian habitats

Control of invasive species, particularly feral horses, Johnson Grass (*Sorghum halepense*) and Buffel Grass (*Cenchrus ciliaris*) are key management activities. Building fences that keep out larger feral animals but allow native species to pass has improved the quality of springs and surrounding areas. Bush Heritage ecologists report an increase in ground-nesting birds and small mammals, and regeneration of vegetation communities surrounding springs as a result.

Bush Heritage has adopted a proactive approach to fire management, to increase biodiversity by maximising the diversity of fire regimes across the reserve and reducing the incidence of extensive wildfires.

# Methods

## Taxonomic groups studied and personnel

A number of taxonomic groups were selected as targets for study. Table 1 lists the groups surveyed and the specialists who undertook the fieldwork.

**Table 1** Taxonomic groups surveyed and personnel

Group	Common name	Expert	Affiliation
Mammalia	Mammals	Heather Janetzki	Queensland Museum
Amphibia and Reptilia	Amphibians and reptiles	Andrew Amey	Queensland Museum
Hymenoptera	Ants	Susan Wright	Queensland Museum
	Bees	Remko Leijs	South Australian Museum
Lepidoptera	Butterflies and moths	Noel Starick	Queensland Museum
Diptera	Flies	Christine Lambkin Susan Wright	Queensland Museum
Heteroptera	True bugs	Anna Namyatova	University of New South Wales
Thysanoptera	Thrips	Desley Tree	Department of Primary Industries
Odonata	Damselflies and dragonflies	Noel Starick	Queensland Museum
		Susan Wright	
General invertebrates	General invertebrates	Christine Lambkin Noel Starick Susan Wright	Queensland Museum
Arachnida	Spiders	Barbara Baehr	Queensland Museum
Gastropoda	Snails and slugs	John Stanisic	Queensland Museum
Stygofauna	Groundwater fauna	Remko Leijs	South Australian Museum
Vascular plants	Vascular plants	Bronwyn Collins Emma Toms	Australian National Herbarium

The Bush Blitz team would also like to acknowledge the contributions of the following people:

- Patrick Couper from Queensland Museum assisted with reptile identifications.
- Harry Hines from Queensland Parks and Wildlife Service identified *Uperoleia* and *Pseudophryne* frogs.

- Queensland Museum entomologists identified specific insect groups, including Chris Burwell (dragonflies and ants), Greg Daniels (Asilidae and other Diptera), Lindsay Popple (cicadas), Anthony Ewart (cicadas) and Federica Turco (beetles).
- Katja Hogendoorn from the University of Adelaide helped identify the native bees.
- Laurence Mound from the Australian National Insect Collection (ANIC) assisted with some thrips identifications.
- Martin Baehr from Zoologische Staatssammlung Munich in Germany identified ground beetles.
- Gerry Cassis, Jacqueline Karras and Celia Symonds from the University of New South Wales helped identify true bugs.
- Robert Raven (Queensland Museum), Robert Whyte (Queensland Museum Research Associate), Helen Smith (Australian Museum), Mike Gray (Australian Museum), Volker Framenau (Western Australian Museum), Mark Harvey (Western Australian Museum), Jurgen Otto (Department of Agriculture, NSW) and Pawel Szymkowiak (A. Mickiewicz University, Poland) helped identify some of the spiders.
- Brendan Lepschi, David Mallinson, Maggie Nightingale, Rosemary Purdie, Alexander Schmidt-Lebuhn, Russell Barrett and Dave Albrecht from the Australian National Herbarium, and Robyn Barker from the State Herbarium of South Australia assisted with plant identifications. Chris Flood helped process the plant collections.
- Narelle Power (sorted traps—particularly Malaise traps), Karin Koch (databasing), Geoff Thompson (imaging drawers of specimens), Andy Wang (high resolution images of specimens), Louise Ashton (sorted ant specimens) and Margaret Innes (prepared labels)—all from Queensland Museum.

The BHP Billiton participants were Matthew Aistrope, Adam Hawkins, Brianna Bakker, De-arne McBride, Dominic Stearne, Ellen Couchman, Joel Hunter and Jamie Buchan.

## Site selection

All scientists surveyed two standard survey sites selected by Bush Blitz using modelling prepared by CSIRO. Each standard survey site was centred on a point (permanently marked), but the area surveyed varied between taxa. Standard methodologies were used to sample these sites. Bush Blitz staff also collected soil for detailed analyses of soil and soil biota (as part of the Biomes of Australian Soil Environments program) at these two sites.

The use of standard survey sites provides a unique opportunity to examine broad-spectrum biodiversity. Among other benefits, this will enable Bush Blitz's partners at CSIRO to test assumptions (e.g. about relationships between the diversity of different taxa) that underpin many conservation decisions. It will also allow comparisons between sites, and establish a basis for future monitoring by reserve managers.

Aside from standard survey sites, site selection and collection methods were at the discretion of the individual scientist. CSIRO modelling was provided to suggest survey locations that thoroughly sampled the full range of biophysical characteristics (soil characteristics, elevation, temperature, moisture etc.) on the property. Because different biophysical characteristics are important to different taxa, four sets of sites were selected—each appropriate to a particular taxon or group of taxa.

Where possible, scientists surveyed communities identified as priorities by Bush Heritage: cypress forests (intact, mature stands), Brigalow, vine scrub and springs. The flora had previously been well surveyed, but only in a dry period, and the Bush Heritage ecologist suggested the recently burnt area at the western edge of the reserve as a particular area of interest.

Site selection depended on access, suitability for trapping and time restrictions. Sites were generally selected to sample the widest variety of habitats found on the reserve. Site locations were recorded using global positioning systems.

## Survey techniques

A standard suite of survey techniques was used:

- **Mammals** were collected using transects of 25 Elliott traps and two large wire cage traps. A harp trap was used to collect microbats. Identifiable signs of mammals such as skeletal remains, scats, diggings and footprints were also collected or recorded. Observations were made during spotlight surveys from a vehicle and on foot. Pitfall traps used to capture reptiles and amphibians were also successful in capturing small dasyurids.
- **Reptiles and amphibians** were collected using pitfall traps and by looking under bark, turning rocks and logs, sifting leaf litter and soil. The pitfall traps used were those established by Bush Heritage during previous surveys. Observations were also made during spotlight transects from a vehicle along roads and on foot—approximately hour-long searches on foot and longer by vehicle.
- **Ants** were collected at each site using small pitfall traps, Pyrethrum knockdown and timed (one hour) searches for active worker ants. They were also captured in coloured pan traps and Malaise traps used to collect flies.

Pitfall traps consisted of 10 x 120 ml plastic vials filled with ethanol inserted into holes in the ground drilled by hand auger. Pitfall traps were equally spaced in a line with a suspended roof over each vial. They were left open for five days.

Litter samples consisted of 1 litre of leaf litter collected from several locations within the site, placed into a Tullgren (Berlese) funnel for extraction, run for up to 24 hours and collected into 95% ethanol.

Five living trees of at least 20 cm diameter at breast height were sprayed with a synthetic pyrethroid from ground to as high as spray reached up the trunk. After 15 minutes, specimens were collected by hand from nylon sheets spread around the tree. Specimens from the five trees were pooled into one sample for the site.

Sixteen coloured pans (four each of yellow, blue, white and red bowls 14 cm in diameter) were laid in a line 1 m apart and left for 24 hours. Each pan contained approximately 250 ml of solution (4 L water with a couple of drops of detergent). Specimens were pooled into one sample for each colour and sorted later.

- **Bees** were mostly collected using a hand net, blue vane traps and a vehicle net. Collecting sites were chosen to sample as many vegetation types as possible that had flowering plants. Plant species from which specimens were collected were also recorded. Native bees are generally collected on flowering plants where they collect pollen and nectar for their brood, and often they only visit particular plant species.
- **Butterflies** were caught using timed (one hour) and untimed hand net collection.
- **Moths** were collected by hand from a light sheet. Light sheets were run most nights using a 250 V mercury vapour lamp for at least three hours from dusk.
- **Flies** were collected by Malaise traps, timed (one hour) and untimed hand net collection, and coloured pans (as per the method used to collect ants described above). A Malaise trap was set in each site and left for up to five days. Each Sharkey (from Sante Traps) Malaise trap was approximately 1 m high, 2 m long, with black walls and a white roof and 70% ethanol was used as the preservative in the collection jar. They were tied to vegetation and pegged out across flight

paths, across dry creek beds, near drying pools of water or within flowering vegetation, with the collection jar exposed to morning sun if possible.

- **True bugs** were collected by beating (where plants are beaten and specimens dislodged into an insect net and collected by aspirator) or sweeping vegetation, focusing particularly on flowers, fruits and seeds. Sites were not pre-selected. Sites with flowering plants were targeted: 37 sites and 51 host plants were surveyed over a six-day period.
- **Thrips** were collected by hand beating vegetation (targeting flowers, grasses, live leaves, dead wood and dead leaves) over a white plastic tray, with individuals picked up using a small paint brush moistened with 95% ethanol. Leaf litter samples from the base of mature *Eucalyptus* trees were placed into Berlese funnels. Samples covered approximately 1 m<sup>2</sup> to the depth of the leaf litter just above the soil. The trunks of mature *Eucalyptus* trees (approximately 90–100 cm circumference at breast height) with flaky or creviced bark were sprayed thoroughly with quick knockdown insecticide (non-residual) as far up the trunk as possible. After 20 minutes all insects on the ground sheet were shaken into a funnel and collected.
- **Damselflies and dragonflies** were caught using timed (one hour) and untimed hand net collection. Specimens were placed in paper envelopes and dried using acetone to prevent colour loss.
- **Spiders** were surveyed at 32 sites by hand collection. Ten small pitfall traps (ice-cream containers) filled with propylene glycol were also used to collect spiders at six of these sites.
- **Snails and slugs** were collected by hand from under woody debris, the underside of rocks, sparse litter between rocks, in sandy soil and on the ground. Leaf litter was taken from some sites for sorting by microscope in the laboratory. Both live snails and dead shells were taken. The great majority of land snails can be identified from the shells alone and their presence usually indicates the presence of living individuals, especially in drier areas. Post mortem collection is critical to providing a comprehensive inventory of the species that are present. Only 18 of the 634 specimens were collected live. Most species were buried deep in rock piles: the rain in the lead-up to the survey was insufficient to entice them out of their winter aestivation.
- **Stygofauna (groundwater fauna)** sites were chosen mostly for easy access to springs, to allow heavy equipment to be carried to the site. The Bou-Rouch method was used to sample areas where groundwater was upwelling in a creek bed consisting of coarse sand or gravel. A perforated iron rod was hammered into the creek bed about one metre deep and 50–100 L of water was pumped using a hand/bilge pump through a fine net to retrieve the fauna. Groundwater surfacing through rock fissures was collected by inserting tubes or small nets.
- **Flowering plants** were collected by hand, pressed and dried. Ten collecting sites were chosen, supplemented by opportunistic collecting whilst travelling around the reserve. The aim was to provide up-to-date records and fill gaps in species distribution for the reserve. Specimens of all fertile species at a site were taken. DNA samples of orchids (Orchidaceae) and daisies (Asteraceae) were also collected and preserved in silica gel. At the time of collection, photographs were taken of many specimens for the Australian Plant Image Index.

## Identification

The specimens taken were identified using available literature and the holdings of museums and herbaria. Fauna specimens were deposited with the Queensland Museum, vascular plants with the Australian National Herbarium, with duplicates sent to the Queensland Herbarium (Brisbane) and other herbaria.

## Results

Locational data for all collection or observation records are available to reserve managers. It is estimated that 705 species were new records for the reserve (some results are yet to be finalised), including 127 putative new species—these await formal identification. Four threatened animal species were recorded and two threatened plants. Thirteen exotic or pest animal species and 17 weed species were also recorded. Table 2 provides a summary of the flora and fauna records for the reserve.

**Table 2 Summary of flora and fauna records**

Group	Common name	Total species recorded	Species newly recorded for reserve	Putative new species	Threatened species*	Exotic and pest species**
Mammalia	Mammals	26	5	0	2	5
Aves	Birds	98	2	0	1	1
Reptilia	Reptiles	25	15	0	1	0
Amphibia	Frogs and toads	11	6	0	0	1
Hymenoptera	Ants	148	101	0	0	0
Hymenoptera	Bees	55	54	1	0	1
Lepidoptera	Butterflies	37	17	0	0	0
Lepidoptera	Moths	13	10	0	0	0
Diptera	Flies	100	92	1	0	0
Coleoptera	Beetles	31	31	10	0	0
Heteroptera	True bugs	120	120	37	0	1
Coccoidea	Scale insects	2	2	0	0	0
Aphidoidea	Aphids	2	2	0	0	0
Cicadoidea	Cicadas	4	4	1	0	0
Thysanoptera	Thrips	114	109	31	0	3
Blattodea	Cockroaches	4	4	0	0	0
Odonata	Damselflies and dragonflies	13	7	0	0	0
Arachnida	Spiders	70	54	34	0	0
Crustacea	Ostracods, copepods and amphipods	5	5	5	0	0
Annelida	Segmented worms	1	1	1	0	0
Gastropoda	Snails and slugs	21	21	5	0	1

Group	Common name	Total species recorded	Species newly recorded for reserve	Putative new species	Threatened species*	Exotic and pest species**
Turbellaria	Free-living flatworms	1	1	1	0	0
Tracheophytes	Vascular plants	221	42	0	2	17
<b>Total</b>		1125	705	127	6	30

\* Species listed under the EPBC Act or NCA.

\*\* Includes native species that are at times pests or are exotic to this region.

## Species lists

Lists of all species recorded during the survey are provided in [Appendix A](#). Species lists were compiled using data from participating institutions.

Names in **red bold text** are putative new species. Species marked with an asterisk (\*) have not been previously recorded. Those without an asterisk have been recorded previously and were confirmed by this survey.

Some specimens have been identified only to family or genus level. This is partly because identifying specimens is very time-consuming, with detailed microscopic examination needed in many cases. Also, some groups are 'orphans': there are no experts currently working on them, and the taxonomic literature is out of date. Species-level identification is not possible for these groups. Unidentified Bush Blitz specimens are held in institutional collections where they can be subject to future study.

Nomenclature and taxonomic concepts used in this report are consistent with the Australian Faunal Directory, Australian Plant Name Index and Australian Plant Census.

# Discussion

## Putative new species

Here we use the term ‘putative new species’ to mean an unnamed species that, as far as can be ascertained, was collected for the first time during the survey. It is confirmed as a new species once it is named and its description published. Specimens collected during the Bush Blitz also include unnamed taxa that are already known from museum and herbarium collections: these are not counted as putative new species.

## Fauna

### *Invertebrates*

#### *Bees*

At this stage, one bee taxon is considered new to science; however, further examination of unidentified specimens will likely result in the recognition of more new species.

#### *Flies*

One putative new species of fly was collected. In addition, specimens collected on the Bush Blitz should facilitate the description of eight other unnamed fly species; these had previously been collected but could not be described on the basis of the material available.

#### *Beetles*

Nine new ground beetle (Carabidae) species and one new wedge-shaped beetle (Rhipiphoridae) were collected. Four of the ground beetles belong to the genus *Carenum*, for which there is no recent taxonomic revision, making it impossible to describe these species at present.

#### *True bugs*

Thirty-seven putative new species of true bug were collected, belonging to the families Miridae (34 species) and Tingidae (3 species).

#### *Cicadas*

One putative new species of cicada was collected. In addition, specimens collected on the Bush Blitz should facilitate the description of two undescribed cicada species.

#### *Thrips*

Of the 33 undescribed species of thrips collected, 31 were putative new species. In addition, specimens collected on the Bush Blitz should facilitate the description of two previously known but undescribed thrips species. Phlaeothripinae gen. 02 (gen. nr *Horistothrips*) had been collected only once from Cairns and Phlaeothripinae gen. 05 (gen. nov *Callitris*) had been collected widely in eastern Australia.

### Spiders

More than 70% of the spider species collected were new, including four new genera and 34 new species from 17 families. This result is unsurprising; comprehensive revisions of ground-dwelling spiders over recent years have revealed huge numbers of new taxa in many spider families.

Almost all the new species are medium-sized hunting spiders: Corinnidae (1 species), Cycloctenidae (1 species), Desidae (3 species), Lamponidae (1 species), Lycosidae (1 species), Miturgidae (3 species), Oonopidae (1 species) Oxyopidae (6 species), Salticidae (3 species), Selenopidae (1 species), Sprarassidae (2 species), Theridiidae (1 species), Trochanteriidae (2 species), Zodariidae (3 species), Barychelidae (2 species), Idiopidae (2 species), Nemesiidae (1 species).

Swift spiders (Corinnidae) are extremely fast ground-hunting spiders that mimic ants and are often seen amongst them. The new species from Carnarvon Station belongs to a new genus characterised by spiders with extremely long legs.

Scuttling spiders (Cycloctenidae) are ground dwelling and move with a rapid sideways scuttle when disturbed. Their taxonomy is poorly known and the new species of scuttling spider collected also represents a new genus.

House spiders (Desidae) are difficult to characterise by their physical features alone. Often, new house spider genera are based on expert opinion rather than rigorous phylogenetic analysis. Expert assessment of the specimens from Carnarvon Station identified a new genus and new species—Desidae n. gen. n. sp. 18. *Forsterina* includes seven described species in Australia; recent taxonomy is unavailable. Expert assessment identified *Forsterina* n. sp. 05 and *Forsterina* n. sp. 36 from Carnarvon Station as species new to science.

White-tailed spiders (Lamponidae) are generally dark-coloured and ground-dwelling, often with a conspicuous white spot at the back of their abdomen just above the spinnerets. White-tailed spiders of Australia have been recently revised. *Lampona* n. sp. 44 from Carnarvon Station is not described in this revision and is most probably new to science.

Wolf spiders (Lycosidae) are one of the most diverse spider families in Australia and only partly revised. They require a specialist to identify them correctly. The new species from Carnarvon Station belongs to the genus *Tasmanicosa*, which has recently been revised. This is now published and is the Bushblitz Wolf Spider, *Tasmanicosa fulgor* Framenau & Baehr 2016.

False wolf spiders (Miturgidae) are nocturnal ground dwellers of forests and grassy vegetation. The family is partly revised and currently for *Miturga* includes 16 species from Australia. Modern taxonomy for *Miturga* is unavailable, so species-level identification is impossible for most specimens. Two new species of false wolf spider were identified for Carnarvon Station— *Miturga* n. sp. 11 and *Miturga* n. sp. 28.

Goblin spiders (Oonopidae) are mostly hard-bodied, with strong sclerotised abdominal plates (scutes), and orange-brown in colour. Not much would be known about the tiny litter-dwelling and canopy-dwelling goblins if they had not been the object of an international research effort, a Planetary Biodiversity Inventory funded by the National Science Foundation in the USA. The genus *Pelcinus* is not yet revised for Australia. Only one named species, *P. saaristoi*, is known from Australia and it is found in WA. The *Pelcinus* n. sp. 27 from Carnarvon Station is one of many new *Pelcinus* species awaiting description.

Six species of lynx spiders (Oxyopidae) collected at Carnarvon Station are most probably new to science. Lynx spiders are common in all vegetated terrestrial habitats throughout Australia. The published record for lynx spiders in Australia lists 19 species in four genera of which *Oxyopes* is most common. The Australian lynx spiders have been taxonomically revised in a thesis, but most of the results remain unpublished and are therefore nomenclaturally invalid.

Jumping spiders (Salticidae) are the most species rich and diverse of all spider families in Australia. Two new species of peacock spiders were found in bluegrass at Carnarvon Station. They have a spectacular colourful back with shiny silvery or iridescent hairs and are named peacock spiders because of the lovely dance the male presents to the female. These new species are *Maratus julianneae* Baehr & Whyte 2016 and *Maratus licunxini* Baehr & Whyte 2016.

The comb-footed spiders (Theridiidae) are an extremely diverse family and many genera and species await description. A comb-footed spider belonging to a new genus and a new species from the subfamily Hadrotarsinae was identified from Carnarvon Station.

Ant-eating spiders (Zodariidae) are the most diverse ground dwelling hunters at Carnarvon Station. Although some genera are recently revised, others are still unknown. One of them is the newly described genus *Nosterella*, with *Nosterella fitzgibboni* Baehr & Jocque 2017 found at Carnarvon Station in Brigalow.

It is unknown whether these new species are endemic to the Carnarvon Ranges.

### *Snails and slugs*

Five putative new species of land snail were recorded. So far these species are only known from the Carnarvon Station vine thickets. These vegetation communities are important refugia for a large number of invertebrate species and the prospect of these land snail species being restricted to these vine thickets highlights their importance for biodiversity conservation at the local level. In addition, specimens collected on the Bush Blitz facilitated the description of a new species of camaenid, *Pallidelix simonhudsoni*; this had previously been collected but could not be described on the basis of the material available.

### *Stygofauna*

All but one of the eight stygofauna species collected are putative new species. Stygofauna have very small distributions: they are confined to individual aquifers or catchments, so the chance of finding new species is high.

**Table 3 Putative new invertebrate species**

Family	Species
<b>Bees</b>	
Colletidae	<i>Hylaeus</i> n. sp. RLCA08
<b>Flies</b>	
Therevidae	Therevidae New Gen. New sp. CNBB sp. 01

<b>Family</b>	<b>Species</b>
<b>Beetles</b>	
Carabidae	<i>Carenum</i> n. sp. 01
Carabidae	<i>Carenum</i> n. sp. 02
Carabidae	<i>Carenum</i> n. sp. 04
Carabidae	<i>Carenum</i> n. sp. 05
Carabidae	<i>Castelnaudia</i> n. sp. 06
Carabidae	<i>Euryscaphus</i> n. sp. 03
Carabidae	<i>Hypharpax</i> n. sp. 09
Carabidae	<i>Pamborus</i> n. sp. 07
Carabidae	<i>Prosopogmus</i> n. sp. 08
Ripiphoridae	<i>Macrosiagon</i> CNBB sp. 01
<b>True bugs</b>	
Miridae	<i>Exocarpocoris</i> prob. BBCQLD14 n. sp. 087
Miridae	gn_Orthotylinae BBCQLD14 n. sp. 083
Miridae	gn_Mirinae_001_n.gen. BBCQLD14 n. sp. 075
Miridae	gn_Mirinae_005 BBCQLD14 n. sp. 100
Miridae	gn_Orthotylinae_001 BBCQLD14 n. sp. 103
Miridae	gn_Orthotylinae_002 BBCQLD14 n. sp. 107
Miridae	gn_Orthotylinae_003 BBCQLD14 n. sp. 106
Miridae	gn_Orthotylinae_004 BBCQLD14 n. sp. 108
Miridae	gn_Orthotylinae_006 BBCQLD14 n. sp. 078
Miridae	gn_Orthotylinae_007 BBCQLD14 n. sp. 079
Miridae	gn_Orthotylinae_008 BBCQLD14 n. sp. 081
Miridae	gn_Orthotylinae_010 BBCQLD14 n. sp. 091
Miridae	gn_Orthotylinae_011 BBCQLD14 n. sp. 092
Miridae	gn_Orthotylinae_011 BBCQLD14 n. sp. 117
Miridae	gn_Orthotylinae_012 BBCQLD14 n. sp. 093
Miridae	gn_Orthotylinae_013 BBCQLD14 n. sp. 104
Miridae	gn_Orthotylinae_014 BBCQLD14 n. sp. 099

<b>Family</b>	<b>Species</b>
Miridae	gn_Orthotylinae_015 BBCQLD14 n. sp. 098
Miridae	gn_Orthotylinae_016 BBCQLD14 n. sp. 119
Miridae	gn_Orthotylinae_017 BBCQLD14 n. sp. 120
Miridae	gn_Orthotylinae_019 BBCQLD14 n. sp. 116
Miridae	gn_Phylinae_004 (prob. <i>Wallabicoris</i> ) BBCQLD14 n. sp. 086
Miridae	gn_Phylinae_008 BBCQLD14 n. sp. 094
Miridae	gn_Phylinae_009 BBCQLD14 n. sp. 102
Miridae	gn_Phylinae_010 BBCQLD14 n. sp. 121
Miridae	gn_Phylinae_011 BBCQLD14 n. sp. 095
Miridae	gn_Phylinae_018 BBCQLD14 n. sp. 114
Miridae	gn_Phylinae_20 BBCQLD14 n. sp. 109
Miridae	gn_Phylinae_21 BBCQLD14 n. sp. 112
Miridae	gn_Phylinae_22 BBCQLD14 n. sp. 113
Miridae	gn_Phylinae_23 BBCQLD14 n. sp. 115
Miridae	<i>Pseudoloxops</i> BBCQLD14 n. sp. 082
Miridae	<i>Rayieria</i> BBCQLD14 n. sp. 077
Miridae	<i>Surinomellini</i> BBCQLD14 n. sp. 118
Tingidae	<i>Epimixia</i> BBCQLD14 n. sp. 066
Tingidae	<i>Epimixia</i> BBCQLD14 n. sp. 067
Tingidae	<i>Tingis</i> BBCQLD14 n. sp. 073 nr <i>perkensi</i>
<b>Cicadas</b>	
Cicadidae	<i>Yoyetta</i> CNBB sp. 01
<b>Thrips</b>	
Phlaeothripidae	<i>Azaleothrips</i> sp. 01
Phlaeothripidae	<i>Brakothrips</i> sp. 01
Phlaeothripidae	<i>Carientothrips</i> sp. 01
Phlaeothripidae	<i>Cryptothrips</i> sp. 01
Phlaeothripidae	<i>Deplorothrips</i> sp. 01
Phlaeothripidae	<i>Dyothrips</i> sp. 01

<b>Family</b>	<b>Species</b>
Phlaeothripidae	<i>Ethirotrips</i> sp. 01
Phlaeothripidae	<i>Ethirotrips</i> sp. 02
Phlaeothripidae	<i>Ethirotrips</i> sp. 03
Phlaeothripidae	<i>Gastrothrips</i> sp. 01
Phlaeothripidae	<i>Holoengythrips</i> sp. 01
Phlaeothripidae	<i>Hoplandrothrips</i> sp. 01
Phlaeothripidae	<i>Hoplothrips</i> sp. 01
Phlaeothripidae	<i>Kellyia</i> sp. 01
Phlaeothripidae	<i>Kladothrips</i> sp. 01
Phlaeothripidae	<i>Lichanothrips</i> sp. 01
Phlaeothripidae	<i>Lissothrips</i> sp. 01
Phlaeothripidae	Phlaeothripinae gen. 01 (gen. nr <i>Plectrothrips</i> )
Phlaeothripidae	Phlaeothripinae gen. 03 (gen. nr <i>Phlaeothrips</i> )
Phlaeothripidae	Phlaeothripinae gen. 06 (gen. nr <i>Azaleothrips</i> )
Phlaeothripidae	Phlaeothripinae gen. 09 (gen. nr <i>Hoplothrips</i> )
Phlaeothripidae	<i>Plectrothrips</i> sp. 01
Phlaeothripidae	<i>Rhopalothripoides</i> sp. 01
Phlaeothripidae	<i>Strepterothrips</i> sp. 01
Phlaeothripidae	<i>Teuchothrips</i> sp. 01
Phlaeothripidae	<i>Teuchothrips</i> sp. 02
Phlaeothripidae	<i>Teuchothrips</i> sp. 03
Phlaeothripidae	<i>Xyelethrips</i> sp. 01
Thripidae	<i>Anaphothrips</i> sp. 01
Thripidae	<i>Odontothripiella</i> sp. 01
Thripidae	<i>Odontothripiella</i> sp. 02
<b>Spiders</b>	
Barychelidae	<i>Ozicrypta</i> n. sp. 26
Barychelidae	<i>Trittame</i> n. sp. 47
Corinnidae	Corinnidae n. gen. n. sp. 20

Family	Species
Cycloctenidae	Cycloctenidae n. gen. n. sp. 25
Desidae	Desidae n. gen. n. sp. 18
Desidae	<i>Forsterina</i> n. sp. 05
Desidae	<i>Forsterina</i> n. sp. 36
Idiopidae	<i>Aganippe</i> n. sp. 08
Idiopidae	<i>Arbanitis</i> n. sp. 14
Lamponidae	<i>Lampona</i> n. sp. 44
Lycosidae	<i>Tasmanicosa fulgor</i> Framenau & Baehr 2016
Miturgidae	<i>Miturga</i> n. sp. 11
Miturgidae	<i>Miturga</i> n. sp. 28
Nemesiidae	<i>Aname</i> n. sp. 06
Oxyopidae	<i>Pelcinus</i> n. sp. 27
Oxyopidae	<i>Oxyopes</i> n. sp. 30
Oxyopidae	<i>Oxyopes</i> n. sp. 31
Oxyopidae	<i>Oxyopes</i> n. sp. 32
Oxyopidae	<i>Oxyopes</i> n. sp. 35
Oxyopidae	<i>Oxyopes</i> n. sp. 38
Oxyopidae	<i>Oxyopes</i> n. sp. 39
Salticidae	<i>Maratus julianneae</i> Baehr & Whyte 2016
Salticidae	<i>Maratus licunxini</i> Baehr & Whyte 2016
Salticidae	<i>Rhombonotus</i> n. sp. 23
Selenopidae	<i>Karaops</i> n. sp. 09
Sparassidae	<i>Isopedella</i> n. sp. 42
Sparassidae	<i>Neosparassus</i> n. sp. 41
Theridiidae	Hadrotarsinae n. gen. n. sp. 16
Trochanteriidae	<i>Hemicloeina</i> n. sp. 40
Trochanteriidae	<i>Hemicloeina</i> n. sp. 43
Zodariidae	<i>Neostorena</i> n. sp. 12
Zodariidae	<i>Neostorena</i> n. sp. 29

Family	Species
Zodariidae	<i>Nosterella fitzgibboni</i> Baehr & Jocque 2017
Zoridae	<i>Hestimodema</i> n. sp. 10
<b>Crustaceans</b>	
[Class Ostracoda]	Ostracoda n. sp.
[Order Cyclopoida]	Cyclopoida n. sp.
[Order Harpacticoida]	Harpacticoida n. sp.
Paramelitidae	Paramelitidae new gen. n. sp. RLCA26
Paramelitidae	Paramelitidae new gen. n. sp. RLCA27
<b>Annelida</b>	
[Class Oligochaeta]	Oligochaeta n. sp.
<b>Snails</b>	
Charopidae	Charopidae BL 39
Charopidae	Charopidae BL 40
Charopidae	Charopidae BL 41
Helicarionidae	Helicarionidae BL 26
Punctidae	Punctidae BL 3
<b>Platyhelminthes</b>	
[Class Turbellaria]	Microturbellaria n. sp.

## Threatened species

Australia is home to an estimated 580,000–680,000 species, most of which have not been described. Approximately 92% of Australian plants, 87% of mammals, 93% of reptiles and 45% of birds are endemic. Changes to the landscape resulting from human activity have put many of these unique species at risk. Over the last 200 years, many species have become extinct; many others are considered to be threatened, i.e. at risk of extinction.<sup>1</sup>

### Fauna

#### *Mammals*

South-eastern Long-eared Bat or Corben's Long-eared Bat (*Nyctophilus corbeni*) is listed under the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999* (EBPC Act) and

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<sup>1</sup> Chapman, A. D. 2009, *Numbers of Living Species in Australia and the World*, 2nd edn. Australian Biological Resources Study, Canberra.

Queensland's *Nature Conservation Act 1992 (NCA)* as Vulnerable. The species record is new for the reserve and extends its northern range. More knowledge is needed about its range in Queensland: the two specimens collected will be a valuable reference.

A skull collected on the reserve in 2008 was identified as belonging to a Koala (*Phascolarctos cinereus*) however this species was not observed during the survey period. Koala is listed as Vulnerable (EPBC Act & NCA) in south-east Queensland.

### Birds

Bird species sighted during the survey period were recorded by Brian Hawkins of the Bush Blitz team. Sightings included Squatter Pigeon (southern), *Geophaps scripta scripta*, which is listed as Vulnerable under the EPBC Act and NCA.

### Reptiles

A single juvenile specimen of an Adorned Delma (*Delma torquata*) was collected in an invertebrate trap. The species is listed as Vulnerable under the EPBC Act and NCA.

The Adorned Delma is more common in south-east Queensland, with a stronghold in Brisbane's western suburbs; however, its distribution is notoriously patchy with recent observations including the Blackdown Tablelands and Roma area. The vouchered record nearest to Carnarvon Station was collected in 2004 from the Warrego Stock Route, approximately 190 km to the south. Populations of this species are usually sparse. Its distribution and biology are poorly understood.

The record of the Adorned Delma highlights the importance of Carnarvon Station as a conservation reserve. Further survey work is recommended at the capture site and other areas of potential habitat to determine its population size and distribution within the reserve.

**Table 4 Threatened vertebrate fauna species**

Family	Species	Common name	Status	Abundance
<b>Mammals</b>				
Phascolarctidae	<i>Phascolarctos cinereus</i>	Koala	Vulnerable EPBC & NCA	Unknown
Vespertilionidae	<i>Nyctophilus corbeni</i>	South-eastern Long-eared Bat; Corben's Long-eared Bat	Vulnerable EPBC & NCA	Unknown
<b>Birds</b>				
Columbidae	<i>Geophaps scripta scripta</i>	Squatter Pigeon (southern)	Vulnerable EPBC & NCA	Unknown
<b>Reptiles</b>				
Pygopodidae	<i>Delma torquata</i>	Adorned Delma	Vulnerable EPBC & NCA	Unknown

## Flora

Collections were made of two threatened plant species.

Austral Cornflower or Native Thistle (*Rhaponticum australe*) is listed as Vulnerable at both the State and Commonwealth level. Historical records show it occurring as far south as Victoria. It is now considered extinct in NSW and Victoria due to vegetation clearing, grazing and urban development.

Hairy Anchor Plant or Australian Anchor Plant (*Discaria pubescens*), while widespread, is considered Near Threatened in Queensland. It is at risk from vegetation clearing, habitat fragmentation and grazing. It resembles a number of spiny introduced weeds, which may place it at risk of accidental destruction during weed control programs.

Table 5 lists the flowering plant species that were found during the survey that are protected under the EPBC Act and NCA.

**Table 5** Threatened flowering plants

Family	Species	Common name	Status	Comments
Asteraceae	<i>Rhaponticum australe</i>	Austral Cornflower, Native Thistle	Vulnerable EPBC & NCA	South side of Channin Creek opposite homestead, beside eastern side of driveway. Common at the collection site; according to the local staff this is the only known population on the reserve. It is not known whether an earlier recorded population (2001) still exists.
Rhamnaceae	<i>Discaria pubescens</i>	Hairy Anchor Plant, Australian Anchor Plant	Near Threatened NCA	Upper Channin Road, near crossing over Channin Creek, between the road and creek. Rare.

## Exotic and pest species

Conservation reserves help protect Australia's rare and threatened ecosystems and provide refuge for species at risk. Invasive species can have a major impact on already vulnerable species and ecosystems, as well as economic, environmental and social impacts. The inclusion of exotic and pest species records as part of this report is designed to provide land managers with baseline information to assist with further pest management programs.

## Fauna

### Vertebrates

Table 6 lists the exotic and pest vertebrate species that were recorded in the reserve.

**Table 6 Exotic and pest vertebrate species**

Family	Species	Common name	Abundance/Comments
<b>Mammals</b>			
Canidae	<i>Canis familiaris</i>	Dog or Dingo	Piebald Spring, skull bone remains
Felidae	<i>Felis catus</i>	Cat	Fig Tree Road, observed during spotlighting
Leporidae	<i>Oryctolagus cuniculus</i>	Rabbit	Spine Road, observed during spotlighting
Muridae	<i>Mus musculus</i>	Mouse	Common at several locations (15 Mile Bore, Honeymoon Shack, Piebald Spring, Conglomerate Spring, Homestead)
Suidae	<i>Sus scrofa</i>	Pig	Diggings at Piebald Springs and along road after rain, scats
<b>Birds</b>			
Sturnidae	<i>Sturnus tristis</i>	Common Myna	New record for the reserve
<b>Frogs</b>			
Bufoidea	<i>Rhinella marina</i>	Cane Toad	Common. Vouchered at three localities on the station (homestead, Spine Road, Piebald Spring) but commonly encountered, especially in and around waterways

### **Invertebrates**

#### *Bees*

The European Honey Bee (*Apis mellifera*), an introduced species, although recorded during the survey was not abundant. It is not a listed pest but may behave like one under certain circumstances. Feral colonies can take over or occupy nesting hollows that are otherwise used by birds such as breeding parrots, lorikeets and cockatoos. European Honey Bees may also compete with native bees, birds and small mammals for nectar and pollen when these resources are scarce. To control feral honey bees it is necessary to minimise access to water.

#### *True bugs*

The Rutherglen Bug (*Nysius vinitor*) was collected at multiple sites. This minor pest is a widespread native species that can migrate into crops in very large numbers during favourable seasons.

#### *Thrips*

Three common species of pest thrips were collected during the survey.

Plague Thrips (*Thrips imaginis*) is endemic to Australia, highly polyphagous and found in large numbers in flowers of native and introduced plants. It causes damage to plants by feeding in flowers, particularly

of apples, grapes, strawberries and stone fruit. Numbers increase in early spring and are highest in summer. It is known from Australia, New Calendoncia and New Zealand. Despite the economic importance of this species no recent biology studies have been undertaken for Plague Thrips.

Onion Thrips (*Thrips tabaci*) is generally widespread throughout the temperate regions of the world and rare in the wet tropics. In Australia low numbers are found on native vegetation, however large populations can develop on some crops, particularly *Allium* spp. (e.g. onions, garlic, leeks), cereals, potatoes, vines and glasshouse crops. It feeds on flowers and leaves of many crops and also predate on mites.

Tomato Thrips (*Frankliniella schultzei*) is believed to have originated from South America or Africa but is now considered to be pantropical: it occurs across Australia. It is a pest on cultivated plants feeding on the flowers and leaves of cotton, lettuce, beans, cucurbits and onions. Tomato Thrips is also known to be a vector of tospoviruses, which cause spotting and wilting in a large number of plant families, including food crops such as peanuts, watermelons and tomatoes, and ornamental species such as calla lily, chrysanthemums and iris.

### Snails

A Three-band Garden Slug, *Ambigolimax valentianus*, was recorded from under timber around Carnarvon Station homestead. This species has been recorded from Brisbane and Perth; however, as a Northern Hemisphere-derived worldwide tramp it is likely to have a much wider Australian distribution. Examining specimens in local museum collections is needed to verify the Australian distribution of this species, since it is easily confused with *Ambigolimax nyctelia*.

Table 7 lists the exotic and pest invertebrate species that were collected in the reserve.

**Table 7 Exotic and pest invertebrate species**

Family	Species	Common name	Abundance
<b>Bees</b>			
Apidae	<i>Apis mellifera</i>	European Honey Bee	Not abundant
<b>True Bugs</b>			
Lygaeidae	<i>Nysius vinitor</i>	Rutherglen Bug	Found at multiple sites
<b>Thrips</b>			
Thripidae	<i>Frankliniella schultzei</i>	Tomato Thrips	Very low. Recorded on <i>Swainsona</i> sp.
Thripidae	<i>Thrips imaginis</i>	Plague Thrips	Very low. Recorded on <i>Lysicarpus angustifolius</i> flowers.
Thripidae	<i>Thrips tabaci</i>	Onion Thrips	Very low at all sites. Recorded on <i>Swainsona</i> sp., <i>Rosa banksiae</i> , <i>Casuarina cunninghami</i> and <i>Brachyloma daphnoides</i> flowers.

Family	Species	Common name	Abundance
<b>Snail and Slugs</b>			
Limacidae	<i>Ambigolimax valentianus</i>	Three-band Garden Slug	Probably widespread and confused in collections with the widespread <i>Ambigolimax nyctelia</i> ; reliably recorded from Queensland (Brisbane) and Western Australia (Perth)

## Flora

The majority of the introduced plants collected were found at disturbed sites such as roadsides, dam margins and the previously cultivated valley floor. Whoa-boys (low profile, trafficable earth banks that intercept run-off flowing down roads and tracks) and cuttings beside creek crossings were notable for being extremely weedy. Less disturbed areas had generally low numbers of weeds. While some of the plants are known to be problematic in other locations the majority are generally considered benign in undisturbed environments.

Of the 17 introduced species recorded, none are currently listed under Commonwealth or State legislation. Seven taxa (*Argemone ochroleuca* subsp. *ochroleuca*, *Bidens pilosa*, *Centaurea melitensis*, *Cyperus brevifolius*, *Glandularia aristigera*, *Lepidium bonariense* and *Zinnia peruviana*) are considered potential environmental weeds in Queensland.

Kyllinga Weed or Mullumbimby Couch (*Cyperus brevifolius*), common at the source of Mailman Springs, has the potential to invade other wetland sites within the reserve. It could spread by water movement or by animals such as stock or water birds.

There is some taxonomic uncertainty about the status of Couch (*Cynodon dactylon* var. *dactylon*); both native and introduced forms are thought to occur in Australia. Either way, Couch appears to be rare in the reserve with only one population seen during the survey; but there is a 2001 collection record from close to the homestead. It has almost formed a monoculture in the dry creek bed where it was collected, suggesting that it could be a problem weed if conditions favour its dispersal.

Table 8 lists the introduced weeds that were identified.

**Table 8 Non-gazetted weed species**

Family	Species	Common name	Abundance/Comments
Asteraceae	<i>Bidens pilosa</i>	Cobbler's Pegs	Piebald Circuit. Southern end of circuit. Generally restricted to disturbed areas such as pig rooting sites, and recently burnt area at Fig Tree Spring. Abundant when present.
Asteraceae	<i>Centaurea melitensis</i>	Maltese Cockspur	Wet Weather Road, north-east of 15 Mile Trapping Yard. Uncommon. Potential environmental weed in Qld.

Family	Species	Common name	Abundance/Comments
Asteraceae	<i>Verbesina encelioides</i>	Wild Sunflower, Crownbeard	White Stallion Road at Channin Creek crossing. Whoa-boy (erosion control bank) on north side of the creek. Common at site but not widely seen throughout Reserve.
Asteraceae	<i>Zinnia peruviana</i>	Field Zinnia, Wild Zinnia	High Country Road, about 9.6 km north-east of the homestead. Scattered, found in disturbed areas such as whoa-boys. Potential environmental weed in Qld.
Brassicaceae	<i>Brassica tournefortii</i>	Mediterranean Turnip	Beside driveway to homestead 200 m before the ford on the south side of Channin Creek. Frequently seen, mostly at disturbed sites.
Brassicaceae	<i>Lepidium bonariense</i>	Peppergrass	Beside driveway to homestead 200 m before the ford on the south side of Channin Creek. Very common at weedy roadside areas. Potential environmental weed in Qld.
Cyperaceae	<i>Cyperus brevifolius</i>	Kyllinga Weed, Mullumbimby Couch	Common at the source of Mailman Spring. Not seen at the other springs visited. Potential environmental weed in Qld.
Fabaceae	<i>Medicago polymorpha</i>	Burr Medic	Beside driveway to homestead 200 m before the ford on the south side of Channin Creek. Locally abundant in disturbed areas.
Lamiaceae	<i>Salvia reflexa</i>	Mintweed	Lorikeet Circuit, about 2.3 km west of turn off to Lorikeet Spring. Rare.
Malvaceae	<i>Modiola caroliniana</i>	Red-flowered Mallow	Beside driveway to homestead 200 m before the ford on the south side of Channin Creek. Restricted to disturbed areas.
Onagraceae	<i>Oenothera curtiflora</i>	Velvetweed	Channin Creek crossing, just before the fork in the road to Fig Tree and Ti Tree Springs. Common at the site but not seen elsewhere on the reserve.

Family	Species	Common name	Abundance/Comments
Papaveraceae	<i>Argemone ochroleuca</i> subsp. <i>ochroleuca</i>	Prickly Poppy, Mexican Poppy	White Stallion Road at Channin Creek crossing. Erosion control bank on the north side of the creek. Abundant where found but restricted to disturbed areas. Potential environmental weed in Qld.
Papaveraceae	<i>Papaver aculeatum</i>	Native Poppy, Bristle Poppy	Channin Creek crossing, just before the fork in the road to Fig Tree and Ti Tree Springs. Common at this site but not seen elsewhere on the reserve.
Poaceae	<i>Cynodon dactylon</i> var. <i>dactylon</i>	Couch	Caves Creek Road, about 1.6 km from the south west boundary. Creek perpendicular to eastern side of the road running in a north-westerly direction. Dominant where found but not seen elsewhere on the reserve.
Poaceae	<i>Melinis repens</i>	Natal Grass	Recorded as a host plant by the Heteroptera team. No voucher taken.
Verbenaceae	<i>Glandularia aristigera</i>	Mayne's Pest	Beside driveway to homestead 200 m before the ford on the south side of Channin Creek. Common along the roadside, especially on the valley floor. Potential environmental weed in Qld.
Verbenaceae	<i>Verbena bonariensis</i>	Purpletop Verbena	Near Lorikeet Spring, on the track to Barking Owl Spring. Frequent in disturbed areas.

## Range extensions

### Fauna

#### Vertebrates

##### Bats

The two specimens of South-eastern Long-eared Bat or Corben's Long-eared Bat (*Nyctophilus corbeni*) collected extend its northern range by 75 km and will become a valuable reference resource.

##### Reptiles

The specimen of Southern Spotted Velvet Gecko (*Oedura tryoni*) is the most westerly record in the Queensland Museum collection. The distribution of Adorned Delma (*Delma torquata*) is poorly understood—although centred in the suburbs of Brisbane and the Toowoomba Ranges, it has turned up in several, apparently isolated sites, to which Carnarvon Station can now be added.

### **Invertebrates**

The Queensland Museum Entomology Report includes many first records for Carnarvon Station. The nearby Carnarvon National Park has been well surveyed, particularly the Mt Moffatt section of the park (30 km away). If a species has not been recorded from Carnarvon National Park, it is considered a significant range extension. If a species has never been recorded from anywhere except Carnarvon National Park, it is considered a scientifically important range extension. Range extensions were recorded for 27 fly, 48 butterfly and 17 damselfly/dragonfly species however only those considered either significant or scientifically important have been included in [Table 9](#). Some of these range extensions are known from collections made during a 2010 survey—these are noted below and appear in [blue text](#) in the table.

For some invertebrate species, including moths and thrips, there was not enough data on their distribution to enable comment on range extensions. Range extensions do not apply to stygofauna because dispersal to adjacent aquifers is not possible.

#### **Ants**

The collection of the ant *Leptomyrmex aitchisoni* appears to be a large north-westerly range extension of over 500 km. This species has been recorded as relatively widespread in north-eastern NSW and south-eastern Queensland, as far north as Crows Nest National Park. It has been found previously in a range of forest habitats from wet sclerophyll to rainforest, where it nests under stones, quite unlike the habitats of Brigalow and Callitris stands from where it was first recorded on the reserve in 2010.

#### **Bees**

Range extensions for native bee species are not known as fine scale distribution data is not available; however, Carnarvon Station is an outlier in the distribution of a number of taxa recorded, though the reason is unclear.

#### **Butterflies**

Two butterfly species recorded during the survey are not recorded from Carnarvon National Park: the Moonlight Jewel (*Hypochrysops delicia delicia*) and the Brown Ringlet (*Hypocysta metirius*). The subspecies *Hypochrysops delicia duaringae* has been collected from Duaringa, 220 km from Carnarvon Station, but that subspecies is very dark and quite distinct from *Hypochrysops delicia delicia*.

#### **Flies**

The record of the march fly *Palimmecomomyia walkeri* represents a range extension of around 600 km—the nearest record was from Brisbane Forest Park. Other noteworthy range extensions include *Microconops fasciatus*, *Physocephala australiana*, *Agapophytus decorus*, *Manestella cooloola*, *Manestella obscura* and *Pseudotabanus silvester*, which was only recorded during the 2010 survey.

#### **Beetles**

Notable range extensions include *Ancita marginicollis*, *Rhinophthalmus nasutus*, *Hispellinus multispinosus*, *Coccinella transversalis* and *Leperina lacera*. There are no records of *Leperina lacera* in the Atlas of Living Australia (ALA) and the Australian Faunal Directory records the species merely from NSW.

### True bugs

For all the true bug species identified, all records represent minor range extensions however these are not considered significant because of a lack of background data.

### Damselflies

The collection of the Common Bluetail (*Ischnura heterosticta heterosticta*) was a new record for the area in 2010, with the nearest records from Taroom over 200 km away.

### Snails

Specimens of six described species of land snail represent western extension of their ranges.

## Flora

A number of the plant collections have filled distribution gaps in the area with seven extending the confirmed ranges of those taxa in Queensland. The collections have helped fill some distributional gaps and added to the known vascular flora of the reserve.

**Table 9 Range extensions**

Family	Species	Common name	Nearest previous record
<b>Bats</b>			
Rhinolophidae	<i>Rhinolophus megaphyllus</i>	Eastern Horseshoe-bat	56 km to the south east, Carnarvon Creek crossing 180km to the north, Peak Vale
Vespertilionidae	<i>Nyctophilus corbeni</i>	South-eastern Long-eared Bat; Corben's Long-eared Bat	110 km to NW, 80km west of Taroom
<b>Reptiles</b>			
Diplodactylidae	<i>Oedura tryoni</i>	Southern Spotted Velvet Gecko	28 km, Kenniff Caves
Pygopodidae	<i>Delma torquata</i>	Adorned Delma	190 km, the Warrego Stock Route
<b>Ants</b>			
Formicidae	<i>Leptomyrmex aitchisoni</i>	An ant	520 km, Crows Nest National Park
<b>Butterflies</b>			
Lycaenidae	<i>Hypochrysops delicia delicia</i>	Moonlight Jewel	390 km, Miriam Vale for this subspecies, 220km at Duaringa for the species
Nymphalidae	<i>Hypocysta metirius</i>	Brown Ringlet	160 km, Blackdown Tableland

Family	Species	Common name	Nearest previous record
<b>Flies</b>			
Bombyliidae	<i>Thevenetimyia furvicostata</i>	A beefly	400 km, known only from the type locality, Westwood QLD
Conopidae	<i>Microconops fasciatus</i>	A thick-headed fly	341 km
Conopidae	<i>Neoconops glaber</i>	A thick-headed fly	30 km, known only from the type, Mt Moffatt
Conopidae	<i>Physocephala australiana</i>	A thick-headed fly	440 km, Biggenden
Mydidae	<i>Neorhaphiomidas queenslandensis</i>	A mydas fly	30 km, only known from the type locality, Mt Moffatt
Tabanidae	<i>Palimmecomomyia walkeri</i>	A march fly	600 km, Brisbane
Tabanidae	<i>Pseudotabanus silvester</i>	A march fly	220 km, Duaringa
Tephritidae	<i>Dioxyna hyalina</i>	A fruit fly	214 km, Moura
Tephritidae	<i>Paraspathulina apicomacula</i>	A fruit fly	214 km, Moura and 240 km, Charleville
Tephritidae	<i>Trupanea glauca</i>	A fruit fly	450 km, widespread in coastal QLD and Eungella
Therevidae	<i>Agapophytus decorus</i>	A stiletto fly	550 km, described only from south-east QLD at Brisbane Forest Park and Rainbow Beach
Therevidae	<i>Anabarhynchus moffat</i>	A stiletto fly	30 km, described only from Mt Moffatt
Therevidae	<i>Manestella cooloola</i>	A stiletto fly	550 km, described only from south-east QLD in the Great Sandy National Park and Bribie Island
Therevidae	<i>Manestella obscura</i>	A stiletto fly	600 km, described only from Brisbane
<b>Beetles</b>			
Cerambycidae	<i>Ancita marginicollis</i>	A beetle	400 km, Bunya Mountains
Cerambycidae	<i>Rhinophthalmus nasutus</i>	A beetle	300 km, Mackay

Family	Species	Common name	Nearest previous record
Chrysomelidae	<i>Hispellinus multispinosus</i>	A beetle	300 km, Mackay
Coccinellidae	<i>Coccinella transversalis</i>	A beetle	80 km, Springsure
Trogossitidae	<i>Leperina lacera</i>	A beetle	NSW
<b>Damselflies</b>			
Coenagrionidae	<i>Ischnura heterosticta heterosticta</i>	Common Bluetail	230 km, Taroom
<b>Flowering plants</b>			
Apocynaceae	<i>Alyxia ruscifolia</i>	Chain Fruit	80 km. The furthest inland record for Queensland, along with a collection from 50 km WNW on the Nogoa River from 1891.
Hemerocallidaceae	<i>Caesia parviflora</i> var. <i>parviflora</i>	Grass-lily	100 km. Most inland collection of this variety in Queensland. Two collections of the species (not identified to infraspecific level) recorded in the Mt Moffatt and Gorge sections of Carnarvon National Park.
Vitaceae	<i>Cissus oblonga</i>	—	40 km. The furthest inland record for Queensland along with a collection from 50 km WNW on the Nogoa River from 1890.
Hemerocallidaceae	<i>Geitonoplesium cymosum</i>	Climbing Lily	250 km. Furthest inland collection. Quite disjunct from the generally more coastal collections.
Philydraceae	<i>Philydrum lanuginosum</i>	Frogsmouth	100 km. Furthest inland collection in Queensland (excluding Lawn Hill National Park and Westmoreland valley collections near the northern border with the Northern Territory). Appears to be a recent arrival to the reserve.

Family	Species	Common name	Nearest previous record
Ranunculaceae	<i>Ranunculus inundatus</i>	River Buttercup	270 km. Most north-westerly confirmed collection in Qld; quite disjunct from other collections.
Asteraceae	<i>Senecio pinnatifolius</i> var. <i>pinnatifolius</i>	Common Coast Groundsel	75 km. Furthest inland collection in Qld.

## Other points of interest

### Fauna

#### Vertebrates

Some parts of the reserve were not sampled sufficiently due to time constraints and rain restricting travel. Further survey work would increase the number of vertebrate species known from the reserve.

#### Mammals

Twenty-one native mammal species were recorded through trapping, observations and from remains (including a skull from a Koala from previous survey work by Elizabeth Leichid, 2008). The survey has added significantly to the collection from this area—previously, only the Delicate Mouse (*Pseudomys delicatulus*), Central Short-tailed Mouse (*Leggadina foresti*) and Narrow-nosed Planigale (*Planigale tenuirostris*) were represented in the Queensland Museum collection from Carnarvon Station. Five species not previously recorded on the reserve were also added to the species list.

Three rodent species were collected, with Pale Field-rat (*Rattus tunneyi*) being a new species record for the reserve. Vouchering specimens to confirm identification is important for all rodent species. Often skull features need to be inspected to positively identify some species.

Additional bat species were recorded for the region, including Eastern Horseshoe-bat (*Rhinolophus megaphyllus*) and two species of vesper bats (*Nyctophilus* spp.). More search effort is needed to collect free-tailed bats (*Mormopterus* spp.). A review of *Mormopterus* spp is currently underway and specimens from this area would be useful. Close examination of physical features and tissue samples from vouchered specimens will help resolve some of the taxonomy of this group, and is generally necessary to identify many species of bat.

The Common Planigale (*Planigale maculata*) was the only dasyurid found in the survey although *Planigale tenuirostris* has been previously recorded from this site. Antechinus species are currently under review and a specimen from this region would be useful.

Only two macropod species were observed and another two identified from skulls. The lack of common macropod species in the reserve is bewildering and needs further investigation. Eastern Grey Kangaroos (*Macropus giganteus*), for example, were uncommon in the reserve but numerous on adjacent property roads.

### *Reptiles and amphibians*

The survey increased the number of amphibian and reptile species represented by museum specimens from Carnarvon Station from 24 to 45. Only one other survey, by Queensland Environment Protection Agency staff in 2005, resulted in vouchered herpetological specimens from the reserve (17 specimens). Otherwise, the only other specimens were collected via Queensland Museum entomology pitfall traps in 2010 (32 specimens).

### *Invertebrates*

#### *Bees*

There were no previous records of native bees on the reserve. A number of species were common and widespread in the reserve especially in the family Apidae. Sugarbag or stingless bees (*Tetragonula* spp.) were found on most flowering plants and caught in the vehicle net. These species are the only native bees in Australia that are highly social. Other common species were *Braunsapis* and *Exoneura* (Allodapine genera). *Braunsapis* is especially common in the subtropics. *Exoneura* are mainly found in southern Australia and along the east coast until about the NSW–QLD border. Carnarvon Station represents a north-west inland outlier in their distribution. The large metallic Green Carpenter Bee (*Xylocopa bombylans*) was common in the east of the reserve, where it excavates nests in old flowering stalks of Johnson's Grass Tree (*Xanthorrhoea johnsonii*). The main distribution of this species is from around Sydney north towards Papua New Guinea. Carnarvon Station also represents a far inland outlier for this species' distribution. Apart from the Green Carpenter Bee, there was no overlap with the species documented from Carnarvon National Park.

The results of this survey are a snapshot of the potential bee biodiversity of the reserve. Most species were only encountered in low numbers and collected during a short period. Longer survey times in different seasons will record more species.

#### *Butterflies*

Collecting 37 butterfly species was remarkable, considering they were only a small part of the target taxa. In total, 49 butterfly species have been collected at Carnarvon Station and 81 at Carnarvon National Park.

#### *Moths*

Twenty-seven moth species from 11 families have now been documented for Carnarvon Station.

#### *Flies*

Highlights included the collection of two species previously known only from Mount Moffat—*Neoconops glaber*, a species known only by a single specimen, and *Neorhaphiomidas queenslandensis*, a recently described species.

The behaviour of Therevidae New Gen. New sp. CNBB sp. 01 was able to be observed and documented before collection. Specimens of this undescribed genus have been collected from Mount Moffatt, Carnarvon Gorge, Expedition Range and Barakula. Molecular studies have been carried out on several of the populations, including those at Carnarvon Station, and work to revise the taxonomy is underway.

The march flies *Palimmecomyia walkeri* were reported to be attacking people, which is unusual as they are considered to be nectar feeders.

The collection of four undescribed species of robber flies (Asilidae) during the 2010 and 2014 surveys have provided more material for research currently underway to revise this group.

### *Beetles*

Around half of the beetle taxa collected by Queensland Museum could only be identified to genus. Three of the species—*Eleale lepida*, *Adelium augurale* and *Micraspis frenata*—have also been collected from Carnarvon National Park. The collection of the putative new species of bark beetle *Macrosiagon* CNBB sp. 01 provided extra material to help revise the group.

### *True bugs*

All true bug records are new for Carnarvon Station. This region has had little sampling effort compared to coastal Queensland. Specimens were taken from 37 sites, with 120 species from 19 families collected. The majority of the species belong to the family Miridae (47 species), which is typical for Australia. True bugs were collected from 51 host plant species belonging to 19 families of flowering plants, the majority belonging to the speciose families Fabaceae and Myrtaceae.

### *Thrips*

Thrips have a diverse range of biologies with the majority of species being fungus feeders from the Phlaeothripidae family. The generic and tribal classification within this family remains poorly known and is the subject of ongoing generic revisions therefore the Phlaeothripidae family was a target for collection. Thrips from many other groups were also collected.

Thirty sites were visited and approximately 1,400 thrips specimens collected. This comprised 114 thrips species (from 72 genera) with representatives from five of the six families known from Australia. Almost all were new records for Carnarvon Station. This reserve had not been previously surveyed for thrips except for six specimens (five species) collected as bycatch by Queensland Museum entomologists in 2010.

The 30 sites visited covered a wide variety of habitats including grasslands, creek banks, escarpments, vine thickets, mountains, Brigalow patches, *Acacia*, *Eucalyptus* and *Callitris* woodlands and cycad communities. The majority of thrips collected are fungus feeders from dead plant material; others included flower feeders, leaf feeders and a few predatory species.

The 81 described species collected represent around 10% of the approximately 800 known Australian thrips fauna. This is a truly amazing result. The reserve includes an overlap of diverse bioregions leading to many different soil types, which lead to diverse plant communities and therefore a diverse fauna—as shown during a 12-month study of fungal-feeding thrips from D’Aguilar National Park, South East Queensland. Also the rainfall that occurred a few weeks before the survey would have stimulated insect activity.

Thirty-three thrips taxa collected are unplaced/undescribed. There are many reasons why some thrips specimens could not be placed in genera or species: genera/species are new to science and need to be formally described in taxonomic revisions; more uncommon genera/species need to be compared to reference slides in ANIC to confirm identification; only one specimen was collected and a series of specimens are needed to confirm identification (polymorphism is common in fungus-feeding thrips); specimens are too damaged to identify further; and if only one sex is collected the other gender needs to be collected to confirm identification (such as in *Odontothripella*).

The collection of *Phlaeothrips* is possibly a new record for Australia. This fungus-feeding genus is currently known from Indonesia, India, California (USA) and Europe. Two females and two males were collected from dead *Eucalyptus* branches. The specimens will need to be compared with *Phlaeothrips* slides held in the international thrips collection at ANIC to confirm their identifications.

Two of the largest known thrips species were collected from dead leaves—*Idolothrips spectrum*, which feeds only on whole fungus spores associated with *Eucalyptus* spp. and *Mecynothrips hardyi*, which feeds only on whole fungus spores associated with Brigalow (*Acacia harpophylla*). These two species can measure up to 8–10 mm. In comparison, one of the smallest thrips species collected, *Merothrips floridensis*, which is also a fungus feeder, is usually just under 1 mm in length.

The thrips collected from Standard Survey Sites 1 and 2 reflect the varying habitats. Site 1 was on sandy soil with many flowering native plants and large pieces of shed bark around mature trees but no leaf litter. Nearly all thrips collected from Site 1 were flower-feeding species, with only one fungus-feeding species *Cryptothrips* sp. 01 collected from the ‘bark litter’ (one female only) and no thrips collected from under bark. Site 2 was a woodland habitat with various plants, grasses, plenty of dead wood and a creek nearby providing moisture for the plants. Most thrips from Site 2 were fungus-feeding thrips collected from beating dead plant material and under bark but, surprisingly, not from the leaf litter.

Standard Survey Site 2 and vine thicket at the base of Mt Lambert proved to yield the highest diversity and abundance of thrips; presumably these sites contained the greatest diversity of thrips habitats such as dead wood, grasses, leaves, plentiful leaf litter and flowers. The most abundant species collected were *Ethirothrips* spp. (whole fungal spore feeders), *Haplothrips* spp. (fungi, flower and leaf feeders) and *Australothrips bicolor* (older leaf feeders).

#### *Damselflies and dragonflies*

Seventeen odonate fauna are now known for Carnarvon Station. A noteworthy collection was the single female specimen of the Carnarvon Tigertail (*Eusynthemis deniseae*) recorded at Bluewater Spring. The Carnarvon region has three endemic dragonfly species of which the Carnarvon Tigertail is one; the others are the Carnarvon Darner (*Austroaeschna muelleri*) and Carnarvon Evening Darner (*Telephlebia undia*). Also noteworthy were the two female specimens of Arrowhead Rockmaster (*Diphlebia nymphoides*) collected from Channin Creek near Carnarvon Station homestead. Species of rockmaster damselflies (*Diphlebia* spp.) are mostly restricted to coastal areas of eastern Australia, but an isolated population is known from the Carnarvon region.

#### *Spiders*

Previously 11 spider species were recorded from Carnarvon Station during a 2013 entomology survey. During this survey, 70 species belonging to 31 families were collected, of which 16 are unknown due to a lack of taxonomic revisions. *Molycrion moffat* is most probably endemic to the area, whereas most of the other described species have a wider distribution.

#### *Snails and slugs*

Ten sites were sampled (some on multiple occasions) for land snails from which 20 native species were collected representing eight families. All the named species are first records for the reserve. Eleven unnamed species were documented. More specimens are needed for most of the unnamed species in order to progress their description.

Sites were selected to cover major vegetation types with an emphasis on vine thickets. Survey efforts on the plains was concentrated in woodland—scattered woody debris with associated fungal growth is a

preferred microhabitat of eastern Australian land snails. In vine thicket and rocky microhabitat, live snails were sealed to the underside of rocks and dead shells lay in the litter. These microhabitats tend to conserve moisture even in fairly dry times. The snails in rocky habitats graze on the biofilm (fungi, algae, lichens) that forms on the rocks during periods of moisture. In the grassy woodlands dead shells were usually strewn on the ground and live specimens were found in the grass.

Most of the snails documented on the reserve are vine thicket obligates with a few being widespread across woodland habitats. Vine thickets are important refugia for a large number of invertebrate species: their management should be a priority, particularly in relation to fire. On the reserve, vine thickets occur on basalt with deep talus and are currently unmapped.

Ten snail species are known only from Carnarvon Station. Future collecting in surrounding areas may extend the range of some of these 'endemic' species beyond the reserve. It is highly likely, however, that vine thicket-associated charopids and the helicarionid semi-slug (Helicarionidae BL 26) are true Carnarvon Station endemics.

The species list of land snails for Carnarvon Station is now reasonably comprehensive as far as family representation. For all the named species, the reserve is the western extent of their known distribution. Some of these (*Pleuropoma talusata*, *Cylindrovertilla hedleyi*, *Gastrocopta pediculus*, *Pumilicopta bifurcata*, *Glyptopupoides egregia*, *Eremopeas tuckeri*, *Discocharopa aperta*) are found in most vine thickets of southern and central Queensland. The Punctidae specimens represent only the second and third records of this family from the Central Highlands indicating that more work is to be done if their true distribution is to be fully understood.

More species of Charopidae are likely to be recorded with additional collecting effort. Most charopids are restricted in their distributions and the Carnarvon Station species appear to follow this pattern. The new charopids appear to belong to a more extensive radiation centred on the 'sandstone belt' of inland central Queensland with related taxa occurring from Blackdown Tableland in the Expedition Range, central Queensland to Carnarvon National Park.

The helicarionid semi-slug (Helicarionidae BL 26) is an interesting find. This species could belong to a group also present in the Minerva Hills near Springsure and the Peak Range via Clermont. More material, especially live, is needed in order to clarify its relationships.

Collecting dead shells and microscope sorting leaf litter was critical to provide a comprehensive inventory of the species present on the reserve. Only 18 of the 634 specimens were collected live, possibly because most species were buried deep in rock piles to avoid drying out. Rain several months prior to the survey was insufficient to entice most species out of their winter aestivation.

Land snails are important biodiversity predictors flagging areas where other significant invertebrate diversity also resides and in these situations can act as surrogates for all invertebrate biodiversity. Land snails form an estimated 6% of the terrestrial invertebrate fauna and are a key bio-indicator group linked to the decomposition process in the environment. Their presence is an indication of environmental integrity and health. They are also important bio-predictors signalling the presence of other significant invertebrates and invertebrate communities.

### *Stygofauna (groundwater fauna)*

Stygofauna were recorded for the first time on Carnarvon Station. There were no previous records of stygofauna from aquifers or catchments on or surrounding the property.

Stygofauna is usually found wherever there is permanent freshwater such as a spring or hyporheic water in a creek bed associated with groundwater upwelling. Carnarvon Station has many natural springs with good quality water that feed the creeks belonging to a tributary of the headwaters of the Warrego River. The chances of finding stygofauna were high.

Data on subsurface groundwater-dependent ecosystems in Queensland is restricted to a low number of sites, with only a handful of stygofauna species described from Queensland. Documenting two more amphipod species for Queensland during this survey is significant as previously only a single amphipod species was known from the state. Other stygofauna recorded include Copepoda, Ostracoda, Oligochaeta, Microturbellaria and dytiscid diving beetles.

## Flora

In total 205 taxa were collected, of which 42 were new records for the reserve. The collections are valuable additions to the ANH. A number of taxa collected are poorly represented in the ANH with either few examples from Queensland or few examples at all. An additional five species were recorded from the standard survey sites and a further 11 species were recorded as host plants by the Heteroptera team.

A large area of the reserve was covered with collection sites in as many different vegetation types as was possible in the given time. Even so, a number of groups were not collected extensively, presumably due to seasonal effects. For example, very few Poaceae or *Acacia* species were fertile at the time of the visit. Drier hillsides in the south-west of the reserve were also lacking many fertile taxa at the time.

While the reserve had been collected previously, the majority of records are from observations without supporting herbarium vouchers lodged in recognized herbaria. In addition, there had been recent large-scale bushfires in the reserve with the possibility of new or rarely recorded species occurring in the regenerating areas.

Initial plant surveys of Carnarvon Station were undertaken around the time Bush Heritage purchased the reserve. Don and Betty Wood also conducted a number of vegetation surveys and compiled a reference herbarium located at the reserve. Some specimens were lodged with state herbaria and photos for a number of their collections are available through the ALA.

While some of the newly collected taxa are widely distributed across the continent (for example *Enneapogon lindleyanus* and *Solanum ellipticum*) a number of them are approaching the edge of their range. It is known that many plant species have their distributional limits in the Carnarvon Range and others have disjunct populations there. The Carnarvon Range's gorges, peaks, cliffs, slopes and valleys contain a high diversity of habitats, along with relatively high rainfall compared to the surrounding region. Some species' (e.g. *Hardenbergia violacea*, *Hybanthus monopetalus*) distributions follow the range. With only 2.2% of the Brigalow Belt South biogeographic region protected, reserves like Carnarvon Station and Carnarvon National Park may have allowed plant species to survive that have disappeared from the heavily-cleared surrounding areas.

The many springs on the reserve provide habitat for wetland species. Wetland species are carried by water movement but also by animals such as water birds, which could explain the apparent spontaneous arrival of species such as *Philydrum lanuginosum* in recent years.

A specimen of *Abutilon* (BMC 438) could not be identified. The taxonomy of genera in some sections of the Malvaceae family, especially *Sida* and *Abutilon*, are currently not well resolved. Both *Abutilon* and *Sida* are under active revision and the specimen will be further investigated.

The reserve's plant list requires minor revision. The Illawarra Greenhood (*Pterostylis gibbosa*), although listed for the reserve, is not known to occur in Queensland. A closely related species, Mitchell's Rustyhood (*Pterostylis mitchellii*), does occur in Carnarvon National Park. A synonym of *P. mitchellii* is *P. gibbosa* subsp. *mitchellii*, which is perhaps where the confusion originates. There are no records for Carnarvon Station of either a herbarium specimen or observation record of any *Pterostylis* spp., although a number are likely to occur there, including *P. mitchellii*.

## Glossary

**Berlese funnel:** collected leaf is placed into a funnel with a light bulb on top, the insects move away from the light and warmth and fall into a ethanol collection jar at the base.

**Hand beating:** collecting specimens by beating flowers, grasses, live leaves, dead wood and dead leaves over a white plastic tray. Specimens are picked up from the plate with a small paint brush which has been moistened with fluid (e.g. 95% ethanol) or by using an aspirator.

**Hyporheic zone:** The region below and alongside a streambed where groundwater and surface water mix in the gaps within the sediment.

**Polyphagous:** Feeding on many different types of food.

**Putative new species:** An unnamed species that, as far as can be ascertained, was collected for the first time during the survey.

**Range extension:** Increase in the known distribution or area of occurrence of a species.

**Stygofauna:** Animals that live in underground water, including crustaceans, worms, snails, insects, other invertebrate groups, and in Australia a blind fish and a newt.

**Taxon** (plural taxa): A member of any particular taxonomic group (e.g. a species, genus, family).

**Taxonomy:** The categorisation and naming of species. The science of identifying and naming species, as well as grouping them based on their relatedness.

**Type locality:** The location where the holotype (type specimen) was originally found.

**Type specimen** (holotype): The specimen, or each of a set of specimens, on which the description and name of a new species is based.

**Undescribed taxon:** A taxon (usually a species) that has not yet been formally described or named.

# Notes

**All publications are available online at:  
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**FRONT COVER** Moonlight Jewel (*Hypochrysops delicia delicia*), photo Brianna Bakker

**BACK COVER** *Ficus virens* var. *virens*, photo Brianna Bakker



**Bush Blitz**  
SPECIALIST ECOSYSTEM RESPONSE

**Carnarvon Station Reserve**

**Queensland**

**7–17 October 2014**



Australian Government

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