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Albino Brown Booby - Lacepede Islands.
Photo: Kevin Coate.

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Level 2, The Beaufort Centre, 82 Beaufort St, Perth.
Postal Address: PO Box 8257, Perth Business Centre 6849
Telephone: (08) 9228 2495
email: info@naturalists.org.au
www.wanaturalists.org.au

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SOME DIETARY ITEMS OF OUTER-URBAN GREY BUTCHERBIRDS IN THE PERTH HILLS

By LAURIE E. TWIGG
Adjunct Associate Professor, School of Biological Science and Biotechnology, Murdoch University, South St, Murdoch, WA 6150 Australia.
Email: let_consultants@iprimus.com.au

ABSTRACT

The diet of Grey Butcherbirds in an outer-urban environment was examined by analysing the prey items of pellets (n = 36) regurgitated by known birds frequenting an artificial feeding station in the Perth Hills. Regardless of season, beetles (Coleoptera) were by far the most important prey category in both adult and juvenile butcherbirds followed by lizards in adult birds, and earwigs (Dermaptera) in juvenile butcherbirds. Seeds were found in 28% of the pellets (10/36) and occasionally in considerable numbers. Although food availability was not measured, these butcherbirds seem to be harvesting most key prey categories more or less relative to their availability as the seasonal fluctuations seen in their diet broadly followed the expected seasonal abundances of the key prey categories.

INTRODUCTION

The Grey Butcherbird (*Cracticus torquatus*) is a widely distributed species endemic to Australia. It occurs in a range of different habitats including arid, semi-arid, and temperate zones (Chapman *et al.* 1986). However, although its prey can include small mammals, birds, eggs, reptiles and insects, detailed information on the diet of this species is rather scanty (Barker and Vestjens 1989; Legge 1931),

particularly for urban and outer-urban environments. This paper examines the latter by assessing the diet of free-ranging outer-urban butcherbirds using the prey items identified in the regurgitated pellets of known birds. An Index of Relative Importance (IRI) was calculated to assess the relative importance of each dietary category to these birds.

METHODS

Origin of Regurgitated Pellets

The pellets were collected from known butcherbirds frequenting an artificial feeding station at Lesmurdie on the Darling Scarp, Perth, Western Australia (32° 0'30.56"S; 116° 2'15.47"E). The breeding adult female first arrived as a sub-adult late in 2005, and then with an adult male in early 2006. She subsequently brought two offspring in each of the following two years. Thus the pellets were collected over approximately 2.5 years (2005–2007), with the birds being regular visitors over this period. Individual birds (n = 6) could be easily identified by their physical characteristics, and their behavioural traits. The butcherbirds ultimately stopped their visitation due to continued harassment by Red Wattlebirds (*Anthochaera carunculata*). Only those pellets that could be clearly assigned as belonging to a butcherbird were collected. There were 36 pellets in total: 15 from the adult female, 11 from the same offspring when adult, 4 from known juvenile birds, and 6 whose owner could not be ascertained (left while two birds were feeding). Of the latter, and based on the size and contents of the pellets, 5 unknowns were considered to be from adult birds and the remaining pellet from a juvenile.

Pellet Processing

The pellets were kept frozen (–12 °C) in individually labelled vials until analysed. Individually thawed pellets were placed in a Petri dish containing a 50% (v/v) aqueous ethanol solution, and the items sorted into each food category using a dissecting microscope. The area occupied by each food category relative to the area of all items in a pellet was then determined. This measure becomes 'A' in the Index of Relative Importance (see below). A whiteboard card with a 10 x 10 grid of 6 mm squares was used when estimating 'A'. The pellet contents were identified as specifically as possible using: the Insects of Australia manual (CSIRO 1973), the Pest and Disease Image Library located at http://www.padil.gov.au/ (November 2011), Google Images at http://www.google.com.au/imghp?hl=en&tab=wi (November 2011), reference specimens collected at the study site, and the valued experience of several colleagues (see Acknowledgements).

Index of Relative Importance (IRI) and Dietary Breadth

The Index of Relative Importance (IRI) was first used in dietary studies of fishes (Pinkas 1971). It is usually determined for each prey category as follows:

$$IRI = (N + V) * F$$

where N = the numerical percentage (i.e. the numbers of a particular prey item as a percentage of the total number of all items in that sample), V = the volumetric percentage (i.e. the volume of an item as a percentage of the total sample volume), and F = frequency of occurrence percentage (i.e. the number of stomachs containing a particular food category), although the percentage volume as been replaced with the weight (biomass) percentage (W) in some studies (e.g. Martin *et al.* 1996; Twigg *et al.* 1996). However, with the butcherbird study, and mainly because of fragmentation, it was not possible to realistically count or weigh the individual items so the area covered by each food category ('A') was measured as the percentage area relative to the total area occupied by all items in each pellet.

Consequently, a modified IRI was used:

$$IRI = A * F$$

'A' was calculated for each individual pellet and the mean value for each category was then used to determine the IRI. Adult birds were treated separately from juvenile birds, and the unidentified category was excluded from the analysis. This modified IRI is similar to that used for turtle (*Elseya* sp.) diet by Armstrong and Booth (2005), except that they used 'V' and 'F' only. The IRI allows a relative comparison of the importance of each food category, but it does not take into account any differences in the calorific and nutritional value of individual food items.

Dietary (niche) Breadth (D_B) was calculated according to Pianka and Pianka (1976). Dietary breadth is based upon the diversity index of Simpson (1949) and was calculated as

$$D_B = 1/\sum_{i}^{n} pi^2 * 1/n$$

where *pi* is the proportion of the *ith* resource category used. When divided by the number of resource categories used (*n*) this index varies from near zero (1/n - a narrow dietary range) to a maximum of one (a wide range of dietary items).

RESULTS

Beetles (Coleoptera) were the main food items of both adult and juvenile birds (Tables 1 and 2). Lizards, and earwigs (Dermaptera) were next most populous food items but no lizard remains were identified in the pellets from the juvenile birds. For adults, the presence of beetles in the pellets ranged from 4%–98% by percentage area (Mean 66.0%, SD 26.8%, *n* = 31) with all pellets containing some

Table 1. The 12 food categories identified in the regurgitated pellets (n = 31), and their relative importance to adult outer-urban Grey Butcherbirds.

Food Category	Maximum Food Item Area (%) [A]	Mean Food Item Area (%) [B]	% of Pellets	IRI	IRI Rank
Coleoptera	98	66.0	100.0	6599.7	1
Lizard	45	7.7	58.1	443.9	2
Dermaptera	96	8.9	41.9	372.0	3
Seed	40	3.2	25.8	82.8	4
Heteroptera – Nysius bug	53	4.8	12.9	61.4	5
Araneae	20	1.4	32.3	44.2	6
Hymenoptera – Ants	15	0.8	45.2	34.4	7
Blattodea	26	1.7	16.1	27.8	8
Hymenoptera – Bees & Wasps	21	1.3	19.4	24.7	9
Orthoptera & Mantodea	5	0.3	19.4	6.0	10
Diplopoda	10	0.4	12.9	4.8	11
Bird Bone	43	1.4	3.2	4.5	12

A: All minium percentage areas were zero (0) except for Coleoptera which was 4%.
B: Used to calculate the IRI.

Table 2. The food categories identified in the regurgitated pellets (n = 5) of juvenile outer-urban Grey Butcherbirds. Less than 1% of items could not be classified, and no other food categories were seen.

	Coleoptera	Dermaptera	Blattodea	Seed
Mean area (%)	64.0	9.8	8.4	17.2
# Pellets with food category	4	2	1	2

beetle remains. Beetle remains in juvenile butcherbirds ranged from 0% to 100% of the contents (Mean 64.0%, SD 41.7%, n = 5). The juvenile pellet with no recorded beetle contained only seed (77%) and earwig remains (23%). Seeds were the fourth most populous food item occurring in 28% of pellets (i.e. 10/36 – Tables 1 and 2), with 143 seeds and three identifiable seed types in the 10 pellets (Table 3).

Some of the insects more precisely identified from the pellets included: Order Coleoptera: flower chafer beetles (Scarabaeidae, Subfamily Cetoniinae); rhinoceros beetles (Scarabaeidae, Subfamily Dynastinae); green scarab beetle (Scarabaeidae, *Diphucephala* sp.); jewel beetles (Buprestidae); longicorn beetles (Cerambycidae); and weevils (Curculionoidea); Order Hemiptera: *Nysius* sp. (Suborder Heteroptera, Lygaeidae, Subfamily Orsillinae – most likely the Rutherglen Bug, *Nysius*

Table 3. Measurements (mm) of some seeds and lizard bones recovered from the butcherbird pellets.

			Dimensions (mm)			
			Length		Width	
Category	Description	*n*	Mean	SD	Mean	SD
PLANT						
Seed Type 1	Creamy, ovoid, Dicot[A]	12	1.71	0.17	1.36	0.11
Seed Type 2	Brown, kidney-shaped, hard, Dicot, Legume[B]	19	5.63	0.78	4.29	0.65
Fruit	Ericaceae[C] – Creamy, ovoid, very hard, nut-like	1	5.00	–	2.75	–
					Min	Max
LIZARD	Jaw	8	4.88	0.82	3.50	6.00
	Leg Bone	8	5.18	1.75	3.00	6.75
	Rib	3	3.17	0.14	3.00	3.25
	Vertebrae	12	1.78	0.47	1.00	2.75

A: Identified by the presence of endosperm and two cotyledons in dissected seed.

B: Identified by the characteristic shape, and the presence of endosperm and two cotyledons in dissected seed. Possibly *Podalyria* sp. (?).

C: Australian heaths (Epacrids), identified by the Western Australian Herbarium.

vinitor); Order Hymenoptera: Formicidae: *Pheidole* ant queens (*Pheidole* sp.); bulldog ants (*Myrmecia* sp.); *Camponotus* sp. ants; Apidae: European honey bees (*Apis mellifera*); Hymenoptera: wasps; Order Mantodea: mantids. Likely identifications included: shield bugs (Hemiptera, Suborder Heteroptera, Superfamily Pentatomoidea, possibly *Poecilometis* sp.). Of the above, only *Nysius* sp. and European Honey Bees were known to comprise introduced species suggesting that butcherbirds eat a range of indigenous invertebrates.

In general, adult butcherbirds had a fairly narrow range of food items with only 12 categories identified from the pellets over the 2.5 year study with the top five ranked categories making up 90.5% of all items by percentage area (Table 1) (excludes the unidentified category – see below). This was further illustrated by the low Dietary Breadth index of 0.1842 (near zero values indicate a narrow dietary range). The diet of juvenile birds seemed even narrower than that of adults and included only four identifiable food categories (Table 2). The importance of beetles to adult birds seemed greatest in winter (Figure 1) when, perhaps, the range of available food items is more limited. The reliance on

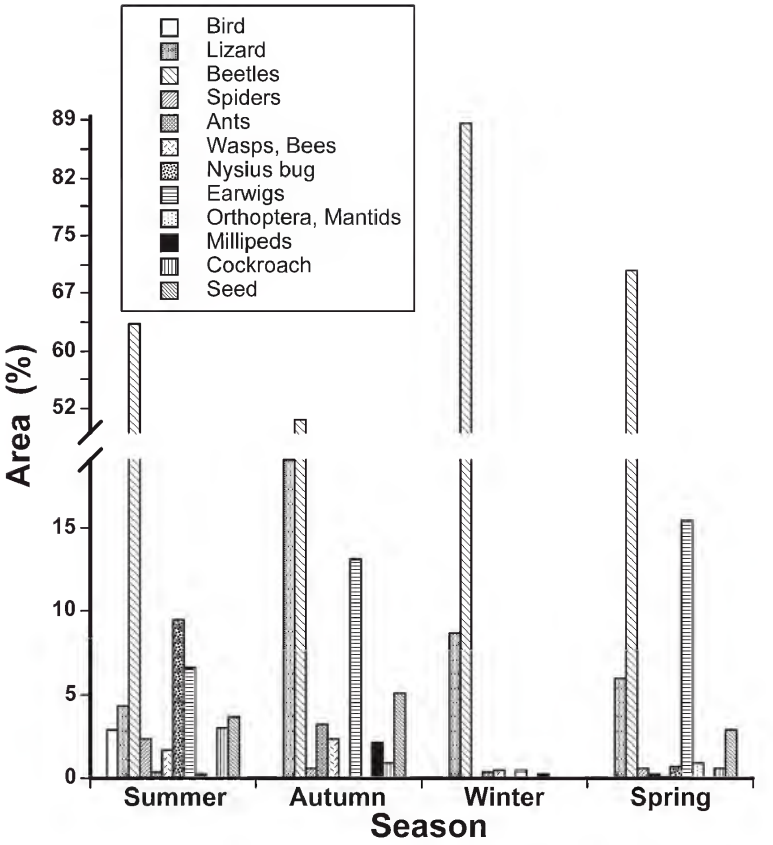

Figure 1. Seasonal changes in the food items consumed by outer-urban adult Grey Butcherbirds based on the analysis of regurgitated pellets (n = 31) collected at Lesmurdie, WA. n = 15, 5, 4, and 7 pellets for each season respectively. ' % Area' is the percentage area of a given category relative to the area occupied by all categories for the pellets (see Methods).

beetles as food appeared least in autumn, and this corresponded with the greatest occurrence of lizard remains. Nevertheless, lizard remains were found across all seasons for adult birds (Figure 1).

The remains of lizards were identified by the presence of complete jaw bones, 'scales', and obvious skin (with some colouration retained in some instances). These bones were also quite small and delicate ranging from 1.0 mm (vertebrae) to 6.8 mm (leg bone) in length (Table 3). Although bird bone (most likely from a young immature individual) was found in one adult pellet, no feathers or hair were

recovered from any pellet. Ants had been clearly ingested by the butcherbirds as these remains were usually comprised of incomplete heads, and occasionally, incomplete bodies, imbedded within the pellets. The importance of ants may have therefore been underestimated in the diet because of their limited recovery. Seeds also appeared to have been deliberately ingested by some butcherbirds as 95 seeds of Seed Type 1 (Table 3) were found in a single pellet from the adult female. These seeds, which were ovoid in shape, were quite small (Table 3) with 123 of these seeds recovered from two pellets from the adult female. A total of 19 relatively large, kidney-shaped, legume seeds (5.6 x 4.3 mm; Seed Type 2 – Table 3) were also recovered from three pellets from two different birds (1 adult –2 pellets, 1 juvenile pellet). Seeds also included a fruit of an unknown Epacrid (Ericaceae – Table 3).

The percentage area of those fragments/items which could not be classified ranged from 0% to 8% for adult butcherbirds (Mean 2.35% ± 2.26% SD, n = 31), and 0% to 1% for the juvenile birds (Mean 0.60% ± 0.55% SD, n = 5). Very small amounts of plant vegetative fragments were found in three pellets, three young conifer buds (growing tips) in one adult pellet, small quartz grains (1–3 mm) in four pellets, and what appeared to be insect egg cases (n = 15) in one pellet. All these items were included in the unidentifiable category, and therefore excluded from the IRI.

The 'species accumulation curve' showing the effect of increasing the number of pellets examined on the cumulative number of identifiable food categories (Figure 2) indicated that the number of pellets used in this study was adequate to gain an understanding of the diet of outer-urban Grey Butcher birds. Eighty-three percent of the food categories could be found using just 6 pellets (Figure 2).

DISCUSSION

The reliance of outer-urban Grey Butcherbirds on beetles (Coleoptera) as their primary prey item is consistent with that reported elsewhere for this, and closely related (e.g. Pied Butcherbird *C. nigrogularis*), species (Chapman *et al.* 1986; Barker and Vestjens 1989). For adult birds, lizard remains comprised the second most important prey item in the pellets. Moreover, based on the measurements of recovered bone (Table 3), the lizards consumed were quite small and were probably skinks. This food category was most abundant in autumn, which corresponds with the season when most juvenile skinks hatch in urban areas in Perth (Ric How, personal communication). Grey Butcherbirds are also known to capture and skewer live skinks (e.g. *Ctenotus regius*) in the wild (Fitzsimons and Thomas 2010). The absence of lizard remains from the outer-

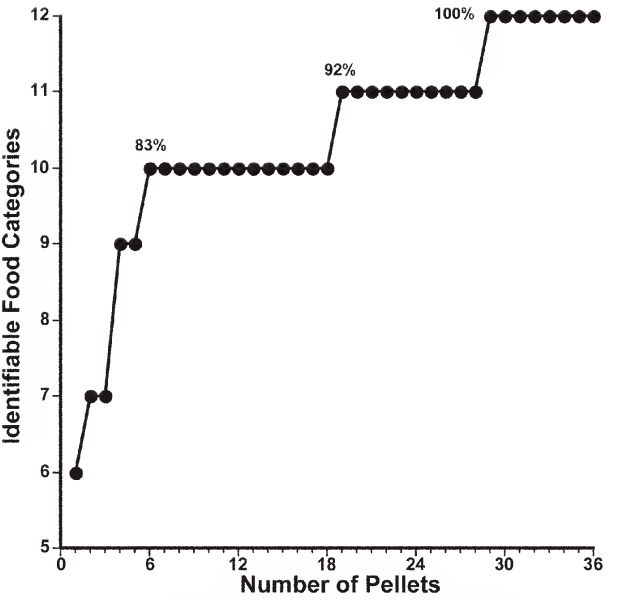

Figure 2. 'Species accumulation curve' showing the effect of the number of pellets examined on the cumulative number of identifiable food categories in the butcherbird pellets. Eighty-three percent of the food categories were identified in just 6 pellets.

urban juvenile butcherbird pellets suggests that young birds may be less astute than older birds at catching such prey. However, the Grey Butcherbird observed by Fitzsimons and Thomas (2010) was classified as 'immature' indicating that these birds can catch small skinks on occasion, at least in semi-arid environments.

Seeds and fruit have been reported in the diet of Grey Butcherbirds (Chapman *et al.* 1986; Barker and Vestjens 1989), and the Collared Butcherbird (*C. destructor*) is known to consume ripe figs (Chandler 1915). Grey Butcherbirds have also been observed feeding on the flesh of *Macrozamia* fruit (Stranger and Stranger 1970). The sheer number of seeds found in the pellets of the outer-urban Grey Butcherbirds suggests that they were deliberately ingested. However, whether they were gathered as seeds or eaten with a fruit is unknown. The inclusion of the kidney-shaped legume seed is interesting because it superficially resembled some of the beetle remains found in the pellets. Some birds may have therefore mistaken these seeds for beetles, although this is only speculative. The recovered legume seeds, which had a very

hard testa, seemed entirely intact (germination tests could not be done as the samples had been frozen). The inclusion of the small conifer buds in one adult pellet most likely resulted from accidental ingestion while catching arboreal prey.

Although no feathers were found, there appeared to be bone remains of a young (nestling?) bird in one pellet of an adult butcherbird. Again, this is consistent with what is known about the diet these birds. Small birds, eggs, and nestlings can be consumed by Grey, and other, butcherbirds (Chapman *et al.* 1986; Barker and Vestjens 1989); Higgins *et al.* 2006), and this includes House Sparrows *Passer domesticus* (Legge 1931).

Although my outer-urban study is the first I know of that tracks individual birds for over two years, and which includes both adult and juvenile birds, some caveats still need to be considered.

While the number of pellets examined was adequate to gain a broad understanding of the diet of outer-urban butcherbirds (see Figure 2), they were nevertheless collected from only 4–6 individual birds. There were also only 5 pellets from known juvenile birds. However, the available literature, and the 'species accumulation curve' (Figure 2), suggests that this outer-urban study does, nevertheless, reflect the diet of Grey Butcherbirds in this environment.

Some prey categories (e.g. ants, spiders) may have been underestimated in the diet because little of their exoskeletons remained in the pellets. That is, the importance of each food category was based solely upon the area that it occupied as a percentage of all the items found in a pellet.

As mentioned previously, although the IRI approach enables a comparison of the relative importance of individual prey items, it does not take into account the differences in the calorific and nutritional value of the food items consumed. For example, at times, the benefit-cost of catching and consuming small skinks may be more favourable than feeding on ants. Similarly, beetles are probably the most abundant available food, and therefore may require less effort to find and consume (i.e. equals the best optimal foraging strategy).

I had no measure of prey/food availability in the associated outer-urban environment and therefore it is not possible to make definitive conclusions on whether outer-urban butcherbirds were preferentially targeting some prey (but see below), or whether they were simply harvesting them according to their relative availability in the environment.

Despite the above caveats, however, this study suggests that beetles are the most important prey category for outer-urban Grey Butcherbirds, and that few mammals and birds appear to be

consumed (based on the lack of hair and feathers in the pellets). These butcherbirds also seem to be harvesting most of their prey more or less relative to their availability, as the seasonal fluctuations seen in their diet broadly follow the expected seasonal abundances of the key prey categories. However, further detailed study would be required to confirm this. It also appears that the diet of outer-urban Grey Butcherbirds may be similar to that seen for more urban individuals of this species, although the available data for the later is rather limited (Claire Stevenson personal communication).

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A NEW COMBINATION IN *DRYANDRA* (PROTEACEAE)

By ALEX S. GEORGE
'Four Gables', 18 Barclay Road, Kardinya, WA 6163, Australia

ABSTRACT

The new combination *Dryandra meganotia* subsp. *recurvistylis* (K.R.Thiele) A.S.George, based on *Banksia recurvistylis* K.R.Thiele, is provided.

INTRODUCTION

Mast and Thiele (2007) published a paper combining *Dryandra* with *Banksia*, with a further paper later that year covering names that were overlooked in the first paper (Thiele & Mast 2007). The transfer was based on phylogenetic analyses of molecular data (Mast *et al.* 2005). The Australian herbaria quickly adopted the change for the Australian Plant Census, but both the transfer and its acceptance have been met with concern and resistance from many users of plant names (see for instance Cavanagh 2008a, 2008b, Barrow 2009, Dixon 2011). Indeed, the website for Australia's Virtual Herbarium (http://chah.gov.au/avh/public_query_help.jsp, accessed 20 May 2012) states that 'some herbaria still recognise the genus *Dryandra*, while in other herbaria *Dryandra* is merged with *Banksia*.' The Australian Native Plants Society also continues to recognise *Dryandra* (http://anpsa.org.au/dryand1.html, accessed 20 May 2012).

The merger ran counter to conclusions reached in my research of over 50 years in the field, in the herbarium, in horticulture and in the literature and I have prepared a paper arguing against it (George in press). Morphologically the two genera are readily distinguished and recognisable, although I have deliberated whether certain small groups within each genus should themselves be recognised at generic rank, in particular subg. *Isostylis* of *Banksia* and subg. *Hemiclidia* and subg. *Diplophragma* of *Dryandra*.

The *International Code of Botanical Nomenclature* (*ICBN*, McNeill *et al.* 2006) sets out the criteria for valid publication of scientific plant names but gives no further direction on how to choose a name when there is more than one valid name for a taxon. The choice is taxonomic, not nomenclatural, so it depends on the user's preference. There is no obligation to follow a change simply because it is the latest published or because certain institutions have adopted it.

Likewise, there is no mandatory requirement to follow the Australian Plant Census, coordinated by the major Australian herbaria. All species except one of *Dryandra* now have valid names within both *Banksia* and *Dryandra*, hence users can choose which name to use. The exception is the recently described *Banksia recurvistylis* K.R.Thiele (Thiele 2009), for which there is currently no combination in *Dryandra*. I present here a new combination for this taxon as a subspecies of *Dryandra meganotia*.

Because the morphological differences between this taxon and its closest relative, *Dryandra meganotia* A.S.George, are of similar weight to those that I adopted within other species such as *Dryandra armata*, *D. fraseri* and *D. kippistiana* (George 1996 p. 314), and because this taxon is geographically disjunct from typical *D. meganotia*, I consider that subspecific rank within that species is appropriate. In making new combinations of *Dryandra* in *Banksia*, Mast and Thiele (2007) accepted infraspecific taxa in the above three species based on these criteria.

Subspecies *recurvistylis* differs from typical *D. meganotia* in its taller, non-lignotuberous habit, longer leaves and larger flowers. The distinctions tabulated by Thiele (2009 p. 281) are less clear-cut when specimens of *D. meganotia* collected since my accounts (George 1996, 1999) are taken into account. These show the taxon to be more varied than previously thought, in habit and dimensions of leaves and flowers. *Dryandra meganotia* subsp. *meganotia* can have leaves up to 8 cm long and 30 mm wide, with up to 12 lobes each side; its perianth may be up to 25 mm long and its pistil up to 37 mm long. Field measurements made at two populations of *B. recurvistylis* (the localities of *F. Hort 3182*, *F. Hort 2143*) show that the perianth may be as short as 29 mm and the pistil as short as 38 mm.

Table 1. Main morphological differences between *Dryandra meganotia* subsp. *meganotia* and subsp. *recurvistylis*.

Character	subsp. *meganotia*	subsp. *recurvistylis*
Lignotuber	present	absent
Leaves	3–8 cm long 6–12 lobes each side	8–11 cm long 10–16 lobes each side
Perianth	22–25 mm long	29–38 mm long
Pistil	26–37 mm long	38–55 mm long

Dryandra meganotia subsp. ***recurvistylis*** (K.R.Thiele) A.S.George, **comb. et stat. nov.**

Basionym: *Banksia recurvistylis* K.R.Thiele, *Nuytsia* 19: 278 (2009)

Type: 'Wandering', Western Australia, 10 Nov. 2008, *F.Hort 3369* (holotype: PERTH 07702604; isotypes: CANB, K).

Also referred to as *Banksia* sp. Wandering (F. & J. Hort 3181), Western Australian Herbarium, in *FloraBase*, http://www.florabase.dec.wa.gov.au. The type locality is more than 40 km NNW of Wandering.

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CYTISUS SCOPARIUS (SCOTCH BROOM) IN WESTERN AUSTRALIA

By GREG KEIGHERY

Science Division, Department of Environment and Conservation, Locked Bag 104, Bentley Delivery Centre, Western Australia, 6983.

Email: greg.keighery@dec.wa.gov.au

ABSTRACT

Cytisus scoparius, a weed of National Significance was recorded as naturalised in Western Australia for the first time around the Wellington Dam and along the Collie River in 2010. Immediate action by the DEC staff from Collie District has resulted in the removal of nearly all plants and set the stage for the likely eradication of this species in the wild in Western Australia.

INTRODUCTION

Cytisus scoparius (L.) Link. of the family Fabaceae, is a member of a group of closely related genera of long branched green stemmed shrubs with racemes of yellow flowers commonly referred to as Brooms native to the Northern Hemisphere. *Cytisus scoparius* which has several common names including, Scotch, English or Common Broom, is native to Europe from the Ukraine to Ireland, south to Spain and north to Sweden. The species is widely cultivated and has become a weed of temperate areas of western USA, Hawaii, Canada (British Columbia), Australia, New Zealand, Iran, India and South Africa (Hosking *et al.* 1998).

At present a series of other species within the Brooms are also naturalised in Australia, including the closely related Tagasaste or Tree Lucerne (*Chamaecytisus palmensis*), promoted as a fodder plant in Western Australia and the White Spanish broom (*Cytisus multiflorus*).

Other less closely related Brooms naturalised in Australia (Victorian Department of Primary Industries 2011) are Montpellier Broom (*Genista monspessulana*), Flax-Leaved Broom (*Genista linifolia*), Madeira Broom (*Genista stenopetala*), Spanish Broom (*Spartium junceum*), Canary Island Stick Broom (*Adenocarpus complicatus*) and White Broom (*Retama raetum*).

Five Brooms are recorded as naturalised in Western Australia (Hussey *et al.* 2007). These are: *Adenocarpus complicatus*, *Chamaecytisus palmensis*, *Genista*

linifolia, *Genista monspessulana* and *Retama raetum*. The last three species being the most invasive environmental weeds. Occasional feral plants and small populations of another three Brooms *Genista horrida*, *Spartium junceum* and *Genista florida* have also been recorded by me but are not yet fully naturalised in Western Australia.

Cytisus scoparius is currently recorded as naturalised in Australia in the Australian Capital Territory, New South Wales, Victoria, Tasmania and South Australia. Within these jurisdictions major infestations occur in eastern New South Wales (especially Barrington Tops, Shoalhaven River Catchment, Kosciuszko National Park and the Blue Mountains area), and in Victoria, over 150,000 hectares of land in Victoria's central highland and alpine regions. These infestations have led to this species being nominated and subsequently accepted as a Weed of National Significance (Victorian Department of Primary Industries 2011) in 2012.

Cytisus scoparius has never been recorded as naturalised in Western Australia, despite being freely available in the nursery trade and widely grown. However, much of the lower South-West is modelled as a very favourable climatic zone (Victorian Department of Primary Industries 2011) for the species.

This brief note documents the discovery and subsequent attempt to remove this potentially very serious weed species in Western Australia.

RESULTS

During surveys of the flora of Wellington National Park in 2009/10 scattered plants of *Cytisus scoparius* were located in the National Park along the banks of the Collie River. Upon tracing these occurrences upstream towards the Wellington Dam a large population of the weed was located in the Wellington Dam Tourist Precinct. This population is not mentioned in the Management Plan for the area (Conservation Commission of Western Australia 2008), nor on the local Flora (Wheeler, *et al.* (2002). There are no records of *Cytisus scoparius* naturalised in Western Australia on Florabase or the Australian Virtual Herbarium (Western Australian Herbarium 1998).

While most plants were yellow flowered (voucher G. Keighery 17639), red and yellow flowered plants (voucher G. Keighery 17640) were also present in the area. The latter plants are described by Hosking *et al.* (2000) as "Red and yellow flowered hybrids (i.e. horticultural selections from hybrids between *Cytisus scoparius* and other *Cytisus* / *Genista* species) similar to the cultivars Andreanus and Andreanus Yellow have become naturalized in New South Wales, Victoria and Tasmania)". Apparently at least two separate plantings/introductions were

made into the area giving rise to the two colour forms recorded.

The populations along the Collie River and Wellington National Park apparently date from sometime after 1960 when Public Works Architect John Oldham was engaged to landscape the area around the northern side of the enlarged dam and the large quarry (called the Wellington Dam Precinct) which had been used to provide material for the dam.

Oldham stated "We screened and protected the quarry by a natural stone wall around the top – this will guide visitors toward a new lookout designed to project from the hillside pointing firmly back at the dam. The walls of the quarry were scaled down. It was back filled with good soil, planted with lawn and trees, furnished with shelters and barbeques and became a hazard free picnic area.... the lozenge shaped shelters deliberately echo the viewing platform and Dam in shape and materials. Most trees in the quarry are deciduous to let the sun through in winter. The quarry was popular from the start – it came into use immediately after completion" (Oldham, John, 'Landscape of water resources', unpublished speech, held at Heritage Council of Western Australia Library).

Other aspects of the landscaping design included a lookout at the top of the dam, car parks, toilets and a new zigzag road that took visitors below the Dam. The parking areas were designed to follow the contours and prevent removal of trees, and the toilets were blended into the surrounding bushland.

Oldham directed that plantings were, therefore, native species except in the Quarry (PWD file, Wellington Dam, landscaping & buildings, State Records Office Western Australia, WAS 3035 CONS 1869, Item 1960/0424; Oldham, *op cit*, list of native plants sourced from Yilgarnia Nursery). Flowering species for the carpark and toilet surrounds included some 570 kangaroo paw (*Anigozanthos* sp.) of various colour, *Crowea dentata*, Black Wattle (*Acacia decurrens*), a groundcover (*Lechenaultia biloba*), and bottlebrush (*Callistemon* sp, stated as *phoenicus*), as well as 70 Karri (likely the Karri Hazel *Trymalium odoratissimum*). Obviously a broad definition of native to Australia was used to define native species.

After establishment of the viewing area in 1960, a caretaker's quarters and kiosk/cafe were constructed in 1966, following requests for more public facilities. It was probably during the 1970 –1990 period when the original plantings had senesced or died (the café was also closed for several years for two periods over this time) that the *Cytisus* were obtained and planted during attempts at refurbishment of the gardens. By this time the original concept of planting mainly ?local native species in the precinct had been lost and only sporadic maintenance was

occurring. A complete list of plants present in the Wellington Dam precinct has been compiled by me and will be presented as an annotated list in the planned paper on the flora of Wellington National Park.

The oldest *Cytisus* plants present were not now in any garden site and from their size were probably under 20 years old, suggesting that the original garden plantings had also died or been lost. Downey and Smith (2000) have noted that individuals may live for over 30 years, but reach heights of over 6 metres in that time!

There were plants of *Cytisus* all around the margins of the car park spreading down slope into the adjacent Jarrah–Marri Woodlands and onto granite slopes above the dam which are dominated by low heaths of *Verticordia* and *Calytrix* species grading into tall *Acacia* shrublands. Population size of the weed was over 100 mature plants with numerous juveniles. Scattered plants were located along the river edge in *Eucalyptus rudis* woodland below the granite cliffs below the dam and for several kilometres downstream. In eastern Australia the species is known to be an aggressive invader of fertile relatively open sites, such as granite soils and riverine edges. Smith (2000) noted that the seed can be carried long distances in the bed load of rivers, where scouring in the stream bed may scarify the seed preparing it for germination when it washes up on the bank.

Subsequent to the discovery of this population, DEC staff from Collie carried out control measures on the area following techniques outlined in Hosking *et al.* (2000) which has resulted in the cutting down / spraying of all adult plants and juveniles resulting in the destruction of over 95% of the population. I have removed any plants located along the river. It is encouraging to note that significant progress has been made on eradicating a potential serious environmental weed immediately after its discovery.

However, Downey and Smith (2000), Hosking *et al.* (1998) and Bossard (2000) note that this species produces some 8–15,000 seeds per adult plant per year which can remain viable for at least 5 (and up to 30) years in the soil, so continual monitoring of the Park will be vital for many years

CONCLUSIONS

The discovery of this population of Scotch Broom highlights the need for surveillance and early control efforts for these potentially serious weeds. Most water supply dams had gardens established around their lookouts and these should be surveyed for more populations of this weed. It also illustrates the need for vigilance in the planting of such species within natural environments and the need for removal and replace-

ment by more benign species of all Brooms from the Australian nursery trade.

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NATURAL HISTORY NOTES ON TWO PILBARA ENDEMIC LIZARDS, *DIPORIPHORA VALENS* AND *VARANUS BUSHI*, WITH BRIEF COMMENTS ON SURVEY METHODOLOGY

By BRAD MARYAN
63 Wallaby Parade, Baldivis 6171
and
JEFF TURPIN
6 Mount Dale View, Roleystone 6111

INTRODUCTION

The descriptions of new species continually adds to Australia's incredibly diverse herpetofauna as shown by the increase in number of species in the three revised editions of Wilson and Swan's "*A Complete Guide to Reptiles of Australia*" since 2003. Despite this increase in taxonomic information, we know very little about even the basic natural history of many species, including those that we encounter on a regular basis. For this reason, it is important to record observations of specific ecology, behaviour and habitat preference. Regarding the latter, many species, especially those that are found in a particular region, in this case the Pilbara, are documented as being 'widespread' or 'generalist'. They are widespread but not necessarily continuous throughout the Pilbara and appear to be patchily distributed in discrete habitats and/or microhabitats. In this paper, we present basic natural history observations on two Pilbara endemic lizards, that are the Southern Pilbara Spinifex Dragon *Diporiphora valens* and the Pilbara Mulga Goanna *Varanus bushi*.

DIPORIPHORA VALENS

The Southern Pilbara Spinifex Dragon *Diporiphora valens* (Figure 1) is almost entirely endemic to the Hamersley Range, with another discrete population occurring north of the Fortescue Basin recently described as *D. vescus* (Doughty *et al.* 2012). In various publications, *D. valens* is documented as being found in various shrublands and low woodlands with an understorey of *Triodia* hummock grass (Wilson and Knowles 1988; Ehmann 1992; Wilson and Swan 2010) or in stands of Acacia and from spinifex bushes (Doughty *et al.* 2012) which more or less describes a large proportion of the vegetation structure in the Pilbara. In this region, there are

Figure 1. Adult female *Diporiphora valens.*

Figure 2. Survey site where *Triodia melvillei* is the dominant ground cover and *Diporiphora valens* are observed active between and perched atop clumps.

up to sixteen species of *Triodia* (Florabase Database, Department of Environment and Conservation 2011) of which some are 'hard' while others are 'soft', and our observations suggests that *D. valens* in the central Pilbara (eastern Hamersley Range) appears to favour areas that support certain species of hummock grass. With regards to fauna surveys, even some species of typically-diurnal dragon lizard that are readily observed or caught in traps, can go undetected simply because a specific habitat has not been investigated.

A series of surveys by environmental consultancy companies, mainly Biologic Environmental Survey, have observed a strong association between *D. valens* in areas where *Triodia melvillei* provides the main ground cover (Figure 2). *T. melvillei* is a 'soft' species of hummock grass that occurs on plains, rocky hills and sand dunes across Western Australia from the Pilbara south to the Murchison and east to the central deserts. Our capture records of *D. valens* in 2010–11 from a total number of 45 survey sites named Area C West A, Area C West B and Mudlark in the vicinity of Mount Robinson and The Governor approximately 100km WNW Newman, indicated that *D. valens* was recorded from 9 sites that supported *T. melvillei* as the main understorey or it was in association with either *T. pungens* or *T. wiseana*. At 23 other survey sites named Marillana and Mindi Mainline, notable for their absence of *T. melvillei*, we did not record *D. valens*. Individuals were either caught in funnel or pit-traps. When observed active, have been mostly breeding males (development of reddish hues in groin and along base of tail) perched atop clumps that they quickly 'dive' into when disturbed. This perching behaviour has been similarly observed in other *Diporiphora* spp. where the main ground cover is also *Triodia* or other grasses (pers. obs.).

VARANUS BUSHI

Another endemic Pilbara lizard is the Pilbara Mulga Goanna *Varanus bushi*, which was only described recently (Aplin *et al.* 2006). Similar to its closest relatives *V. caudolineatus* and *V. gilleni*, this species is arboreal often being found behind bark on Mulga (*Acacia*) trees and occasionally inside hollow tree limbs (Wilson and Swan 2010 and pers. obs.). Observations of these small tree-climbing *Varanus* spp. active on the ground are infrequent, despite them being occasionally caught in funnel/pit-traps, found sheltering under ground debris and seen as roadkill (pers. obs.).

During a series of surveys in 2011 by Biologic Environmental Survey in the central Pilbara we have recorded *V. bushi* from most sites supporting Mulga woodlands and on two occasions in close sympatry with *V. caudolineatus*. During one winter

survey between the 9–10th July one of us (BM) and Matthew Johnston found ten (one juvenile, nine adults) *V.bushi* inside unused termite mounds in Mulga woodland near Mount Robinson. In two separate mounds we found three individuals, which were all in a torpid state and occupied the cavities within the highest point of the mounds, where it is assumed they would obtain maxi-mum indirect exposure to the sun. In July 2011 the average minimum and maximum temperatures recorded at Newman have been 9.6° and 22.8° respectively. Due to the cool temperatures experienced at this time of year we assumed the *V. bushi* we found had 'vacated' the more typical retreat of the trees to take-up winter residence inside the mounds as they provided a very stable temperature and secure environment. We also speculate that predation on the torpid and more vulnerable *V. bushi* would be less due to the cold conditions. This is reinforced by us only a finding a single *V. bushi* behind bark on a tree in the vicinity of the mounds. However, this seasonal movement 'en masse' to termite mounds is clearly presumptuous, as further visits to the same area would have to be made during the warmer months.

It is well known that termite mounds are occupied by a wide variety of animals, particularly reptiles, in the arid regions of Australia as they provide adequate shelter, a virtually inexhaustible food supply for many small species, especially geckos, and a very temperature-stable environment for egg deposition which has been documented for other varanid species (King and Green 1993; Gaikhorst 2002). It is unknown at this stage whether *V. bushi* utilises termite mounds for egg deposition.

DISCUSSION

Specimens of *D. valens* at the WA Museum suggest that the main centre of distribution for this species is the Hamersley Range extending southeast to Kumarina in the Gascoyne region and east in the Little Sandy Desert (Doughty *et al.* 2012). The Hamersley Range is a regionally unique area consisting of a large elevated range and plateau that contains some of the highest peaks in the Pilbara, including the highest in Western Australia, Mount Meharry at 1200 metres. As a result of the elevated topography, the Hamersley Range receives a higher amount of rainfall (both average annual rainfall and annual average number of days with rainfall greater than 1mm) when compared to the surrounding area such as at Newman. Consequently the range supports a high level of endemism with flora (eg. *Pilbara trudgenii* and *Acacia hamersleyensis*), invertebrates such as snails and spiders (B. Durrant pers. comm.), and

vertebrates (eg. *Underwoodisaurus seorsus* and *Lerista zietzi*) and there still remain undescribed species of reptiles. Contrary to popular belief, not all of the Hamersley Range occurs within the boundaries of the Karijini National Park, which only statutory 'protects' a small area. Large areas of the Hamersley Range remain unprotected and are as equally scenic and biologically/geologically diverse as the national park.

Despite the Pilbara region being one of the most intensely collected areas in Western Australia (How and Cowan 2006) the paucity of *D. valens* records strongly suggests a patchy distribution and that it is not as widespread as general distribution statements imply. Natural history observations such as those reported here are generally not documented during larger, broad-scale surveys that are heavily reliant on a presence v. absence trapping result methodology. This survey focus tends to negate the time available to actively forage, observe and record. To downplay the importance of active searching for reptiles by suggesting it contributes little towards the outcomes of the study (Rolfe and McKenzie 2000) is fundamentally wrong. A survey that does not employ all available sampling techniques, including active searching, is flawed and will always contribute to the exclusion of reptile groups from a survey analyses due to inadequate trapping methodology and/or time restraints as stated by Doughty *et al.* (2011). This is evidently clear with the arboreal species of reptiles such as *V. bushi* that are infrequently trapped compared to active searching (pers. obs.). From a total of 297 survey quadrats, the captures of small to medium-sized arboreal goanna species in the Pilbara resulted in *V. caudolineatus* and *V. bushi* being recorded from only 17 and *V. tristis* from two (Doughty *et al.* 2011).

Surveys that combine trapping with active searching by experienced field naturalists is important and play a crucial role in specific areas resulting in an increased knowledge of local distribution, relative abundance and habitat preference. The importance of active searching should never be underestimated, as demonstrated by the recent rediscovery of *Aprasia rostrata* on the Montebello Islands (Maryan and Bush 2007) and the first Pilbara mainland record of *Ctenotus angusticeps* (Turpin and Ford in press), both species of which are listed as vulnerable under state legislation.

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AN ASSESSMENT OF YOURDAMUNG AND NALYERIN LAKES IN THE JARRAH FOREST REGION OF WESTERN AUSTRALIA

By BRUCE WARD*, RAY CRANFIELD and GRAEME LIDDELOW
Science Division, Department of Environment and Conservation, Manjimup 6258, Western Australia
*Corresponding author. Email: bruce.ward@dec.wa.gov.au

ABSTRACT

Surveys of fringing and aquatic plants, birds and aquatic macro-invertebrate species were carried out at Lake Yourdamung and Lake Nalyerin during 2002. The purpose of this survey was to determine whether Lake Yourdamung, situated on private land, was suitable for inclusion into the Lane-Poole Reserve. Results provided technical and scientific support of an application for land acquisition, which proved to be successful and the 81 ha (182 acres) property was purchased in 2004. After applying wetland functional indices to a range of wetland characteristics, Lake Yourdamung was rated as partially degraded due to draining and clearing (50%) of its fringing vegetation. Despite these interventions, it had retained good water quality and a high diversity of plant, bird and aquatic invertebrate fauna. Lake Nalyerin in comparison was in near natural condition but had suffered some degradation due to vehicle damage of the reed beds. Lake Yourdamung with some remedial restoration could in time return to a near-natural condition and form an important wetland environment, the only one on the Bingham River system. Lakes Yourdamung and Nalyerin appear to meet criteria for listing in the Directory of Important Wetlands in Australia.

INTRODUCTION

Since European settlement wetlands have been destroyed at an alarming rate either filled in or drained and used for other purposes. It is only in the past few decades that we have begun to understand the many ecological functions associated with wetlands and their significance to society (ANCA 1996). Wetlands are among the most productive ecosystems in the world and are a source of substantial biodiversity in supporting numerous species from all of the major groups of organisms – from microbes to mammals. Physical and chemical features such as climate, top-

ography, geology, nutrients, and hydrology help to determine the plants and animals that inhabit various wetlands. The combination of shallow water, high levels of inorganic nutrients, and high rates of primary productivity is ideal for the development of organisms that form the base of a dynamic food web (US EPA 2010).

Lake Yourdamung is located on the head-waters of the Bingham River at 33°12'S and 116°16'E situated some 30km north-east of Collie, Western Australia, while Lake Nalyerin, a further 10 km north east of Yourdamung at 33°08'S and 116°22'E (Figure 1), is fully within state forest on the Harris River. Lake Nalyerin provided a benchmark to compare against as it was in natural forest and has had minimal disturbance. Both Lake Nalyerin and Lake Yourdamung are natural sumpland type wetlands and as such have an important functional role. Benefits of these wetlands include water storage, flood control and help with groundwater recharge. In addition, many of the aquatic and semi-aquatic plants assist with stripping nutrients and harmful contaminants from the

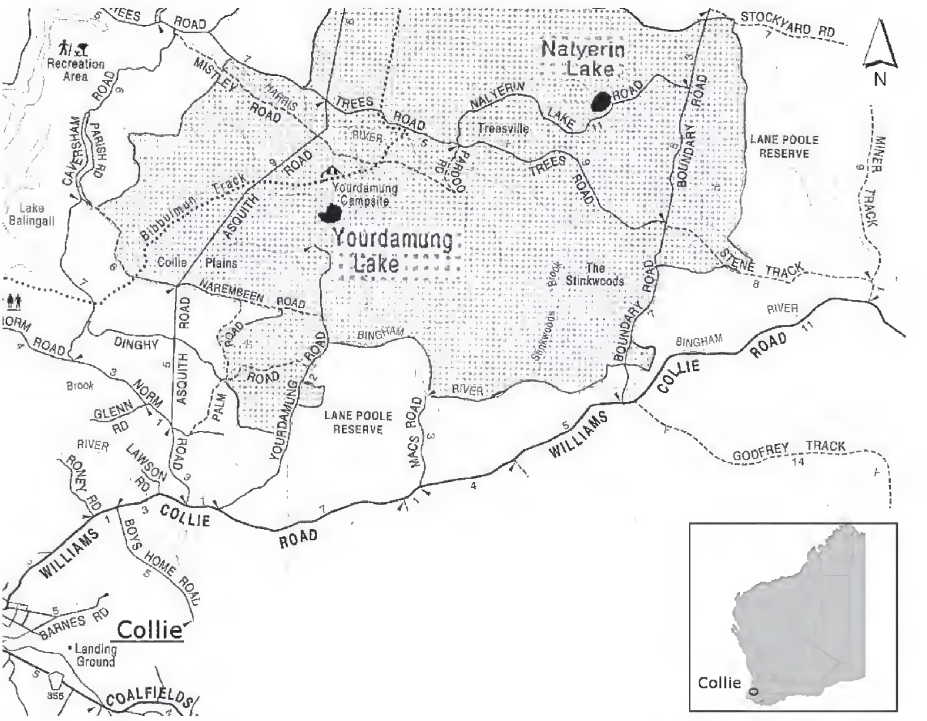

Figure 1. Location of Nalyering and Yourdamung Lakes within the Lane–Poole Reserve and their proximity to Collie, Western Australia.

water improving its quality. The wetlands also provide habitats for many plants and animals, thereby increasing species diversity. Biological monitoring of macro-invertebrate fauna is often done to assess water quality and the health of a system.

A drainage channel across the south west side effectively drained the majority of Lake Yourdamung, reducing the lake area from 30 hectares down to about one hectare. Fringing vegetation from the original lake level was still evident with a new rim of vegetation developing around the current high water-mark.

The aim of this investigation was to record and measure vegetation, birds and aquatic invertebrates for Lake Yourdamung and Lake Nalyerin and rate their health and condition. The study further aimed to determine if Lake Yourdamung would revert to natural condition forming a worthwhile addition to the State's conservation areas.

METHOD

Australia has an immense array of diversity, both physical and biological, and to describe and manage this diversity areas of similar ecosystems have been divided into biogeographic regions (ANCA 1996). Biogeographical regions are defined according to biological and environmental attributes, which include terrain, climate, geology, soil, flora and fauna. Both lakes are situated within the Jarrah forest biogeographic region, which is defined as: duricrust plateau of Yilgarn Craton characterised by Jarrah–Marri forest on laterite gravels and, in the eastern part, by Marri–Wandoo woodlands and clayey soils. Eluvial and alluvial deposits support *Agonis* shrublands. In areas of Mesozoic sediments, Jarrah forests occur in a mosaic with a variety of species-rich shrublands and warm Mediterranean climate (ANCA 1996). Wetlands of the Jarrah forest biogeographic region are poorly represented in the Directory of Important Wetlands in Australia (Environment Australia 2001). Only seven wetlands / wetland systems have been listed in the directory as being of national significance. All of these are on the periphery of the region, with five along the southern edge and two on the northern tip.

A visit to the lakes was conducted on the 20 November 2002 to sample plant material for identification and species listing of fringing and aquatic plants (See Appendix 1 for plant species, Appendix 3 for cryptogams). The fringing vegetation area sampled was between the high water mark and the lake edge. Aquatic and semi-aquatic plants from within the lake were also included along with cryptogams. Voucher specimens for study were collected from plants flowering at the time of the survey and returned to the laboratory, where they were processed and later sent to

the Western Australian Herbarium. A rapid assessment technique rated the condition of the fringing vegetation and provided a comparative species listing to determine the level of degradation and species composition for both lake systems

Aquatic macro-invertebrate taxa were quantified to determine water quality and lake condition at Yourdamung Lake, whereas only a visual inspection was done at Lake Nalyerin due to time constraints. The method used a timed survey technique where sweeps of the water from surface to lakebed with a fine mesh net were conducted over a 20-second period. Ten sweeps placed at random locations around the lake produced sample specimens, which were returned to the laboratory. Identification of specimens using available keys provided a list of species which, together with a measure of their abundance, were applied to tables published by Davis and Christidis (1997) to determine water quality and the health of the system.

Bird counts of fringing and in-lake vegetation at Lake Yourdamung assessed numbers of bird species. The assessment used the standard Birds Australia point transect method (Davies 1983) and sightings and sounds of bird species were recorded at points around the lake. A bird list for Lake Yourdamung is presented in Appendix 2.

Analysis

Data from both lakes (Nalyering and Yourdamung) was applied to a functional capacity rating system which assesses each attribute separately by applying a score based on its condition. All scores are added together to provide an overall total which is compared with a standard. This produces a functional capacity index derived by the following equation for the wetland (adapted from Smith *et al.* 1995) (see Table 3).

FCI = Functional capacity measured / Functional capacity standard

RESULTS

Vegetation species data collected for fringing and aquatic plants are summarised for lakes Yourdamung and Nalyerin in Table 1.

A comparison of the fringing vegetation for both lakes, shows Lake Yourdamung to have

Table 1. Number of fringing and aquatic vegetation species in each lake

	Total number of species	Species common to both	Weed species
Lake Yourdamung	87	19	28
Lake Nalyerin	50	19	2

significantly more weed species than Lake Nalyerin. This is not surprising given that up to 50% of the fringing vegetation was removed to provide pasture for grazing, allowing 28 exotic grasses and weeds to become established compared with only two weeds at Lake Nalyerin. Once the weed species were deducted from the species list there was a similar level of species with Lake Yourdamung having slightly higher species numbers. However, only 19 species are common to both lakes and this shows that these two lakes have dramatically different species composition even though they are only 10km apart.

At sweep sites 'Yourdamung', 10 aquatic invertebrate taxa were present in low numbers and of a type consistent with good water quality (Davis and Christidis 1997) (Table 2). Time allowed for only a visual inspection of Lake Nalyerin, which showed a high abundance of shrimp and other crustaceans that are sensitive to pollution and are species consistent with a healthy system.

Table 2. Macro-invertebrate taxa and abundance at Yourdamung Lake.

	Taxa	Abundance
Caddis fly	Trichoptera	1
Clam shrimp	Mollusca	40
Mites	Arichnida	15
Backswimmer	Hemiptera	10
Beetle	Coleoptera Sp1	5
Beetle	Coleoptera Sp2	3
Dragonfly	Odonata	2
Midges	Diptera	6
Worms	Oligochaeta	20
Mosquitoes	Diptera	2

Bird counts using standard bird census techniques over two mornings at Yourdamung returned a species list of 74 birds (See Appendix 3 for complete list).

Water quality was measured twice at Lake Yourdamung during 2002, in July a period of maximum dilution and again in December during the peak of concentration. The results show; pH ranging from 6.0 in July to 7.49 in December and conductivity from 104 to 177 µS/cm (0.06–0.1ppt) respectively. The dissolved oxygen concentration was 83% in July. The pH of Lake Yourdamung is slightly acidic but well within the range of values reported for other lakes in South-Western Australia (Lane *et al.* 2004, 2011), most of which are more alkaline, probably due to differences in soils and vegetation. Salinity values are very low compared with those of most South West Wetland Monitoring Program (SWWMP) wetlands, as is typical in the Jarrah forest. Lake Yourdamung had a maximum depth in its current state of about 1m, which is lower than that of most SWWMP wetlands.

A functional capacity index of each lake was calculated from wetland attributes that rated the level of degradation and compared against a standard value (Table 3). The functional capacity index was determined by entering the total of all ratings into

Table 3. Showing functional capacity index for both lakes compared with the standard for each function

Function	standard	Yourdamung index	Nalyerin index	Comments
Water storage	1.0	0.5	1.0	Yourdamung drained
Nutrient cycling	1.0	0.8	1.0	Intact aquatic vegetation
Removal of compounds	1.0	0.6	1.0	Area at Yourdamung reduced
Organic carbon	1.0	0.6	1.0	Area of Yourdamung reduced
Maintain plant community	1.0	0.9	0.9	
Maintain detrital biomass	1.0	0.9	1.0	
Spatial structure of habitat	1.0	0.6	1.0	
Connectivity	1.0	0.3	1.0	
Abundance of invertebrates	1.0	0.9	0.9	
Abundance of vertebrates	1.0	0.9	0.9	
Water quality	1.0	0.9	0.9	
Total	11.0	7.9	10.6	

the equation from Smith *et al.* (1995).

FCI = Functional capacity measured / Functional capacity standard

Lake Yourdamung = 7.9/11 gives a FCI of 0.71

Lake Nalyering = 10.6/11 gives a FCI of 0.96

A wetland in pristine condition would have a score of 1.0 and both lakes rated highly.

DISCUSSION

The fringing vegetation is subject to inundation annually and forms a natural filtration system that strips and retains nutrients and harmful pollutants from the water improving water quality discharged into the river system. Comparison of plant diversity for both lakes show the numbers of species to be similar but they have distinctly different species composition and this highlights the spatial differences between the two catchments. Lake Yourdamung has more species with higher levels of grasses and weeds, which has resulted from disturbance associated with clearing to produce pastured land. This lake although cleared of some of its fringing vegetation has maintained good water quality and a high diversity of plant, bird and aquatic invertebrate species. The land surrounding the lake is mostly pastured farmland with a narrow strip of vegetation upstream that provides some connectivity to the natural forest to the north.

The areas cleared would easily revert to natural vegetation and already show some evidence of sedges and reed beds becoming established, an observation noted during the initial visit and a subsequent visit during 2010. Lake Nalyerin in comparison is in near-natural condition but has some damage due to vehicle traffic crossing reed beds. Some remedial action could rectify this area by resiting tracks and access points.

Lake Yourdamung appears to meet Criteria for listing in the Directory of Important Wetlands in Australia. Such as, *It is a good example of a wetland type occurring within a biogeographic region in Australia* but, due to a lack of data demonstrating national significance at the time of assessment of wetlands in this region (J. Lane, pers. comm., 3 March 2011), has not been listed. Lake Yourdamung is also not included among the 152 wetlands of the Department of Environment and Conservation's 'South West Wetlands Monitoring Program' which, for historical reasons, has an emphasis on wetlands of the wheatbelt and the coastal plains. Most lakes in this monitoring program are within national parks or nature reserves established prior to 2000 (Lane *et al.* 2004, 2011). The Lake Yourdamung property was within, but not part of, the Lane-Poole Reserve and had many reasons why it should be added to the reserve. These include: it has a high diversity of plant, bird and animal species; it can be restored back to a natural state; it is within the boundaries of the Lane–Poole Reserve; and it contains habitat suitable for the reintroduction of rare fauna such as Tammar, Woylie and Chuditch also lakes listed in the Directory of Important Wetlands in Australia are poorly represented in the Jarrah forest biogeographical region. Combined, these reasons provided compelling biological evidence to support the application for land acquisition which was finally achieved in 2004.

Restoration of Lake Yourdamung

A priority following land acquisition was to destock the property of cattle and sheep. This significantly reduced grazing pressure allowing natural vegetation to re-establish. As part of the farming activities, a drain cut on the south-eastern edge effectively lowered the lake by 0.8–1.0m altering the entire hydrology of the lake. The lake originally covered about 36 hectares and because of drainage, only about one hectare holds water and actively functions as a sump. To restore this lake to its natural level, forms the next priority and can be achieved by filling in or blocking the drain. Restoration of the damaged fringing vegetation would develop naturally but intervention in the form of replanting and infilling of the vegetation would speed this process. The cost of this type of intervention often

prohibits this work.

There was evidence of water birds nesting and foraging in the water during our visit and suggests that this is an important site for many of these species. Lane–Poole Reserve has 120 species of birds and this survey has captured over 60% from this one site, which emphasises its importance. Increasing the area of the lake back to its original size would benefit these species providing increased habitat and maintenance of diversity. Despite the draining and clearing of the lake, the health of this system is in good order. Evidence of this was shown by the cover of aquatic and semi-aquatic plants, with good water quality capable of supporting growth and a suite of macroinvertebrate fauna recognised for their capacity to only survive in good quality water. The water was clear and contained no evidence of algal blooms.

Lake Yourdamung drains into the Bingham River through a broad valley flat that is subject to inundation. The lake forms a natural sump and experiences a strong seasonal hydrological cycle of flooding during winter while drying out in summer and is typical of the natural wetlands found in the Jarrah forest. Once restored, it will play a substantial ecological role in the natural functioning of the river system. Restoration of the lake and maintenance of the river system is a responsible goal to preserve the long-term viability of this important habitat and its ecological diversity.

CONCLUSION

Lake Yourdamung showed partial impact from farming and has a high diversity of plant, bird and aquatic animals with fringing vegetation forming an important habitat which would regenerate over time. The property containing the majority of the lake was purchased and incorporated into the Lane–Poole Reserve and will form an important natural wetland for this area.

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APPENDIX 1. (Vegetation species from Lakes Yourdamung and Nalyering in 2002). Genus marked with an asterisk is a weed species

		Lake Yourdamung	Lake Nalyering	
Amaranthaceae		*		
Alternanthera	*nodiflora*			
Apiaceae				
Daucus	*glochidiatus*	*	*	
Homalosciadium	*homalocarpum*	*	*	
Araliaceae				
Trachymene	*pilosa*	*	*	
Asparagaceae				
Chamaescilla	*corymbosa*	*	*	
Sowerbaea	*laxiflora*	*		
Thysanotus	*tenellus*		*	
Asteraceae				
**Arctotheca*	*calendula*	*		
**Cotula*	*coronopifolia*	*		
Helichrysum	*luteoalbum*	*		
**Hypochaeris*	*glabra*	*	*	
Lagenophora	*huegelii*		*	
Senecio	*quadridentatus*		*	
Siloxerus	*humifusus*	*	*	
**Sonchus*	*asper*	*		
**Sonchus*	*oleraceus*	*		
Campanulaceae				
Lobelia	*anceps*	*	*	
**Monopsis*	*debilis*	*		
Wahlenbergia	*gracilenta*	*	*	
Centrolepidaceae				
Aphelia	*cyperoides*	*		
Centrolepis	*aristata*		*	
Characeae				
Chara	sp.		*	algae
Crassulaceae				
**Crassula*	*natans*	*		
Cyperaceae				
Baumea	*articulata*		*	
Baumea	*juncea*		*	
Isolepis	*cyperoides*	*		
**Isolepis*	*marginata*	*		
Isolepis	*stellata*	*		
Dilleniaceae				
Hibbertia	*amplexicaulis*		*	
Hibbertia	*racemosa*	*	*	
Hibbertia	*stellaris*	*		
Elaeocarpaceae				
Platytheca	*galioides*	*		

Appendix 1 (cont.)

				Lake Yourdamung	Lake Nalyering
Ericaceae					
Brachyloma	*geissoloma*			*	
Leucopogon	*capitellatus*			*	
Leucopogon	*propinquus*				*
Leucopogon	*verticillatus*			*	
Fabaceae					
Acacia	*huegelii*			*	
Acacia	*pulchella*			*	
Bossiaea	*linophylla*				*
Eutaxia	*virgata*			*	
Gastrolobium	*ebracteolatum*				*
Gompholobium	*capitatum*			*	
Jacksonia	*furcellata*			*	
**Lotus*	*subbiflorus*			*	
**Trifolium*	*dubium*			*	
**Trifolium*	*subterraneum*			*	
Viminaria	*juncea*				*
Geraniaceae					
Pelargonium	*littorale*			*	
Goodeniaceae					
Dampiera	*linearis*			*	
Goodenia	*filiformis*			*	*
Haemodoraceae					
Conostylis	*aculeata*				*
Haloragaceae					
Myriophyllum	*crispatum*			*	
Myriophyllum	*drummondii*			*	
Hemerocallidaceae					
Caesia	*micrantha*			*	*
Dianella	*revoluta*			*	
Hydrocharitaceae					
Ottelia	*ovalifolia*			*	
Iridaceae					
Patersonia	*occidentalis*			*	
Patersonia	*umbrosa*	var.	*umbrosa*	*	
Juncaceae					
**Juncus*	*microcephalus*			*	
Juncus	*pauciflorus*			*	
Lamiaceae					
**Mentha*	*pulegium*			*	
Lauraceae					
Cassytha	*racemosa*				*
Lentibulariaceae					
Utricularia	*volubilis*				*

				Lake Yourdamung	Lake Nalyering
Loganiaceae					
Phyllangium	*paradoxum*			*	*
Lythraceae					
**Lythrum*	*hyssopifolia*			*	
Menyanthaceae					
Ornduffia	*parnassifolia*			*	*
Myrtaceae					
Astartea	*fascicularis*			*	
Corymbia	*calophylla*			*	
Eucalyptus	*marginata*			*	
Eucalyptus	*rudis*			*	*
Hypocalymma	*angustifolium*			*	
Kunzea	*glabrescens*			*	
Kunzea	*spathulata*				*
Melaleuca	*lateritia*			*	*
Melaleuca	*preissiana*			*	*
Melaleuca	*viminea*			*	*
Onagraceae					
Epilobium	*billardiereanum*	subsp.	*cinereum*	*	
Orchidaceae					
**Disa*	*bracteata*			*	
Elythranthera	*emarginata*				*
Microtis	*brownii*				*
Microtis	*media*	subsp.	*media*	*	*
Microtis	*orbicularis*				*
Thelymitra	*crinita*				*
Orobanchaceae					
**Orobanche*	*minor*			*	
Phyllanthaceae					
Poranthera	*microphylla*				*
Pittosporaceae					
Billardiera	*heterophylla*				*
Poaceae					
**Aira*	*cupaniana*			*	
Amphibromus	*nervosus*			*	
**Briza*	*maxima*			*	
'Briza	*minor*			*	
**Bromus*	*hordeaceus*			*	
**Holcus*	*lanatus*			*	
**Hordeum*	*leporinum*			*	
**Lolium*	*rigidum*			*	
Microlaena	*stipoides*				*
Neurachne	*alopecuroidea*			*	
**Polypogon*	*monspeliensis*			*	
**Rostraria*	*cristata*			*	
**Vulpia*	*bromoides*			*	

Appendix 1 (cont.)

		Lake Yourdamung	Lake Nalyering
Polygonaceae			
Persicaria	*prostrata*	*	
**Rumex*	*brownii*	*	
Proteaceae			
Banksia	*attenuata*		*
Banksia	*littoralis*	*	
Hakea	*prostrata*		*
Hakea	*varia*	*	
Persoonia	*longifolia*	*	
Ranunculaceae			
Ranunculus	*amphitrichus*		*
Rosaceae			
**Acaena*	*echinata*		*
Rutaceae			
Boronia	*dichotoma*	*	
Stylidiaceae			
Levenhookia	*dubia*	*	
Levenhookia	*pusilla*		*
Stylidium	*brunonianum*	*	*
Stylidium	*induratum*	*	
Stylidium	*inundatum*		*
Stylidium	*roseoalatum*	*	
Stylidium	sp.		*
Typhaceae			
**Typha*	*orientalis*	*	
Xanthorrhoeaceae			
Xanthorrhoea	*preissii*	*	
Zamiaceae			
Macrozamia	*riedlei*		*

APPENDIX 2. Birds of Yourdamung Lake

RAOU	Common Name	Scientific Name
001	Emu	*Dromaius novaehollandiae*
035	Brush Bronzewing	*Phaps elegans*
046	Buff-banded Rail	*Gallirallus philippensis*
056	Dusky Moorhen	*Gallinula tenebrosa*
057	Purple Swamphen	*Porphyrio porphyrio*
097	Little Black Cormorant	*Phalacrocorax sulcirostris*
100	Little Pied Cormorant	*Phalacrocorax melanoleucos*
179	Australian White Ibis	*Threskiornis molucca*
182	Yellow-billed Spoonbill	*Platalea flavipes*
188	White Faced Heron	*Ardea novaehollandiae*
189	Pacific Heron	*Ardea pacifica*
203	Black Swan	*Cygnus atratus*
207	Australian Shelduck	*Tadorna tadornoides*
208	Pacific Black Duck	*Anas superciliosa*
210	Chestnut Teal	*Anas castanea*
211	Grey Teal	*Anas gibberifrons*
212	Australasian Shoveler	*Anas rhynchotis*
217	Musk Duck	*Biziura lobata*
218	Spotted Harrier	*Circus assimilis*
219	Swamp Harrier	*Circus approximanis*
221	Brown Goshawk	*Accipiter fasciatus*
222	Collared Sparrowhawk	*Accipiter cirrhocephalus*
224	Wedge-tailed Eagle	*Aquila audax*
235	Australian Hobby	*Falco longipennis*
237	Peregrine Falcon	*Falco peregrinus*
240	Australian Kestrel	*Falco cenchroides*
242	Southern Boobook	*Ninox novaeseelandiae*
264	Red-tailed Black Cockatoo	*Calyptorhynchus magnificus*
266	White-tailed Black Cockatoo	*Calyptorhynchus latirostis*
289	Western Rosella	*Platycercus icterotis*
290	Red-capped Parrot	*Purpureicephalus spuruius*
294	Port Lincoln Ringneck	*Barnardius zonarius semitorquatus*
307	Elegant Parrot	*Neophema elegans*
313	Tawny Frogmouth	*Podargus strigoides*
322	Laughing Kookaburra	*Dacelo novaeguineae*
326	Sacred Kingfisher	*Halcyon sancta*
329	Rainbow Bee-eater	*Merops ornatus*
344	Shining Bronze Cuckoo	*Chrysococcyx lucidus*
347	Richard's Pipit	*Anthus novaeseelandiae*
359	Tree Martin	*Cecropis nigricans*
361	Grey Fantail	*Rhipidura fuliginosa*
364	Willie Wagtail	*Rhipidura leucophrys*
369	Restless Flycatcher	*Myiagra inquieta*
380	Scarlet Robin	*Petroica multicolor*
381	Red-capped Robin	*Petroica goodenovii*
384	Western Yellow Robin	*Epopsaltria grisogularis*

Appendix 2 (cont.)

RAOU	Common Name	Scientific Name
398	Golden Whistler	*Pachycephala pectoralis*
408	Grey Shrike-thrush	*Colluricincla harmonica*
415	Australian Magpie-lark	*Grallina cyancoleuca*
424	Black-faced Cuckoo shrike	*Coracina novaehollandiae*
430	White-winged Triller	*Lalage sueurii*
448	White-fronted Chat	*Ephthianura albifrons*
463	Western Gerygoyne	*Gerygone fusca*
472	Western Thornbill	*Acanthiza inornata*
476	Inland Thornbill	*Acanthiza apicalis*
486	Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*
524	Clamorous Reed-warbler	*Acrocephalus stentoreus*
532	Spendid Fairy-wren	*Malurus splendens*
547	Dusky Woodswallow	*Artamus cyanopterus*
565	Spotted Pardalote	*Pardalotus punctatus*
574	Silvereye	*Zosterops lateralis*
578	White-naped Honeyeater	*Melithreptus lunatus*
592	Western Spinebill	*Acanthorhynchus superciliosus*
597	Brown Honeyeater	*Lichmera indistincta*
608	Singing Honeyeater	*Lichenostomus virescens*
631	New Holland Honeyeater	*Phylidonyris novaehollandiae*
637	Little Wattlebird	*Anthochaera chrysoptera*
638	Red Wattlebird	*Anthochaera carunculata*
651	Red-eared Firetail	*Emblema oculata*
697	Grey Currawong	*Strepera versicolor*
702	Grey Butcherbird	*Cracticus torquatus*
705	Australian Magpie	*Gymnorhina tibicen*
930	Australian Raven	*Corvus coronoides*
976	Striated Pardalote	*Pardalotus striatus*

APPENDIX 3. Mosses and Lichens (Cryptogams) of Yourdamung Lake

FAMILY_NAME	GENUS	SPECIES	Life Form
Cladoniaceae	*Cladia*	*aggregata*	lichen
Collemataceae	*Collema*	*leucocarpum*	lichen
Hypogymniaceae	*Menegazzia*	*caesiopruinosa*	lichen
	Menegazzia	*fertilis*	lichen
Lecanoraceae	*Maronina*	*hesperia*	lichen
Lecanoraceae	*Pyrrhospora*	*laeta*	lichen
Lecanoraceae	*Tephromela*	*alectoronica*	lichen
Lecideaceae	*Lecidea*	*capensis*	lichen
Lecideaceae	*Lecidea*	*tragorum*	lichen
Lichinaceae	*Pyrenopsis*	sp. (D. Richardson 962)	lichen
Parmeliaceae	*Flavoparmelia*	*marchantii*	lichen
Parmeliaceae	*Parmotrema*	*cooperi*	lichen
Parmeliaceae	*Xanthoparmelia*	*fumigata*	lichen
Parmeliaceae	*Xanthoparmelia*	*nana*	lichen
Parmeliaceae	*Xanthoparmelia*	*oleosa*	lichen
Peltulaceae	*Peltula*	*obscurans*	lichen
Pertusariaceae	*Ochrolechia*	*pallescens*	lichen
Pertusariaceae	*Pertusaria*	*scaberula*	lichen
Physciaceae	*Amandinea*	*punctata*	lichen
Physciaceae	*Buellia*	*disciformis*	lichen
Physciaceae	*Buellia*	*dissa*	lichen
Ramalinaceae	*Ramalina*	*inflata*	lichen
Sematophyllaceae	*Sematophyllum*	*subhumile*	moss
Usneaceae	*Usnea*	*dasaea*	lichen
Usneaceae	*Usnea*	*subalpina*	lichen

CALYSTEGIA R.BR. (CONVOLVULACEAE) IN WESTERN AUSTRALIA

By GREG KEIGHERY

Western Australian Conservation Science Centre, Department of Environment and Conservation, Locked Bag 104, Bentley Delivery Centre, Western Australia, 6983.

and

BRONWEN KEIGHERY

224 Hamersley Road, Subiaco, 6008

Previous address: Office of the Environmental Protection Authority, Locked Bag 33, Cloisters Square, Perth, Western Australia, 6850.

ABSTRACT

The genus *Calystegia* (Convolvulaceae) is represented by two native species in Western Australia, *Calystegia soldanella* and *C. sepium*. The latter had not been collected in Western Australia since 1877 until a population was discovered near Busselton in 2008. This was initially considered a weed and highlights the need for careful study of difficult cosmopolitan wetland groups.

INTRODUCTION

Western Australia has two recorded native species of *Calystegia* R.Br. namely *C. soldanella* (L.) Roem. & Schult. and *C. sepium* (L.) R.Br. The former is a rarely recorded plant of coastal fore dunes, while the latter is not represented in collections at PERTH, however, There are six nineteenth century Western Australian collections in Melbourne (MEL) Herbarium. No other collections have been located in Australian Herbaria.

While undertaking surveys of reserves and bushland areas in the Busselton region as part of a conservation plan for the region (Webb *et al.* 2009) a large population of an unknown sterile vine was located in the Broadwater Nature Reserve. When flowering material became available (Figures 1 and 2) this was collected and identified as a pink flowered member of the genus *Calystegia* (Convolvulaceae).

While the genus is distinctive, species of the genus *Calystegia* are difficult to identify. Fang and Brummitt (1995) note that the genus *Calystegia* comprises

> "Approximately 70 intergrading sub specific taxa which can be arbitrarily

combined into about 25 species: mostly temperate but sparingly extending to the tropics. Nearly all taxa in *Calystegia* intergrade geographically into neighbouring taxa with the exception of the widespread coastal species, *C. soldanella* (Linnaeus) R. Brown. Almost half of the genus is endemic

LEFT: Figure 1. Flower of *Calystegia sepium* subsp. *roseata* at Broadwater Nature Reserve

BELOW: Figure 2. Habit of *Calystegia sepium* subsp. *roseata* at Broadwater Nature Reserve

> in California, U.S.A. It is impossible to draw clearly defined specific limits, and intermediate forms are always found where two taxa approximate geographically".

On checking keys and floras, the population at Broadwater fell into the *Calystegia sepium/ silvatica* complex, a sub-cosmopolitan species group centred on the Northern Hemisphere. This species complex consisting of *C. sepium* (Table 1) with nine described subspecies, *C. silvatica*, *Calystegia pulchra* (a species that is probable horticultural derivative), and two other species which are named hybrid derivatives. Of these 13 taxa, five normally have pink flowers like the Broadwater population (Table 1).

Plants from Broadwater were compared and contrasted using the descriptions and keys to these pink flowered taxa (Lockton 2012, Stace and Hilli Thompson 1997, Stace, Van der Medjen and De Kort 2011). Broadwater plants despite having the large pink flowers , normally characteristic of *C. pulchra*, are completely glabrous and can therefore, be excluded from that species. They have overlapping inflated bracteoles which cover the base of the flower and hide the sepals. This is a key character in all recent keys and floras used to separate *C. silvatica* from *C. sepium*.

Table 1. Taxa in the *Calystegia sepium/ silvaticum* complex (Source: Stace and Hilli Thompson (1997), Stace, Van der Medjen & De Kort (2011) and Webb, Sykes and Garnock-Jones (1988))

- *Calystegia sepium* subsp. *americana*. North America (flowers white).
- *Calystegia sepium* subsp. *angulata*. North America (flowers white).
- *Calystegia sepium* subsp. *appalachiana*. Eastern North America (flowers white).
- *Calystegia sepium* subsp. *binghamiae*. Western North America (California, flowers white).
- *Calystegia sepium* subsp. *erratica*. North America (flowers white).
- *Calystegia sepium* subsp. *limnophila*. Southern North America (flowers white).
- *Calystegia sepium* subsp. *roseata*. Sub-cosmopolitan (flowers pink).
- *Calystegia sepium* subsp. *sepium*. Sub-cosmopolitan (flowers white).
- *Calystegia sepium* subsp. *spectabilis*. Siberia. (flowers often pinkish).
- *Calystegia pulchra* (flowers pink).
- *Calystegia silvatica* subsp. *disjuncta* Europe (flowers white).
- *Calystegia silvatica* subsp. *fraterniflora* North America (flowers white).
- *Calystegia silvatica* subsp. *orientalis* Asia (flowers white).
- *Calystegia silvatica* subsp. *silvatica* Europe (flowers white).

Hybrid Taxa (both have pink flowers)

- *Calystegia* x *scania* (*C. sepium* x *pulchra*) UK
- *Calystegia* x *howittorum* (*C. pulchra* x *silvatica*) UK

However, the pink flowers and arrow shaped leaves are atypical of *C. silvatica*. Ogden (1978) noted that populations in New Zealand with this character set (pink flowers, overlapping saccate bracteoles with a deep sinus) were provisionally allocated as hybrids between these species. However, there is only one taxa present at Broadwater with no indication of either putative parent species and the population is the sole highly seed fertile, suggesting that it is not a hybrid swarm.

This rampant vine was thus provisionally identified as the weed *Calystegia* ? *silvatica* and targeted for eradication because of its invasive nature and potential impacts (Keighery and Keighery 2009).

However, because of the provisional nature of the identification, the knowledge that this is a group of intergrading species, that are difficult to accurately identify we continued to attempt to place the population more accurately. Melbourne Herbarium was visited to view existing Western Australian and exotic collections, we had discussions with New Zealand weed experts in Christchurch and sent scans of living and dried plants to Dr R. Brummitt at the Royal Botanic Gardens in Kew, England, the world authority on the genus. This study resulted in the re-assessment of this collection presented here.

CALYSTEGIA IN WESTERN AUSTRALIA

Five species of *Calystegia* are recorded in Australia (Table 2), including a naturalised weed, *Calystegia silvatica*. *Calystegia* in Western Australia is now considered to contain two indigen-

Table 2. *Calystegia* Species Recorded for Australia
(Source Australian Plant Census, 2011 http://www.cpbr.gov,.au/chah/apc/index.html)

Calystegia affinis Endl. Lord Howe & Norfolk Islands
Calystegia marginata R.Br. Qld, NSW & Vic
Calystegia sepium (L.) R.Br. (WA, SA, NSW, Vic, Tas)
Calystegia sepium (L.) R.Br. subsp. *sepium* Only Vic and SA currently recognise subspecies in this species.
Calystegia sepium subsp. *roseata* Brummitt Vic, SA
**Calystegia silvatica* (Kit.) Griseb. Only SA and Vic use subspecific rank in this species. SA (naturalised), NSW (naturalised), Vic (naturalised), Tas (naturalised)
**Calystegia silvatica* (Kit.) Griseb. subsp. *disjuncta* Brummitt Vic (naturalised)
**Calystegia silvatica* (Kit.) Griseb. subsp. *silvatica* SA (naturalised), Vic (naturalised)
Calystegia soldanella (L.) Roem. et Schult. WA, SA, Tas, Vic, NSW

ous species, one with possibly two subspecies.

Key to *Calystegia* in Western Australia

1. Trailing plants, leaves fleshy apex rounded ..... *C. soldanella*
1. Twining plants, leaves not succulent with an acute tip... 2
2. Leaves mostly narrowly triangular with arrow shaped tails, flowers white ..... *C. sepium* subsp. *sepium*
2. Flowers pink ..... *C. sepium* subsp. *roseata*

A general description of the genus follows:

Calystegia R.Br.

Perennial herbs prostrate or erect to twining to several metres tall, rhizomatous [or woody at base]. Leaves subsessile to petiolate, oblong to hastate or sagittate [or rarely pedate]. Inflorescences axillary, 1-flowered [or few-flowered] cymes; bracteoles 2, sepal-like, inserted immediately below calyx, ovate and sometimes saccate, enclosing calyx [or remote from calyx and subulate or leaf-shaped], persistent. Sepals subequal, persistent. Corolla white, pink [or pale yellow], funnelform, with 5 distinct midpetaline bands, glabrous. Stamens included, equal. Pollen globose, pantoporate, not spiny. Ovary 1-loculed, 4-ovuled. Style 1, included in corolla; stigmas 2, clavate. Capsule globose, glabrous, indehiscent. Seeds 4, smooth or minutely tuberculate.

1. *Calystegia soldanella* (L.) Roem. & Schult.

Trailing perennial vine from a ?tuberous rootstock; glabrous. Leaves with lamina reniform to rounded-cordate, fleshy, 1.5–4 cm long, 2 to 4 cm wide; margins undulate; petiole 1–5 cm long. Flowers axillary, solitary on peduncles equal to or longer than petioles; bracteoles broad-ovate, obtuse, 1–1.5 cm long, 8–12 mm wide, slightly shorter than the calyx. Corolla 3–5 cm long, pink. Capsule ovoid, 12–15 mm long. Sea Bindweed.

Specimens examined . WESTERN AUSTRALIA: Mouth of Ellen Brook, 33° 54' 29" S 114° 59' 36"E, 2-Oct.-1988, G.J. Keighery 10506 (PERTH 04431901), Mouth of Ellen Brook, 33° 54' 29" S 114° 59' 36" E, 29-Jan.-1988, G.J. Keighery 9512 (PERTH 03641848), Opposite Chatham Island, 34° 58' 35" S 116° 43' 29" E, Dec.–1912, S.W. Jackson s.n. (PERTH 03634566).

Distribution. Recorded from the Warren bio-region of Western Australia. Also recorded from Queensland, New South Wales, Lord Howe Island, Norfolk Island, South Australia, Victoria and Tasmania.

Habitat. Occurs sporadically along upper margins of the strand line on beaches.

Flowering Period. October to January.

Conservation Status. Although it has been rarely recorded this species is probably not rare.

Notes. This is an uncommon sand binder of the higher rainfall region of southern Western Australia.

2. *Calystegia sepium* (L.) R.Br. ? subsp. *sepium*

All the six individual historical collections from Melbourne Herbarium (MEL) lack any description of flower colour, however, the rather faded flowers on existing herbarium collections lack any pink shades. *Calystegia sepium* subsp. *roseata* is almost always noted as a weedy component of coastal often saline wetlands rather than the riverine habitats of these collections which are the preferred habitat of subspecies *sepium*. Hence they are provisionally attributed to subspecies *sepium*.

Perennial vine from a widely spreading underground horizontal stem; shoots erect, slender, glabrous and twining on supporting vegetation to 5 metres. Leaves alternate with lamina arrow- or heart- shaped, 3–10 cm long, 2–6 cm wide, acuminate with an acute apex; base sagittate or slightly hastate; basal lobes entire to slightly lobed; petiole 2–5 cm long. Flowers axillary, solitary on peduncles much longer than petioles; bracteoles ovate, acute, 1.5–2 cm long, 8–12 mm wide, longer than and enclosing the calyx. Corolla 4–6 cm long, ?white. Capsule ovoid, 7–9 mm long. Large Bindweed.

Specimens examined (all MEL). WESTERN AUSTRALIA:, Tone River, 100 miles west [climber sent to Mueller by Shepherd, Grows in channel on muddy deposits, inundated for a considerable time, flowers about January], MEL 2272160; Upper Warren River, 13-Dec.-1877, MEL 227215; Western Australia, Mrs. Clarke, MEL 2272154; Western Australia, Drummond 219, MEL 2272161; ?Tone or Toms Ranges, Mueller, MEL 2272152; Murchison River, Oldfield, MEL 2272153.

Distribution. Recorded from the Murchison River to the Tone River. *Calystegia sepium* susbsp. *sepium* is also recorded from New South Wales, South Australia, Victoria and Tasmania. Elsewhere, temperate regions of Europe, Africa, Asia and America.

Habitat. Apparently confined to riverine sites.

Flowering Period. December to January.

Conservation Status. Although recorded at least six times in the Nineteenth century, from the Murchison to the Tone River, this species has not been collected since 1877. If this is *Calystegia sepium* subsp. *sepium* then this subspecies is probably extinct in Western Australia.

Notes. Considerable degradation by clearing, grazing, siltation and especially salination of the water has occurred along many Western Australia rivers and this may account for the decline and disappearance of this subspecies.

3. *Calystegia sepium* subsp. *roseata* Brummitt

Perennial vine to 5 metres, from a ?tuberous rootstock, glabrous, with twining stems. Leaves with lamina ovate to lanceolate, 5–10 cm long, 5–10 cm wide, shortly acuminate with an apex acute or narrowly obtuse and finely mucronate; base cordate and shallowly sagitate; petiole 4–8 cm long. Flowers solitary on peduncles longer than petioles; bracteoles broad-ovate, 2–3 cm long, 12–16 mm wide, rounded to truncate, emarginate at the apex, longer than and enclosing the calyx, inflated at the base. Corolla 4–7 cm long, suffused pink. Capsule ovoid, 10–12 mm long. Seeds triangular-ovoid, very dark brown to almost black. Pink Bindweed.

Specimens examined. WESTERN AUSTRALIA: Broadwater Nature Reserve, 33° 39' 52"S 115° 18' 5.1" E, GJ & BJ Keighery 890 (PERTH 07852290).

Distribution. *Calystegia sepium* subsp. *roseata* in Australia has been recorded from South Australia, Victoria and Tasmania. The subspecies is also widespread in temperate areas of New Zealand, Europe and America.

Habitat. A rampant vine occupying a single wetland in the Busselton area (Broadwater Nature Reserve and along the New River). This is an area of fresh to saline coastal lagoonal wetlands which is the preferred habitat of this subspecies (Lockton 2012).

Flowering Period. October to December.

Notes. Despite Stace (1961) reporting that both *C. silvatica* and *C. sepium* are self-incompatible in Britain, the clone of this species at Broadwater produces a large amount of hard black-brown seeds.

Although the New Zealand Plant Conservation Network (2011) noted that fertile hybrids can readily occur between *Calystegia silvatica* and *sepium* especially in urban settings, they normally have pale pink-white striped flowers and both parents have very distinctive nrDNA ITS sequences from which the hybrid can be readily detected. Since only one taxon was detected at Broadwater the possibility that the population is of hybrid origin seems low. New Zealand experts were of the opinion that the collection fell within the limits of *C. sepium* and was probably not of hybrid origin.

The pink flowers (Figure 1) and normally narrow to broadly triangular green to yellow-green leaves with sagittate tails (giving an arrow shape, see Figure 2) also separate this population from the white flowered *Calystegia silvatica* which has broadly triangular to ovate dark green leaves without the tails.

R. Brummitt (pers. com.) considers that *Calystegia sepium* subsp. *roseata* is the correct placement of the population. He also noted that the habitat reflects the normal occurrences

of this subspecies and the population should be considered indigenous not alien.

DISCUSSION

With the new placement of the Busselton collection it becomes the first record of the species, *Calystegia sepium* in Western Australia since 1877. If the older records are indeed subspecies *sepium*, then this is also the first record of subspecies *roseata* from Western Australia, and subspecies *sepium* is probably extinct in Western Australia. That this was initially considered a weed highlights the need for careful study of difficult cosmopolitan wetland groups. Searches need to be undertaken for this species along the upper reaches of the Tone and Warren Rivers to ascertain if they still exist and if they are indeed subspecies *sepium*.

ACKNOWLEDGEMENTS

Pina Milne of Melbourne Herbarium, facilitated access to MEL collections of *Calystegia*. Dr Richard Brummitt of Kew kindly checked the Broadwater material and confirmed this collection as *Calystegia sepium* subsp. *roseata*. Some of this work was supported by funds from Swan Bioplan, a grant from the Minister of the Environment to the then Department of Environmental Protection.

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UNUSUAL BROWN VARIANT OF WESTERN MAGPIE IN PERTH

By JOSEPH FROUDIST
17 Tabard St., Greenwood, Western Australia

The Australian Magpie (*Gymnorhina tibicen*) is found in lightly wooded country in all but the driest and wettest parts of mainland Australia and Tasmania (Storr and Johnstone (1979). This species has adapted well to urban areas, and is common in Australian cities. Australian Magpies divide broadly into two main groups – the white-backed forms and the black-backed forms, each with a number of sub-species. The Western Magpie is *G.tibicen dorsalis*, one of the white-backed sub-species, and is found only in South-Western Australia. All Australian Magpies are primarily black and white, with varying amounts of grey, especially in juveniles and females. Adult female Western Magpies are very distinctive in that the mantle (upper back) has black or dark grey feathers edged with greyish white, as can be seen in Figure 1.

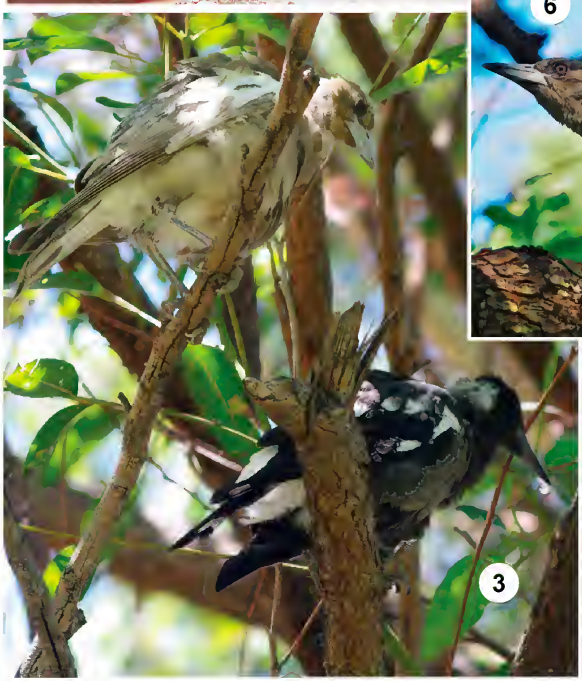
In a park in my suburb of Greenwood (a northern suburb of Perth, Western Australia) there is a large extended family of magpies, consisting of a dominant male, two subordinate males, 27 females, and three young raised to adulthood in 2009/2010. For much of the time, this group tends to split into 2 sub-families of 19 and 14 individuals respectively. At times the two subgroups come together, and also quite regularly there is a break-up into many much smaller groups, with some individuals foraging on their own. The group's territory covers the whole park, plus the yards of surrounding and nearby homes. There is a remarkable lack of aggression between all these individuals, both towards each other, and towards humans and dogs, even at magpie breeding time.

In October 2009 I noticed a female with one juvenile of approximately three-quarter adult size feeding on the ground in the south-western corner of the park, away from the rest of the group. The juvenile was very unusual in that the plumage was brown and white, and did not exhibit any grey or black. I spotted these two birds many times over the next few weeks, always in the same location, and never in the company of the rest of the group. The possibility had to be considered that the unusually coloured juvenile might have been rejected by the group, and that the mother was isolating it in order to protect it.

In late November, however, I spotted the mother and juvenile feeding on the ground with an adult male and five adult females in a location further east along the south side of the park, and there was clearly no aggression toward the brown and white variant magpie. Acceptance by the group was confirmed in the next few weeks when I observed the brown variant and its mother gradually extending their range, and flying with the rest of the group to forage in the park, and front yards south of the park. The mother and juvenile continued to extend their range of activity into 2010, and became active throughout the full range of this family group. Figure 2 was taken in January 2010. The brown variant was foraging in the front yard of a home opposite the park, in the company of its mother and about 10 other magpies from the family group. It can be seen that the juvenile has brown and white plumage, with no black or grey plumage at all. The patterning is very similar to that of a normal juvenile magpie, with brown more or less replacing black and grey. There is not a lot of variation in the shade of brown, and the breast is slightly mottled. There are paler feathers on the back of the neck and upper back, and white areas on the wing and rump, with white colouration extending over the first third or so of the upper tail. Adult magpies have brownish red eyes – the brown variant has the typical brown eyes of a juvenile magpie, although somewhat lighter in colour than those of other juveniles. Figure 3 shows it perched near to a normally coloured young magpie. This picture shows the very pale plumage on the underside. The beak is paler than the beak of the other youngster, and uniformly pale.

It can be seen from Figures 5 and 6 that there have been significant changes in the appearance of the brown variant in the period between January and April. The beak has developed a darker tip, more like the adult beak as in Figure 1. While the eye is still brown, it has darkened in colour. Darker brown feathers are appearing on the face, and there are also darker brown wing and tail feathers beginning to emerge. The back of the neck and the upper back are beginning to develop quite complex markings (Figure 5). The back of the head changes from white to pale grey to darker grey, and then greyish dark brown. These feathers show some pale edging in the neck area, then slight pale edging on some of the mantle feathers, with a white spot at the distal apex of the feather. This looks like a modified version of the Western Magpie markings as seen in the normal adult female in Figure 1.

Figure 6 shows that the sides of the brown variant are still pale brown, while the neck has darkened underneath. The development of grey feathers can be clearly seen on the upper neck,



Figures: 1. Normal Adult Female Western Magpie. **2.** Brown and White Varient Juvenile in Front Yard. January 2010. **3.** Brown Variant Roosting near one of the other young Magpies. January 2010. **4.** Brown variant extending its wing to show the very pale flight feathers. **5.** Brown variant as a Sub-Adult. **6.** Brown variant in April 2010

along with the paler edging. The white rump is clearly visible. More changes in plumage can be expected in coming years. Male sub-adult Australian Magpies have plumage similar to the females, and it is not possible to determine the sex of the brown variant at this stage. Adult male Western Magpies take about 4 years to develop their full adult plumage (Storr and Johnstone, 1979). Both adult males and females of the Western Magpie continue to change their appearance as they get older. The males gradually develop more white in the tail, and older females start to lose the white edging on their backs as they get older, and it may disappear completely in old birds (Slater, Slater and Slater, 2004). It is clear that the unusual and attractive brown variant will continue to change in appearance throughout its life.

Fully white colour morphs in the Western Magpie have been observed in the past, and a fully black magpie has been reported in one of the Eastern States of Australia. A photo of another brown and white magpie has been published on the Australian Broadcasting Corporation website in the "Photos" section by Grant Harrison, and the sighting was made in the latter half of 2009 near Kangarilla, 41 km from Adelaide. This location is within the described range of the Magpie sub-species G. *tibicen telonocua*, another of the white-backed sub-species of Magpie (see Simpson and Day, 2004). The males of all the white-backed races are very similar in their markings, and the photo by Harrison appears to be of an adult male, with brown replacing black. There is no obvious grey colouration present in any of the feathers

In the period between the beginning of March and mid-April 2010 the young adult brown variant was driven away by its mother and became independent, foraging freely on its own or with members of the family group. Unfortunately it seemed to have suffered an injury to its right wing at this time (see Figure 5) and had a "lazy" wing, however this did not seem to affect its flying abilities, and it flew as strongly as the other members of the group. With the mother no longer protecting this young adult, there was some aggressive behaviour towards it, particularly from the adult males, and this bird was increasingly foraging on its own, or on the outside of the group at this time. It seems likely that the wing damage was caused by another magpie.

The brown variant formed a liaison with another young magpie for a short period, but this ceased. On the 27th of April 2010, the day before completion of this article, I observed the brown variant foraging in the close company of three females and an adult male, with no aggression toward the variant being displayed. On the morning of the 28th, I again observed the

brown variant foraging peacefully with an adult male and three females, in a different area of the park. Perhaps this was the beginning of a new sub-group. It is surmised that previous minor aggression towards the brown variant may have been part of the normal magpie group process of dominance confirmation and pecking order establishment, as opposed to a rejection of a visually unusual individual, and that the aggression will continue to settle down more over time. I am not aware of any other information being available on social interactions between other magpie colour variants and their family groups, and I will continue to observe developments with great interest.

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AUSTRALIAN BROADCASTING CORPORATION WEBSITE: www.abc.net.au

Update 1: September 2010 – the sub-group of 5 individuals including the brown variant had left the park and presumably moved to establish their own territory elsewhere

Update 2: November 2011 – the original brown variant has not been sited again, however on several occasions I have observed a new brown variant in a nearby park, one block from the original park. This bird is three-quarters grown, and is developing adult plumage. It wasfirst observed on the ground being fed by an adult male. The family group comprises one adult male and a small number of females, all normally coloured.

Update 3: January 2012 – the new brown variant has not been sighted since December 2011.

Aberrant Plumage in Western Australian Seabirds – Aberrant plumage in seabirds on islands off the Western Australian coast is rarely reported. Over many years of visiting seabird breeding islands I have recorded three instances, (1) an albino Brown Booby *Sula leucogaster*; (2) a Brown Booby showing leucistic or schizochroism plumage; and (3) a leucistic Lesser Noddy *Anous tenuirostris*. I provide photographs and details of them.

1. On a long range excursion along the Kimberley coast in August and September 2006 with the Western Australian Naturalist' Club, a visit was made to the Lacepede Islands – a group of four important seabird and turtle breeding islands lying about 30 km off the mainland about 120 km north of Broome. While observing Brown Boobies on Middle Island on 4 September 2006 an adult albino Brown Booby was seen flying from the breeding area (see photo on cover). The plumage of the Brown Booby is normally a uniform dark brown apart from a white lower breast and belly. However the plumage of this bird was entirely white with pale skin around the throat and pink eyes. The bill and feet were a pale greyish colour with a pinkish tinge. Although late in the season and the breeding cycle almost completed, there were still a number of large fluffy chicks and juveniles scattered over the island. Clustered along the shoreline were many almost fledged juveniles.

2. On 30 July 2004 at Adele Island off the Kimberley coast about 100 km north of Cape Leveque, I photographed an oddly plumaged Brown Booby likely to be leucistic (Johnstone, R. pers. com.). The bird was a fully fledged juvenile capable of flying a short distance. The bill, legs and feet had a pinkish tinge and where the normal plumage of an adult Brown Booby is dark brown, in this instance there was a barely perceptible faint light-fawn wash. In photographs several of the primary wing feathers appear with a light chestnut tinge, but this may have been due to the light. The eye ring was pink and the iris of the eye was blue instead of being yellow or olive.

3. On 3 December 1989 during filming for the documentary "Wilderness Regained" on the Abrolhos Islands about 60 km off the mid west coast of Western Australia, an albino Lesser Noddy *Anous tenuirostris* chick was found on Wooded Island by fellow naturalist Bob Goodale. The bird's entire plumage was white with faint traces of a darker colour on the breast and tips of wings and tail. The flight and tail feathers were not fully developed. In contrast to the black bill and dark legs usually associated with the Lesser Noddy, these were of an orange yellow colour as was the

Western Australian Naturalists on the Lacepede Islands and an Albino Brown Booby – September 2006. Photo Jim Everett.

Aberrant plumage in a juvenile Brown Booby – Adele Island – July 2004. Photo Kevin Coate.

Albino Leucistic Lesser Noddy – Wooded Island – Abrolhos Islands – December 1989. Photo Kevin Coate.

A normal plumaged Brown Booby and chick – Lacepede Islands 1995. Photo Kevin Coate.

skin around the eye. The eyes had a pinkish tinge and the partial eye rings above and below the eye were white. The chick was perched with a normal plumaged adult, presumably a parent, beside a nest in dense mangroves *Avicennia marina* about 2 m from the ground.

Ron Johnstone curator of ornithology at the Western Australian Museum, describes the plumage of the Lesser Noddy as being leucistic as there is some very diluted normal colour showing. He is also inclined toward calling the plumage of the Brown Booby on Adele Island leucistic as well. However the term schizochroistic which covers a variety of plumage abnormalities arising from the loss of one or more pigments could also apply. The term leucistic is the most commonly used.

All three birds appeared to be healthy and in good condition.

KEVIN COATE, 11 Peak View, Canning Vale, W.A. 6155

A TRIBUTE TO ROGER NORMAN HILTON (1927–2012)

By NEALE L. BOUGHER

Western Australian Herbarium, Science Division, Department of Environment and Conservation, Locked Bag 104, Bentley Delivery Centre, WA 6983, Australia

Roger Hilton, formerly Senior Lecturer at the Botany Department University of Western Australia, passed away on 20 June 2012 at the age of 85 years. At a wonderful celebration of Roger's life held in Perth we were privileged, among other tributes, to hear a recorded message from his brother Geoffrey Hilton from Warwickshire in the UK. It was almost as if Roger himself was speaking, such was the very distinctive 'rather Roger' accent.

This tribute is predominantly in recognition of Roger's roles in Botany and Mycology in Australia. However, it is clear that he achieved much during the time before he came to Australia in 1964. After he completed his schooling at the Solihull School in Warwickshire, Roger undertook University studies at Cambridge between 1945 and 1948 at Clare College. Just a year ahead of him at the same college was one David Attenborough. After graduation Roger was employed by the Rubber Research Institute of Malaya as a plant pathologist taking up his appointment on 6 Sept. 1948 where he continued until 3 July 1964. There he focussed on fungal diseases of plantation rubber trees *Hevea brasiliensis*, and in 1959 a major publication from his work was published entitled 'Maladies of Hevea in Malaya'. Roger had been a plant pathologist with the Rubber Research Institute for just 18 months when he was temporarily seconded in 1950 to work in the Malayan Security Forces. His task was to lead a team, often escorted by military jungle squads, registering the occupants of illegal dwellings, with a view to their subsequent resettlement. As an insight into Roger's varied work in Malaya, here is a quote from a letter, from the head of the executive branch of the government in the state of Selangor, to him on his leaving:

> *'On behalf of the State of Selangor I wish to thank you for your great services as a Settlement Officer You have completed the first stage of the settlement of Semenyih where the squatters were reported to be hostile but you managed to smooth out all difficulties and bring in the people by skilful use of tact. You have also engaged in fairly dangerous work in the*

Dengkil area. We wish you could have remained with us longer and would welcome your services again if we could obtain it.'

In 1964, Roger left Malaya to join the staff of the Botany Department of the University of Western Australia (UWA). This coincided with an era of academic expansion when Medicine still followed the classical idea that doctors needed to know something about plants and especially those of medicinal value. Roger was the third new Lecturer appointment made between 1962 and 1964 by Professor Grieve, then Professor and Head of the Botany Dept., along with four part-time Graduate Assistants who helped in the laboratory classes.

Among the greatest legacies from Roger's roles in Botany and Mycology in Australia was the impact of his undergraduate teachings at the University of WA Botany Department from 1964 to 1987. This impact is emphasised by the vast number of former UWA students who fondly remember Roger as an enthusiastic teacher who performed some rather dramatic demonstrations in the old UWA lecture theatres. Roger taught a series of introductory lectures in Plant Anatomy to the 1st year students Botany 100. The lecture that really became a signature one was about anomalous forms of tree-like structures and the highlight was the banana plant of which the 'stem' is actually a series of overlapping leaf bases.

Roger Hilton often used skilled showmanship to engage the attention of students, such as when he demonstrated the anatomy of plants to 1st year UWA Botany students by suddenly pulling out a machete and decapitating a banana plant.

To illustrate, Roger would have a large banana plant erected in front of the lecture bench and at the appropriate moment he would suddenly pull out a machete hidden in the lectern and with a flourish slice through this 'stem' decapitating it to thunderous applause and enormous acclaim. It was a lesson in Botany the students never forgot.

Roger's mycology course to the 2nd year students in Botany 200

focussed on systematic mycology. The entire Fungi Kingdom was explored based on various editions of the classical textbook by Alexopolous and Mims — *Introductory Mycology*. The practical mycology course in Botany 200 had two main objectives: (1) teaching students to find their way about the unfamiliar (to them) Fungal Kingdom and (2) teaching students how to handle fungi, especially maintaining them in a living state. Roger believed that fungi are best studied living or at least fresh. The practicals involved activities ranging from basic pure culture techniques to collecting, identifying and describing a macrofungus species and submitting a detailed report on that fungus.

In Roger's 2nd year mycology course, he once again showed students how he could develop a storyline and get his message across with some skilled showmanship. Most memorable may have been when he gave a demonstration of the release of spores from fungi using a bamboo blowpipe and darts. The students were overjoyed to see those darts piercing into the wooden-panelled wall of the decrepit old Chemistry lecture theatre.

Roger's mycology course to the 3rd year students in Botany 300 included general mycology practicals consisting of three taxonomic/physiological studies, each of several weeks duration. This included activities such as conducting experiments on the response of fungi to growth factors such as temperature, light and mineral nutrition, and identifying moulds from various contaminated material by using guide books such as *Illustrated Genera of Imperfect Fungi* 1972 by Barnett and Hunter.

Roger strongly promoted the need for field experience as an integral part of any mycology course. His fungal forays were a part of the annual field camps when the Botany Department took all its 2nd and 3rd students to some location in the south west for an intensive week of field-based exercises. On some occasions students who were struggling with the complexities of field identification and Latin names would excitedly approach Roger with a specimen in-hand that the student believed to be a new undiscovered species. Roger would ever so gently explain to the student that *'actually this is probably not a new fungus but actually someone's discarded orange peel'*.

To this very day, such stories are recalled time and time again by former students, many of whom went on to professions outside Botany, such as medicine, but still vividly recall Roger's showmanship. One letter kept by Roger from one of these 1st year medical students, concludes as such: *'... although not continuing with botany I feel sure the interest you have stimulated will never be completely lost'*.

Roger taught a significant number of students from the Asian region, particularly Malaya, Singapore, Indonesia and Thailand who came to the University. Many of those who came to Botany hoped to get jobs with the Rubber Institute on their return. Roger's experience with the Rubber Institute, his familiarity and delight in South-east Asian people, their culture and cuisine was a hugely important point of connection for these students.

While undergraduate teaching was a core component of his role in the Botany Department, Roger also undertook a research role. He corresponded by letter (there was no email in Roger's work era) with numerous overseas and Australian colleagues. His correspondence perhaps reached its maximum during the 1970s. Roger had his letters neatly typed up by the Botany Department's secretary. In contrast, the replies he received were often hand-written and sometimes they were so illegible, especially from Dr Roy Watling, that Roger found it necessary to have some of the replies from his colleagues deciphered as best he could and then typed up by the secretary. Correspondence with overseas colleagues during this period included with: C. Bas and R.A. Maas Geesteranus from The Netherlands about WA specimens of *Amanita*; D.N. Pegler Kew about *Polyporus* and other fungi; R. Watling Edinburgh on boletes and other fungi; D.A. Reid Kew about some of the fungi found during Reid's trip to Australia in 1976; E. Horak Switzerland about various local fungi; S. Sunhede Sweden about *Geastrum*; and D.M. Dring Kew about *Ileodictyon*. Correspondence with Australian colleagues during the 1970s included: G.A. Kile Hobart, Tasmania about the identity and increasing prevalence of *Armillaria* at Kings Park in Perth; J.C. Shepherd Canberra about various fungi; P. Christensen about the truffle diet of woylies in south west WA; K.F. Kenneally and A.S. George WA Herbarium about fungi from the Kimberley; and a single 1975 memo Roger sent to J. Gentilli UWA Geography Dept. about '*the urgency to get records of the Mycology Herbarium at UWA on to punch cards so that one can draw up a list from any specified geographical area or plant association*'.

During the period 1965 to 1976, N.E.M. Walters Melbourne, Victoria identified many Western Australian specimens of wood-inhabiting fungi that Roger sent to him. Roger also exchanged many fungi specimens with J.E.C. Aberdeen Indooroopilly, Queensland, and in 1973 during and after they met at an ANZAAS conference they discussed collaborating on the production of a checklist of Australian macrofungi. That same year Roger's correspondence with P.H. Talbot Glen Osmond, South Australia centred on the same theme. e.g. Talbot wrote to Roger in March 1973:

'I think that a mycological Flora Australiensis would be quite impossible for a long time to come. – there are not enough people to tackle it and there is a formidable amount of groundwork to be done before it could even be contemplated. ... What we badly need is a properly documented list of Australian fungi saprophytes as well as parasites'.

Roger corresponded with many additional colleagues during the 1980s. Overseas colleagues included: Orson K. Miller Jr Virginia, USA about various fungi and Miller's visits to WA in 1981 and 1989; G. Thorn Ontario, Canada about *Hohenbuehelia* and its nematode-feeding anamorph; P.K. Buchanan Auckland, New Zealand about the identity of WA polypores; J.M. Trappe and M.A. Castellano Oregon, USA about Australian truffles; and P. Dhitaphichit Thailand about Thai ethnomycology (see Hilton & Dhitaphichit, 1993). Australian colleagues included: G.W. Beaton Eildon, Victoria about truffles and Ascomycetes; A.M. Young Blacktown, NSW then Blackbutt, Queensland about various WA fungi; G.M. Weste Melbourne, Victoria about truffles; J. Walker Rydalmere, New South Wales about smuts and leaf-spot fungi; M.J. Priest Rydalmere then Orange, NSW about *Pisolithus*; G.A. Crichton Croydon, Victoria about *Calostoma*; R.G. Shivas Perth, Western Australia about fungi of Christmas Island; C.A. Grgurinovic Adelaide, South Australia about various fungi; and T.W. May Melbourne, Victoria about *Laccaria* and *Dermocybe*.

Over the years Roger supervised some six Honours students and six MSc/PhD students. He expanded the UWA Mycology Herbarium that had been established some years earlier by his predecessor E.R.L. 'Ruth' Johnson. He ensured that the collection was correctly ordered and available to research students and visiting oversees mycologists. The herbarium was located in room 2.06 on the top floor of the Botany Department building at UWA. All vouchers of fungi were stored on open and glass-fronted shelves of wooden cupboards, and they were arranged in accordance with the classification of Ainsworth, Sparrow and Sussman eds. volumes IVA & B of *The Fungi* 1973. The dried fungi vouchers were kept in 95 long flat white boxes. Pickled specimens in jars were kept in 16 shoe boxes. After Roger's retirement the UWA Mycology Herbarium was transferred to the Western Australian Herbarium at Kensington in 1988, where it is now fully integrated with the PERTH collection. At the time of transfer, the UWA Mycology Herbarium held almost 3,000 vouchers. A total of 2,782 records designated with a UWA origin are currently held at the WA Herbarium.

Roger produced the most substantial census of Western

Australia's macrofungi to date, and this census continues to provide an invaluable basis for assessing the current knowledge base about Western Australia's macrofungi. His census included a total of 504 taxa and was published in two parts (Hilton 1982; 1988a). Significantly, the *Hilton census* was based entirely on citable herbarium specimens – mostly housed at the time at either UWA or at the WA Herbarium (PERTH).

Roger diligently spent considerable time and effort tracing and deciphering the fungi collections of 19th century pioneer botanical collectors in Western Australia. In particular, he studied the collections of James Drummond and Johann August Ludwig Preiss, and undertook visits to Kew and other European herbaria to chase up the location and details of their specimens. This work culminated in two journal papers about those historical collections (Hilton 1983; 1988b).

Roger also did a lot of his own collecting of fungi, and in 1977 was involved in discovering 'the ghoul fungus' *Hebeloma aminophilum* so-named because of its association with decaying animal bodies (Hilton, 1978; Miller & Hilton, 1987). He hosted field expeditions with a number of mycologists from overseas who made visits to WA, and he sent many fungi specimens to them for study. These visitors included: Orson K. Miller Jr from the USA, Derek Reid and Roy Watling from UK, Jasper Daams from the Netherlands, and Egon Horak from Switzerland. During his career Roger co-authored some new species of Australian macrofungi: *Cortinarius phalarus* Bougher & R.N. Hilton published in 1989; *Hebeloma aminophilum* R.N. Hilton & O.K. Mill., 1987; *Inocybe fibrillosibrunnea* O.K. Mill. & R.N. Hilton, 1987; *Lactarius eucalypti* O.K. Mill. & R.N. Hilton, 1987; *Rubinoboletus phaseolisporus* T.H. Li, R.N. Hilton, & Watling, 1999; and *Russula clelandii* O.K. Mill. & R.N. Hilton, 1987. In 1980, Roger co-authored the recombination from *Agaricus* of the distinctive species *Amanita xanthocephala* Berk. D.A. Reid & R.N. Hilton. The fungus *Amanita hiltonii* D.A. Reid was named in honour of Roger in 1978.

Roger shared his extensive knowledge of fungi by regularly assisting many people with the identification of specimens. For example, Kevn Griffiths states in the Preface of his 1985 book entitled 'A Field Guide to the Larger Fungi of the Darling Scarp & South West of Western Australia' that his own '*efforts were assisted by much encouragement and advice from Mr Roger Hilton ...*', and that he is '*greatly indebted to Roger Hilton for his guidance with this book ... and for his painstaking assistance with the identification of specimens*'.

A rather interesting sidelight on Roger's mycological activities was the so-called 'magic mushrooms' and his involvement with these mushrooms at Balingup in

south-western WA. Always good for some humour, Roger got himself involved in 1995 as an honorary performer with the production of a tongue-in-cheek film for SBS entitled 'Fungimentary: The Magic Mushrooms of Balingup' giving a very David Attenborough-like performance. Many people took Roger's performance as a send-up of David, but certainly this was not true. The performance was indeed vintage Roger showmanship, and the similarity to David Attenborough was simply a result of their shared origins and schooling. This documentary is available for viewing on *You Tube*.

Roger retired from the Botany Department and University at the end of 1987. In 1994 he joined the Volunteers group at the Western Australian Herbarium, but several years later he tended his 'resignation' in a letter dated 1 July 1998 to the then Head of the Western Australian Herbarium Neville Marchant a long-term advocate of Mycology writing that:

> *'Clearly the time has come when every effort should be made to make a professional appointment in the area of systematic mycology. My presence at the Herbarium is giving the illusion to the powers-that-be that fungi are in some way catered for ...'.*

Much later on, just several weeks before he passed away, Roger angrily expressed his disappointment that an ongoing salaried position for a mycologist at the Western Australian Herbarium was never created.

In retirement Roger completed a Bachelor of Arts degree and an Honours degree in South East Asian studies at Murdoch University. He joined the Friends of Kings Park in 1988 and continued that involvement until 2009 assisting in the training and mentoring of the 'Friends'. He was President of the Kings Park Guides for 2 years during this period. Roger presented many submissions to the Botanic Gardens and Parks Authority managing agency for Kings Park and Bold Park which influenced their management plans.

While they had been able, Roger and his wife Leila travelled internationally every couple of years during his retirement. In his later years the travels were curtailed as Roger became full-time carer and househusband. Perhaps fittingly, Malaya in 2009 was the last place he visited.

As one of his many former students, inspired by his enthusiastic teachings and mycological studies, I say farewell and thank you to Roger Norman Hilton, a man who always remained very modest of his achievements professionally and personally.

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CLUB NEWS

Programme

General Meetings and Branch Meetings are held at various venues in Nedlands, Kalamunda, Rockingham and North Beach.
The Retired and Leisured Group meets on alternate Wednesdays at 10a.m.
Excursions and field days are planned from time to time and will be advertised in the Club's monthly newsletter "The Naturalist News".

THE WESTERN AUSTRALIAN NATURALIST
(Journal of the W.A. Naturalists' Club)

Editor
MR JOHN DELL

The Western Australian Naturalist publishes original data on all branches of natural science pertaining to Western Australia. Originals and two copies of manuscripts should be submitted to the Editor for review by two referees. Authors are requested to follow current editorial style. If possible, manuscripts should be submitted in Word format. High quality illustrations suitable for some reductions in size are preferred.

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Members are reminded that they may make financial contributions to the club. This funding is very important from the Club's point of view, as it helps our publication activities, field station maintenance and other miscellaneous activities. Members are asked to remember the club and its needs when preparing their Wills and Testaments.
The WA Naturalists' Fund is entered in the register of Environmental Organisations. Donations of $2.00 and over are tax deductible under item 1 Section 30-15 and Subsection 30B of the Income Tax Assessment Act 1997.

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