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AND LAND MANAGEMENT
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MOLE CRICKETS

Terry Houston

IN biology, as in any branch of science, a line of investigation can often lead the researcher into other avenues of investigation, sometimes with unexpected results. This happened at the WA Museum in 2002, the year I began studying the secret lives of sandgropers (see *Western Wildlife* Vol. 7 No. 2, pages 1 and 3).

In order to obtain specimens of sandgropers for my research I launched a public appeal via the electronic and print media. This resulted in a flood of telephone calls, nearly all from the Perth metropolitan area with people claiming they could offer me "any number of sandgropers" from their gardens. While a few calls related to the genuine article, most of the so-called 'sandgropers' proved to be mole crickets. Mole crickets are only distant relatives of sandgropers but they resemble them in certain respects, particularly in having the fore legs highly modified for digging. Like sandgropers, they burrow by simply forcing soil to the sides, creating an open gallery. They don't excavate and throw out soil like most burrowing creatures.

According to many callers, these insects had appeared in their gardens only in the past year or two, infesting lawns, shade-houses and potted plants and often drowning themselves in swimming pools or entering houses. Once I began receiving specimens of these insects it was

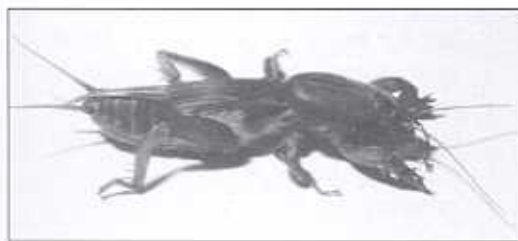


Fig. 1 *Gryllotalpa matt brown*. Female of the 'matt brown' invasive species from Perth (the folded hind wings can be seen extending over the end of the abdomen).



Fig. 2 *Gryllotalpa shiny black*. Male of the 'shiny black' invasive species from Perth (the short fore wings hide the vestigial, non-functional hind wings).

apparent that two species were dominant in suburban gardens. I referred to these as the 'matt brown striped wing' and 'shiny black striped wing' species based on the appearance of their fore body and short fore wings, respectively (Figs 1, 2). Oddly, neither species was represented in the Museum's extensive mole cricket reference collection. A check of the Agriculture Department's insect collection, too, revealed only a few recently collected specimens of these 'invasive' species from suburban localities. It looked suspiciously like these garden-infesting species were recent arrivals from somewhere else, and thus began my interest in the mole crickets of Western Australia.

Whereas sandgropers are descended from the diurnal grasshopper and locust clan, mole crickets are descendants of the mainly nocturnal true crickets (family Gryllidae). The two groups are thus classed in separate suborders of the order Orthoptera. Their similarities are superficial and have arisen independently as adaptations to a burrowing mode of life.

As in the true crickets, males of mole crickets (with some exceptions) are songsters, producing chirping or trilling songs by stridulation (i.e. they rub their shortened fore wings together so that a 'scraper' on one wing rubs over a series of teeth on the other). Males sing in the funnel-shaped entrances to their ground burrows and their

I am editing this edition of *Western Wildlife* while Penny Hussey enjoys a well-earned holiday.

Also taking a holiday is Sylvia Leighton, LFW Officer, Albany. Welcome to Pene Fewson who has joined us for a three-month period while Sylvia is on long service leave. Pene is based at the CALM office in Albany and can be contacted on phone (08) 9842 4500 or email penelopef@calm.wa.gov.au.

The effect of climate change on our flora and fauna has been the subject of several articles in this Newsletter in the past. The decline in rainfall in the south-west of WA over the last 30 years is affecting our native vegetation. In this issue Frank Batini's article on the changing water levels in deep bores in the Helena Catchment indicates that declining groundwater over the last 30 years has placed the native vegetation under chronic stress. Heather Gibbs writes on the effects of climate on breeding in Australian Birds. Just because a bird is common at this point in time does not mean it is immune to the effects of climate change. You can assist by surveying breeding birds

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EDITORIAL

Greetings all!

and returning the survey forms described in the article.

Readers of *Western Wildlife* are quite often prompted to go looking for the native flora and fauna described in these pages. Perhaps you would enjoy looking for the unusual. How about a strange parasite or an underground orchid? One thing we definitely don't want to see in our forests is feral pigs. See these articles and more in this edition.

The article on *Myrmecia* ants in WW Vol.8 No.3 motivated Ian Conochie of Denmark to follow and observe one of these ants for an hour (see page 5). Congratulations Ian for being so persistent! Many readers contacted Terry Houston in response to his article on Sandgropers (WW Vol.7 No.2). Sandgropers are often confused with their distant relatives the Mole Crickets, which lead Terry to undertake research on

these insects. See Terry's article on page 1 of this edition.

In the July 2004 edition of *Western Wildlife* we asked if any *Land for Wildlife* member would like LFW sign number 1080. Six people contacted the Editor to say they would like that number. A name was drawn out of a hat and the sign will be going to Leon and Pauline Guest of Westonia.

Keep sending your letters and photographs as we do enjoy receiving them. We love getting feedback from *Western Wildlife* articles too.

Claire Hall

✉ Emails ✉

With the increasing number of virus-carrying junk emails that are floating about in the ether, would everyone who wishes to contact LFW staff please make their message title very clear. Staff have been asked to trash, unopened, any email from an unknown sender, unless the subject indicates that it is legitimate. "Amazing info!!!" could be another Nigerian scam! Thank you for your consideration.

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Mole Crickets continued from page 1

songs are amplified as a result, being audible for tens or even hundreds of metres away. Generally, too, the mole crickets sing only at dusk and for one to two hours afterwards. Their songs are lower in pitch than those of most other crickets and many people mistakenly attribute them to frogs.

Mole crickets are not as well adapted for life in the soil as are the sandgropers. Their mid and hind legs are quite well developed and they can run about on the ground quite rapidly. Their antennae are whip-like (though shorter than true crickets) and a pair of long slender 'feelers' (cerci) extend rearwards from the end of the abdomen. While hind wings are often reduced or absent in males, they are usually well developed and functional in adult females (they fold like fans and lie along the mid-line of the abdomen, often hanging over the end). Females emerge at night and fly in search of mates, locating the males in their burrows by their songs. The hearing organs, as in other crickets and katydids, are located inside openings on the fore legs. Females are commonly attracted to lights at night.

Apart from having modified fore legs, mole crickets differ from their true cricket relatives also in lacking a needle-like ovipositor in the female. True crickets inject their eggs into the soil using the ovipositor but mole crickets, living underground, lay their eggs in special chambers and are reputed to brood over them.

Mole crickets can be safely handled but they do have a defence mechanism which can be unpleasant – they expel a foul-smelling, dark brown liquid from the anus when disturbed. Some species also expel a clear, colourless, viscid liquid which doubtless serves to entangle attacking ants and other small predators.

Judging by studies overseas, the diet of mole crickets can vary from species to species, some being strictly herbivorous, feeding only on roots or other parts of plants, while others are carnivorous or omnivorous. The diet of Australian

FAUNA



Fig. 3 *Gryllotalpa Wanneroo*. In this native species from the Perth area the fore wings are reduced to tiny discs and hind wings are completely absent.

mole crickets seems to have been little studied but my observations have shown some WA species to be predacious.

In the northern hemisphere, some mole crickets are serious pests of turf, pastures and crops causing damage costing millions of dollars. One in particular, the Changa Mole Cricket, a native of South America, was accidentally introduced into the USA and also appeared in eastern Australia (Rentz 1995). Fortunately, the invasive mole crickets from Perth gardens proved not to be this exotic pest species. Nevertheless, it appeared that because of their large size (body length up to 36 mm) and powerful fore legs, they were capable of causing some damage to lawns and plants simply by breaking their roots as they tunneled around. Generally, though, Australia's native mole crickets have not caused any serious problems in agriculture.

In an attempt to identify the 'invasive' species, I turned to the most recent revision of the Australian mole crickets: Otte & Alexander (1983) included the mole crickets in their revision of the Australian gryllid crickets. They recognized 10 described species of the genus *Gryllotalpa*, noting that perhaps as many as ten more species awaited description and naming. I tentatively matched Perth's invasive species to two eastern states species, *G. australis* and *G. pluvialis*. Given their readiness to make homes in the soil of well-watered potted plants, the insects might have been transported to Perth and other urban areas via the interstate plant trade.

In the early days of my sandgrouper study I attempted to

collect specimens for study using intercept traps to snare the insects as they burrow along just beneath the surface of the sand. This near-surface tunnelling produces raised trails on the surface of bare sand during the wet winter months and I had seen plenty of such trails in bushlands in and around Perth. My traps, however, yielded not sandgropers but mole crickets. Two different species were found, one in coastal dunes and adjacent bushland reserves and the other in *Banksia* woodlands on Bassendean sands. Both of these mole crickets were notable for the great reduction or virtual absence of wings in the adults (Fig. 3) and the absence of the hearing organs on the fore legs. Clearly these are songless species and the question arises as to how the sexes find one another to mate. These two native species were misidentified by Otte & Alexander and are clearly yet to be named and described. A couple of Museum specimens of a handsome species from the extreme South-West were also misidentified as an eastern states species and represent yet another undescribed species.

How many mole cricket species are out there in the wild waiting to be discovered is a moot point, but even for those we know about, distributional information is scant indeed. Not being particularly attractive insects, they are not popular with amateur collectors and tend to be scarce in collections. The reader could assist the WA Museum build a better picture of the taxonomy and distribution of our local mole crickets by forwarding any specimens excavated or captured. Particularly desirable are specimens from outside the Perth metropolitan area, whether from bushlands, farms or regional centres.

For further information telephone Dr Terry Houston, Senior Curator (Entomology), Dept. of Terrestrial Invertebrates, Western Australian Museum on 9427 2742 or e-mail terry.houston@museum.wa.gov.au. A further reading list is available from the Editor.

READERS will most likely be aware of the proposal made last year that the generic name of *Acacia* be conserved with a new Type species chosen from the 'Australian group' of the genus (Orchard & Maslin 2003). (Refer to the article in Western Wildlife, Vol. 7 No.3, page 19–Ed.) Discussions and references concerning this proposal may be found at the following web address: <http://www.worldwidewattle.com/infogallery/taxonomy/>.

The proposal has now been considered by an international panel of nomenclatural experts, the Committee for Spermatophyta, which is a specialist committee of the International Association for Plant Taxonomy (IAPT). The Secretary of that committee, Dr R. Brummitt, recently informed us that the committee has voted to accept the Orchard & Maslin proposal. An official report detailing the reasons for the committee's decision will be published in the journal *Taxon* (probably in the August 2004 issue). In the meantime we have been given permission to make the report available so it has been posted on the WorldWideWattle website at the above address.

FLORA

Acacia pycnantha

MOST AUSTRALIAN WATTLES LIKELY TO REMAIN ACACIA

Bruce Maslin
and Tony Orchard

It should be noted that the Spermatophyta Committee's decision does not become binding until it has been endorsed by the General Committee of IAPT and then ratified at the International Botanical Congress in Vienna in July 2005.

The Orchard & Maslin action was triggered by the stated intentions of some workers to subdivide *Acacia* into a varying number (about five) segregate genera. If the resultant genera were named in accordance with the original Type species of *Acacia* (*A. nilotica*, syn. *A. scorpioides*) it would mean that most of the Australian Wattles (some 948 species from a total of 957 species currently recognized for this continent) would most likely become known as

Racosperma. Of the 390 or so species that occur outside Australia roughly half would remain *Acacia*, namely, about 60 from a total of 185 in the Americas, 73 from a total of 144 in Africa and 36 from a total of 89 in Asia. In these three regions most of the remaining species would become *Senegalia* except that in tropical Asia there would be ten species of *Racosperma* and in the Americas 28 species would be distributed between two small endemic genera.

The strategy proposed by Orchard & Maslin to move the Type species to the phyllodinous species *A. penninervis* Sieber ex DC.

Table 1: Species numbers for the five genera that will probably be recognized following subdivision of *Acacia sens. lat.* (these numbers follow those given in Maslin, Orchard & West 2003). Generic names (column 1) are those that apply following acceptance of the Orchard & Maslin proposal.

Genus	Numbers of species				
	Americas	Africa ¹	Asia	Australia & Pacific	Total
<i>Vachellia</i>	c.60	73	36 (incl. c. 15 also found in Africa)	7	161
<i>Senegalia</i>	97	69	43 (incl. 7 also found in Africa)	2 (incl. 1 also found in Asia)	203
<i>Acaciella</i>	15	-	-	-	15
New genus	13	-	-	-	13
<i>Acacia</i>	-	2 ²	10 (incl. 7 also found in Australia)	955 ³	960
Total number of species	185	144	89 (incl. c. 29 occurring also outside the region)	964 (incl. 1 also found in Asia)	1353

¹ Includes Madagascar, Reunion and Mauritius.

² 2 species in Madagascar, Reunion and Mauritius. (Note: Du Puy & Villiers 2002 consider that only one species of this group occurs in this region.)

³ 948 species in Australia; 7 species in the Pacific.

continued on page 5

FLORA

continued from page 4

would mean that if (when) *Acacia* is dismembered, the name *Acacia* will remain with the by far largest group of about 960 species comprising the 948 Australian species mentioned above plus 10 in tropical Asia, seven in the Pacific and one or two in the Madagascar region. The 73 African, 60 American and 36 Asian species mentioned above, plus seven Australian species would become known as *Vachellia*. The African, Asian, American and Australian species destined for *Senegalia* (and the two minor segregate genera from the Americas) would be excluded from *Acacia* irrespective of the Orchard and Maslin proposal. This new generic arrangement is shown in the table opposite.

What does this mean for Australian *Acacia* nomenclature? Until a formal proposal to dismantle *Acacia sens. lat.* is published, nothing will change, anywhere. If and when someone formally publishes a proposal that, *inter alia*, separates *Acacia* subgen. *Phyllodineae* from the rest of the genus, then this decision means that the name *Acacia* follows its new Type species into the old *Phyllodineae*. For Australian taxonomy, this means that, apart from nine species which will become *Vachellia* and two which will become *Senegalia*, the rest (975 species) remain as *Acacia*.

Bruce Maslin is a Senior Principal Research Scientist with CALM's Science Division, Kensington. He can be contacted by email: brucem@calm.wa.gov.au.

Tony Orchard can be contacted at the Department of Environment & Heritage, GPO Box 787, Canberra, ACT 2601.

Related web link

<http://www.anbg.gov.au/cpbr/taxonomy/acacia-conserved-2004.html>

A reference list is available from the Editor.

BUSH TELEGRAPH



Feather on left - upper side.
Feather on right - underside.

These two beautiful feathers were found beside a fence post in a paddock in Helena Valley. They are mainly dark brown with chocolate and cream mottles. The question is - who dropped them?

Answer from Peter Mawson:

"Clearly this is a predator, as these primary wing feathers are shaped for silent flight. They are too big for a goshawk or a kestrel, and too small for eagles and kites. A Boobook Owl is possible, but they have more white on the outside of the feathers, and usually the tips are frayed for really silent flying. They are probably from a Tawny Frogmouth."

IN BRIEF

Acacias - protection against dieback?

COULD this be the start of finding a biological control for dieback disease in plants? Research was carried out on the ability of five Western Australian *Acacia* species to protect the highly susceptible *Banksia grandis* from infection by the pathogen *Phytophthora cinnamomi* in a rehabilitated bauxite pit at Jarrahdale. Only *Acacia pulchella* (prickly moses) gave significant protection to *Banksia grandis* for up to one year after inoculation. In the glasshouse trial, *A. pulchella*, *A. extensa*, *A. lateriticola* and *A. drummondii* did not protect *B. grandis* from *P. cinnamomi*, but they significantly reduced *P. cinnamomi* in the soil, indicating a possible biological control effect on the pathogen.

For the full story, read: D'Souza, N.K., Colquhoun, I.J., Shearer, B.L. and Hardy, G.E.St.J. The potential of five Western Australian native *Acacia* species for biological

control of *Phytophthora cinnamomi*, *Australian Journal of Botany* 52(2) 267 - 279.

20% decline in Antarctic sea ice extent since the 1950s

If the global temperature were increasing, then you would expect there to be less ice everywhere, including in Antarctica. However it is a difficult thing to measure in a continent so remote and stormy, and with so many natural climate variations to obscure any long-term trends. However, recent evidence from ice cores suggests that the sea ice south of Australia has retreated by about 1.5° of latitude (approximately 170 km) over the last 50 years, which represents a decrease of 20%.

For the full story, read: Curran, M.A.J., van Ommen T.D., Morgan, V.I., Phillips, K.L., Palmer, A.S. 2003. Ice Core Evidence for Antarctic Sea Ice Decline Since the 1950s, *Science* 302: pp. 1203-1206.

FERAL pigs have been seen as an important pest in eastern Australia for decades, but the problems they cause in Western Australia have remained relatively unknown until recent years. A big reason for the increase in public profile has been the recent 'explosion' in feral pig numbers and distribution in WA. Feral pigs are very destructive pests, and cause considerable damage for both conservation and farming, and a relatively small mob of pigs can wreak havoc in the bush or on the farm. Pigs will eat almost anything, but their habit of 'ploughing' through soil with their snouts in the search for food causes the most problems. Environmentally, pigs have been implicated in the spread of dieback, destruction of stands of rare flora, and the decline of rare fauna species such as the quokka. Their impacts on agriculture are equally severe, with damage to crops, dams and fences occurring, as well as transmission of important livestock diseases such as leptospirosis.

Feral pig populations were initially established as a result of escape or release from farms, and are now found right across the south-west, from the Darling Range around Mundaring through to the coastal swamps of the Denmark area. Large feral pig populations also exist in the state's mid-west and Kimberley regions, but pigs have a strict requirement for daily water, and consequently have not established in the state's interior. While pigs are now widespread across the south coast, these populations have only really established in the last decade. Deliberate transportation from established feral pig populations to uninfested areas by recreational hunters has been blamed for much of this recent expansion.

Feral pigs can be controlled via a number of methods, including poison baiting and shooting, but in the forests of WA's south west, trapping has long been considered the only practical method for control. While fairly intensive trapping programs have been in place in certain areas of the south-west for many years, feral pigs

FERAL ALERT

FERAL PIGS IN THE SOUTH WEST

Jordan Hampton

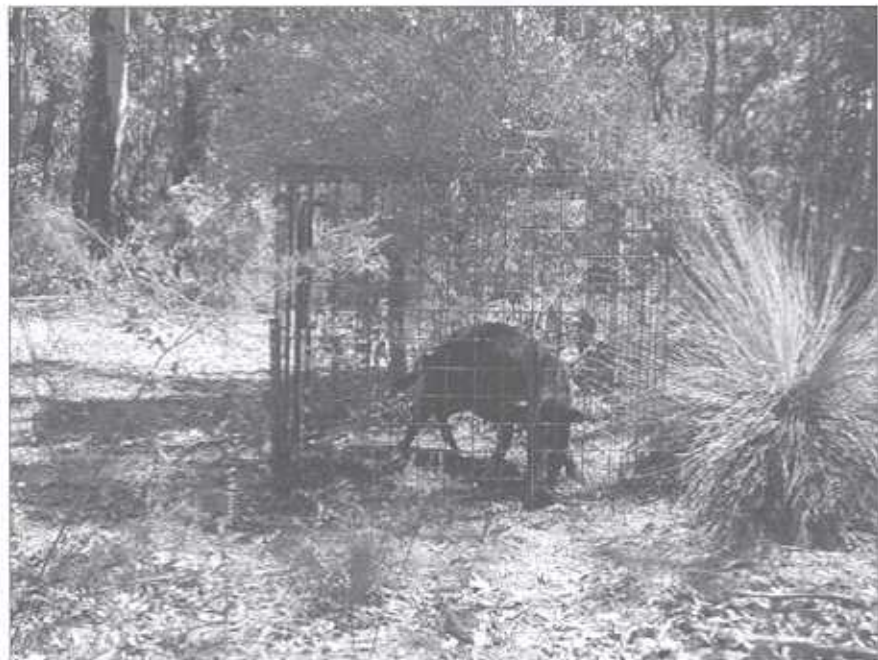
are notoriously difficult pests to control, and eradication, once a population has established, is thought to be close to impossible. Groups such as CALM and Water Corporation aim their control efforts at protecting small sensitive areas, such as endangered fauna habitat, or drinking water reservoirs. Despite removing many pigs through this approach, re-invasion of these sites has always been rapid, necessitating expensive ongoing control programs.

To help address this problem of re-invasion, I undertook a project in 2003, using the modern approach of population genetics to determine where these re-invading animals were coming from, and thus letting management agencies know how large an area they must control in order to protect their sensitive sites. Examining the genetics of a species at a population level also allows us to see whether populations are in decline, and how far individual animals are moving. A similar genetic approach has also

been of great value in controlling the troublesome Australian brush-tailed possum in New Zealand.

This genetic study revealed that feral pigs in the south-west do not form a continuous belt, but rather a series of small, discrete populations, centred on major waterways, with very little movement of pigs between these populations. This is great news for feral pig control, as it will be possible to heavily control one small population at a time without pigs re-invading from neighbouring populations. The trick in long term control and eradication is to be able to divide a group of animals up into units such that migration can not occur between units. This enables a classic 'divide and conquer' approach. Genetics really just defines the natural existing boundaries to migration that would otherwise be difficult to 'see'.

In contrast to the south-west picture, areas 10 times larger would have to be controlled in the eastern states before rapid re-invasion could be avoided. This comparison shows that WA may have the best chance of permanently getting rid of our pigs, given that feral pigs in areas such as the Serpentine River and Denbarker are found in such small discrete pockets. Added to this is the fact that genetic results indicate that several south-west populations have



Feral pig in cage trap.

Feral Pigs continued from page 6

suffered recent crashes in population size, due to intensive control programs. It seems a combination of rugged terrain for pigs to cross and well organised local control efforts has enabled us to get on top of the feral pig problem in the south-west. If feral pig eradication, even at a local scale, is at all possible, south-west WA may be the ideal place to attempt it.

Jordan Hampton completed an honours thesis in 2003 based on his feral pig research. He is currently completing a degree in veterinary science at Murdoch University. He can be contacted by email: j.hampton@student.murdoch.edu.au

Did you know?

about feral pigs...?



- In poor years there are an estimated 3.5 million feral pigs in Australia. In good years, the numbers can reach 23.5 million.
- They occur in nearly 40% of the mainland.
- They are a possible reservoir for a range of diseases (such as foot and mouth) with the potential to decimate Australian livestock industries.
- They cost Australian agriculture over \$100 million annually, through competition with and predation on stock, damage to crops, destruction of pastures and infrastructure damage.
- They also cause environmental damage by degrading habitat and facilitating the spread of soil pathogens, diseases and weeds.
- They also compete with and predate on native fauna, and destroy native flora.

FERAL ALERT

ASIAN HOUSE GECKOS ON THE MOVE



AUSTRALIA'S most successful invasive reptile species, the Asian House Gecko, *Hemidactylus frenatus*, is on the move. Originally from Indo-Malaysia, Indonesia and the Pacific islands, it is thought to have arrived in Darwin in the mid 1960s. They had reached Brisbane by 1983 and are now found as far south as northern coastal NSW. Sources are contradictory about whether they are in the Kimberley – current consensus is 'No'.

It is a moderate-sized gecko, about 10cm long, the back coloured grey or dark brown with black flecks and the underside whitish. It emerges at night to feed on the

insects attracted to lights - both outside and indoors. It has quite a loud call, roughly "chuck-chuck-chuck".

Until recently it was thought that in Australia these geckos only lived in association with humans and their buildings, however Dr Jessica Worthington Wilmer of the Queensland Museum believes they may be moving into bushland and thus affecting local native species.

It would be worthwhile for all northern readers to attempt to identify the geckos around your buildings. You might be surprised to find how many local species there are.

WEED ALERT

HAS KOCHIA BEEN ERADICATED?

People involved in landcare for some years will remember the horrifying case of Kochia, *Bassia scoparia*, brought in to WA from America to rehabilitate salt land in 1990 and sown at 68 sites across the State. When it was pointed out that the plant is a major weed of cropland elsewhere in the world (the importer had not thought to check) an eradication campaign began in 1992, by which time it had naturalised at 52 sites. Determination, vigilance – and \$500,000 – appear to have been successful as no Kochia plants have been found since 2000. If no more plants are discovered, the eradication programme will be judged as successful in 2005.

FOLLOWING UP ON MYRMECIA ANTS

Ian Conochie of Denmark read the article about *Myrmecia* ants in WW8/3 and was motivated to follow a solitary bull ant for nearly an hour as it wandered and paused occasionally as if in a trance. He asks "Why are the *Myrmecia* loners and don't establish ant roads".

Answer: Our 'resident expert' advises that individual foraging is a primitive style of ant behaviour. In other words, not only are they primitive anatomically, they are primitive socially as well. It is thought that the original ant ancestors were loners, gradually coming together in communal nests, then developing a tighter and tighter social structure as it proved to have an evolutionary advantage. When the ants pause during their foraging, they are probably sensing their environment for food or threats.
– Ed.

FLORA

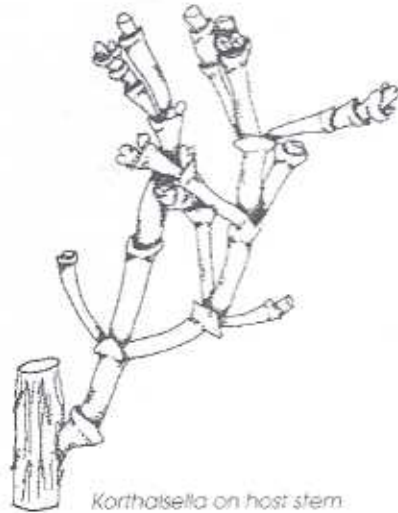
AN unusual looking perennial native parasite that grows on the branches of *Melaleuca lanceolata* has been known for many years but was finally named in 2002. The best way to describe this species is that it looks like a samphire (common salt lake plants) that has been randomly tossed among the *Melaleuca* foliage. The *Melaleuca* trees occur as a fringe around the edge of a small semi-saline lake south west of Eneabba. At present this lake is the only known location of this parasite and although *Melaleuca lanceolata* is fairly common in the area the parasite appears to be restricted to a few trees within the population.

The parasitic plant is relatively small and may vary from 7-10 cm in length with very jointed branches. The flowers are greenish in colour and are 1-1.5 mm long and clustered on the active growing branch nodes, surrounded by an opposing pair of triangular rudimentary leaves. In most instances it is the yellow of the pollen bursting from the male flowers that attracts the eye and has led to the collection of this species. The small green flowers were first noted on specimens collected by me in December 1992. Previous to this collection the parasite was considered to be a sterile relic of an unknown genus as no flowering material had been seen or collected. Although no material had been collected at this stage the plant was thought to be a member of the Loranthaceae or mistletoe family.

The Loranthaceae is a family that is well represented in WA and are easily recognised by the presence of large coloured flowers and sticky soft fruits. In 1960 this family was further divided to create the family Viscaceae based upon differences in floral, embryo and fruit structures. The discovery of flowering specimens led the author to realise that this Eneabba material belonged to the family Viscaceae, could be placed in the genus *Korthalsella*, and was a possible new species.

STRANGE PARASITE

Ray Cranfield



Korthalsella on host stem

Korthalsella is a genus of around 30 species that are parasitic mainly on rainforest to open forest plants occurring in several Pacific Rim countries. In Australia there are 7 species of which 4 are endemic with most species occurring on the east coast. The two currently recognised species that occur in WA are both located in dry sclerophyll scrub and are widely separated from each other. In WA little is known about the pollination of these species or how the seed is dispersed. Based upon other known species of *Korthalsella* we can assume that the fruit is usually under 2 mm long and could be either pear or ellipsoidal in shape. The seed is known to be a disc about 1 mm in diameter.

This new species of *Korthalsella* was formally described and published as *Korthalsella arthroclada**. The specific name refers to the jointed (*arthro*) appearance of the branches (*clados*). There are another two species of *Korthalsella* that have previously been recorded for Western Australia. *Korthalsella leucothrix* has been found growing on the branches of several *Acacia* species within the arid regions south

east of Wiluna to the Warburton area and also located in arid areas of South Australia. The other species recorded for WA was *Korthalsella japonica* subsp. *japonica*, which has been reported growing at Mongers Lake on *Acacia acuminata*.

Korthalsella arthroclada has been placed on the Department of Conservation and Land Management's Priority Flora list. There is a need to find out how many individual plants occur at this site along with the number of host plants infected. Any further records or sighting of this unusual parasite would be appreciated. This species of *Korthalsella* is rare and excessive sampling is to be avoided, photographs would be desirable since our aim is to conserve this state's floral biodiversity. The more we learn about this species the greater the prospect of maintaining the population viability through informed management practices.

Can you help? A good, clear photograph with accompanying details should be sent to Ray at the WA Herbarium, or emailed to rayc@calm.wa.gov.au (Please note, as it is rare, the exact location of the existing population will not be provided.)

* Cranfield, R.J. 2002. *Korthalsella arthroclada* (Viscaceae), a new species from south-west Western Australia. *Nuytsia* 14: 361-364.

Did you know?

That finches can drink with their heads down? They suck up water and therefore, unlike most other birds, do not have to tip up their heads to swallow.

HYDROLOGY

COMPARISON OF CHANGES TO WATER LEVELS IN DEEP BORES - 1975 TO 2004 - HELENA CATCHMENT, WESTERN AUSTRALIA

Frank Batini

DURING the mid 1970's, the Forests Department, being concerned at the possible effects of logging on salinity, commenced some paired catchment studies in the Helena catchment to investigate this matter. Initially, two catchments nominally in the 700 mm rainfall zone were selected for treatment. These catchments were predominantly comprised of jarrah-marri with some patches of wandoo on the lower flats and the upper slopes. Rainfall, runoff, salt discharge, salt storages in the soil profile, groundwater depths and salinities and shallow water-table depths and salinities were recorded. Nine deep bores were established in each catchment, to measure the salinity and depth to the confined groundwater. In addition, about 20 shallow bores were also established to monitor the responses in the perched groundwater table. After a period of three winters (1974-76) for calibration, one catchment was logged in summer 1976-77 and crown density was reduced by about 50 percent. Monitoring then continued for a further eight years.

Runoff data showed that the yield of water was about one percent of the average rainfall of 700mm per annum. Flow-weighted stream chloride concentrations remained very fresh and ranged from 17 to 40 ppm. Data from deep bores between 1975 and 1979 showed that the minimum water levels recorded were already falling in both catchments, by about 0.5 metres/year.

Prior to winter 1976, a further nine deep bores were drilled close to the eastern margin of the catchment, in the 500-600 mm rainfall zone within predominantly wandoo forest in the Talbot block and monitored for four years.

These records now span a period of over 25 years and are of considerable value. In October 2001 I re-measured two of the deep bores in the Wellbucket catchment that formerly had held water and found them dry. In early June 2004, at the request of CALM, all of the useable bores were relocated and measured with Ms Liz Manning and Mr Bruce McGregor of the York LCDC.

Differences between mid to late 1970's recorded bore levels and recent re-measurements some 25 to 30 years later were 9, 6 and 4.6 metres. The water level fell in all bores. Some of the bores were now blocked at depth and in one case a dense mat of tree roots was recovered from within the bore casing. In other cases many bores that had held water in the late 1970's were now dry.

Do any of our readers have similar long-term records of falling water tables? If so, could you let LFW or the Wandoo Recovery Group have access to them?

The following observations are made:

- ▶ The observed reductions in groundwater level over the past 25 years are consistent with records of reductions in rainfall and catchment yield over the same period.
- ▶ Groundwater tables are replenished by rainfall and from shallow groundwater tables, usually through root channels and lines of weakness in the soil. The large decline in groundwater at depth indicates that adequate recharge has not occurred for at least two decades.
- ▶ The large fall in groundwater levels observed in all bores suggests to me that the soil water storage has also been depleted since at least 1975.

▶ While some wandoo trees may access and use some of the groundwater, these stands are not generally reliant on access to a deep groundwater table. In a number of bores drilled in the mid 1970's, healthy wandoo were growing on sites that were found to be dry at depth.

▶ Wandoo is also not reliant on the ephemeral, fresh, shallow groundwater system. In a number of cases, especially on upper slopes, shallow bores were always dry.

Trees are very long-lived and have therefore developed multiple strategies to cope with both climatic change and attack by insects and fungi. Drought strategies include control over transpiration and stomata, thick cuticles and bark, leaf alignment, leaf fall, branch dieback and the replacement of its primary crown by epicormic growth. Attack and infection may be countered by increased leaf or root production and/or mobilisation of defence mechanisms such as gum veins, periderm formation and occlusions. The process is a dynamic one, tree crowns may partially recover, and then be affected once again.

Drought strategies all use less water and therefore mean that a lesser amount of photosynthetic material is produced. Active response to infection or insect attack requires mobilisation of defence mechanisms that need additional photosynthetic products. Where the negative impacts on the trees are sustained over long periods (some years or decades) by a chronic climatic change or attack, the availability of food resources declines, so defence mechanisms are severely stretched and may then fail.

FAUNA

THE EFFECTS OF CLIMATE ON BREEDING IN AUSTRALIAN BIRDS

Heather Gibbs

CLIMATE change is already happening, but how will it affect Australia's unique wildlife?

Effects on coral reefs, alpine regions, changes in vegetation composition, plankton and grassland productivity and others have already been documented¹.

However, effects on birds and other common, easily identified terrestrial species are still little known, largely because of a lack of suitable data – or because the data has not yet been 'discovered' (perhaps it is hiding in some old notebooks...).

As part of my PhD study, I have looked at a lot of bird surveys collected by volunteers in various bird groups (including Atlas and Nest Record Scheme data). Results to date suggest that the effects of climate change will be immediate and substantial.

One of the most useful data sets has turned out to be the *Garden Bird Survey* used by the Canberra Ornithologists Group. I believe it is a very practical and worthwhile way to collect bird breeding data, and I'm hoping that other groups and individuals will be inspired to try it out for themselves.

The survey form looks like this:

Week →	26	27	28	29	30	31	32	33	34	...	21	22	23	24	25	
Species ↓	July					August					...	June				
Magpie																
Willie Wagtail																
Welcome Swallow																
More species ...																

For each week, you record which species are present as well as the stage of breeding. It is very simple, yet effective².

Survey forms and instructions are now available from my web site - <http://www.protoavis.com.au/cbbs.htm>.

It is also possible to submit "instant nest records" via my web site – because I would like to get as much data as possible on the breeding dates of common species (such as magpies), wherever and whenever they are breeding!

If you would like further information Heather Gibbs can be contacted on hgi@deakin.edu.au.

¹ See 'Climate change impacts on biodiversity in Australia' available at <http://www.deh.gov.au/biodiversity/science/hdac/greenhouse/index.html>.

² The data and survey method are documented in Veerman, P.A. (2003) *Canberra Birds: A Report on the first 21 years of the Garden Bird Survey*, Veerman, Canberra.

Comparison of changes to water levels in deep bores - continued from page 9

Such a chronic situation may lead to what is referred to as predisposition of a tree to fungal or insect attack. External influences that may have been dealt with by the tree in a normal situation now lead to severe debility and tree death. A chronic situation such as an extended drought period will not be relieved by one or two wet years. If the soil water storage has been severely depleted over some decades, it can only recover over a longer time period.

The data indicates that groundwater levels have been in decline since at least 1975. The soil water storage

has also been depleted during the past 30 years. These conditions suggest to me that the trees in the eastern Helena catchment have been under a chronic drought stress over this extended period.

Frank Batini was a forest researcher and environmental manager within CALM; now 'retired', he is a consultant in the management of natural resources. He can be contacted on ph: 9457 1952 or email: batini@nw.com.au

REVEGETATION

RECONNECTIONS A NEW LANDSCAPE-SCALE REVEGETATION PROJECT ON THE SOUTH COAST

Barry Heydenrych

SHELL and Greening Australia are partners in a project that addresses some of Australia's key environmental issues whilst researching a "multiple outcome" approach to CO₂ capture. The challenge for this new partnership is to undertake large-scale revegetation that is environmentally sustainable, socially positive and economically feasible, while also adding value to existing regional conservation activities. By combining their skills, knowledge and experience, Shell and Greening Australia have devised a three year project with multiple outcomes which include:

- ▶ Reconstructing native vegetation in strategic areas on a large scale to recreate habitats for declining wildlife, provide protection against wind and water erosion and reduce the impact of salinity;
- ▶ Working with landholders, including indigenous groups, to develop and trial new forms of biodiversity-focussed agriculture that improve the environment whilst developing crops with commercial returns e.g. native sandalwood, indigenous edible crops;
- ▶ Using biodiverse, dry-country revegetation to sequester (store) carbon dioxide, a major greenhouse gas, in ways that also deliver tangible ecological and biodiversity benefits;
- ▶ Developing new models for carbon accounting valid for biodiverse revegetation;
- ▶ Working with groups such as the Fitzgerald Biosphere Group, a community-based organisation whose objectives include developing sustainable agriculture in their region, to further develop skills and



Experimental "industrial strength" direct seeding at Corackerup, funded through the Reconnections project

knowledge amongst local communities.

Information and skills sharing between local communities and experts in the fields of revegetation and carbon accounting will underpin the work of the project. In addition, skills development will be facilitated through hands on involvement of Green Corps teams with local communities over the lifetime of the project.

Importantly, this project contributes to and supports Greening Australia's work as a major partner in the ambitious landscape-scale project known as Gondwana Link (see article on page 17 of this issue). Reconnections is focussed in the Corackerup and Bremer Valleys, which lie between the Stirling Range and Fitzgerald River National Parks. The region contains many locally endemic plant species, as well as a number of wildlife species under threat, such as the Western

Whipbird, Tammar Wallaby and possibly Chuditch, as well as abundant Malleefowl. While it has been fragmented by land clearing in the past, large areas of bushland remain - a valuable area to restore and protect.

The first major part of the Reconnections project, revegetation of damaged landscapes, began in the winter of 2004 with approximately 100 hectares of native vegetation being established, primarily by direct seeding. The plantings have a range of outcomes, focused both on pure biodiversity and mixed biodiversity plantings with potentially commercial native species, both of which have a range of benefits, including nature conservation and carbon storage. The information gathered from this initial work will help determine whether this 'multiple outcome' approach can be applied to a wider landscape, and by doing so, offer input into the

IN BRIEF

Salinisation of the Blackwood River – implications for the inland fish fauna

THE Blackwood River is one of the few river systems in southwestern Australia in which all of the fish species endemic to this region occur. However, a recent study of the Blackwood and its tributaries has identified that salinity has caused a massive decline in, or extinction of, populations of native fish in much of their original distribution. In addition, competition from the introduced species *Gambusia* and the predatory trout and Redfin Perch has contributed to the decline.

The naturally-vegetated, non-saline tributaries contain most of what remains of the original native fish biodiversity. The protection of these unique fish relies upon the preservation of their remaining habitat. The authors conclude: "The example of the salinisation of

Blackwood River highlights the need to act cautiously when removing large expanses of native vegetation, particularly in arid countries such as Australia".

For the full story, read: Morgan, D.L., Thorburn, D.C. and Gill, H.S. 2003. Salinisation of southwestern Western Australian rivers and implications for the inland fish fauna – the Blackwood River, a case study. *Pacific Conservation Biology* 9: 161-71.

Two useful leaflets:

"Introduced freshwater species in Western Australia".

"Native freshwater fishes of south-western Australia"

Obtainable free from Fisheries Western Australia, ph: 9482 7333, email: headoffice@fish.wa.gov.au

Australian Heritage Council established

LATE last year, the Federal Government passed new heritage legislation and, as part of that, has established a new independent advisory body, the Australian Heritage Council. This body will be responsible for assessing the "National Heritage List" and will also provide advice to the Federal Government on heritage matters.

To help, there is a new funding programme called "Distinctively Australian". People are encouraged to nominate places to this list around three themes: a wide and ancient land; building a nation; and the Australian spirit. For more information visit the website at www.ahc.gov.au

Can Echidnas disperse fungal spores?

MYCORRHIZAL fungi are essential for orchid seed germination, thus the distribution and dispersal strategies of the fungi must be understood for the regeneration of endangered orchid populations. Leah Feuerherdt investigated whether echidnas spread these fungi in the Mt Lofty Ranges, SA, and also whether the animals were significant soil disturbers. The answer was yes to the soil disturbance, but no direct evidence of their actually carrying spores in a field situation was recorded, though in the lab they held spores on their feet or fur for at least 45 minutes.

Since the importance of mycorrhizae in the health of our bushland is well known, and since echidna are the only medium-sized soil-disturbing animal left in many wheatbelt remnants, it is interesting to note that they may be inadvertently involved in spreading spores. Another plus for having an echidna on the place!

Ref: *The role of echidnas in dispersing mycorrhizal fungi associated with the endangered Caladenia behrii north of Adelaide and distribution of these fungi at Warren Conservation Park, South Australia.* Leah Feuerherdt, Honours thesis. School of Environmental and Recreation Management, Uni. S.A., Adelaide.

Reconnections - continued from page 11

further development of Australia's Greenhouse Gas and Natural Resource Management Strategies and to revegetation efforts across larger areas of Western Australia. Shell and Greening Australia are working with the Cooperative Research Centre for Greenhouse Accounting in developing the carbon accounting methodology.

Importantly, Shell funding of \$500,000 is being utilised as catalytic funding to lever an additional \$500,000 of "in kind" or financial

support from a variety of sources over the next three years. From an international perspective, Shell believes this project will provide valuable insights into how similar projects can be applied around Australia and in other countries.

Barry Heydenrych is Project Manager, Reconnections with Greening Australia (WA) and can be contacted on tel (08) 9841 6311, email barryh@gawa.org.au.

Disclaimer: Greening Australia is a partner in the Gondwana Link Project, a project which involves the successful drawing together of a diversity of partners with a diversity of approaches and views. Greening Australia acknowledges that, in some cases, our funding sources do not align with other partners funding policies. No financial relationship between the Reconnections project and other Gondwana link partners is implied.

FLORA

TOWARDS THE CONSERVATION OF THE WESTERN AUSTRALIAN UNDERGROUND ORCHID

Andrew Batty, Mark Brundrett, Jeremy Bougoure,
Kingsley Dixon

ONE of Western Australia's most interesting plants and possibly one of the rarest is the underground orchid (*Rhizanthella gardneri*, Fig 1). What makes this plant so interesting you ask. Is it the fact that this orchid germinates, grows and flowers underground or that it has an intimate life long relationship with a specific fungus? Well it doesn't stop there - the orchid only grows in association with the broom honey myrtle where the fungus attaches to the roots of the broom bush completing a three-way relationship.

Recent research at Kings Park & Botanic Garden and the University of Western Australia has successfully germinated seed (Fig 2) of the orchid in association with the plant partner that the orchid needs to ensure a supply of carbohydrate and other nutrients. These plants (Fig 3) have developed rapidly and it is anticipated that some will flower in 2005.

A research project, with outcomes to assist in the conservation of the underground orchid, commenced in 2004. PhD research student Jeremy Bougoure will investigate how *R. gardneri* obtains essential nutrients and sugars. This will be done using labeled isotopes in conjunction with a cutting edge electron microscopy technique. Understanding how this unique species acquires nutrients and especially sugars from its fungal partner will greatly enhance knowledge of this orchid's basic biology and provide valuable information for successful translocation attempts.

Our recent surveys with CALM (Esperance) and Friends of Kings Park have discovered more than fifty flowering plants in the southern populations indicating a bright future. However, the northern populations in the wheatbelt around Corrigin remain on the edge of extinction with only three flowering plants found this year (Fig 4). Given that over 100 plants were found during surveys in the 1980's, urgent work is required to prevent the extinction of these populations. This is especially important as preliminary genetic data suggests that the northern and southern populations may be taxonomically separate. Further research is required to confirm this.

As new information is unraveled we will keep you informed with further updates. Please contact the Orchid Research Group at Kings Park and Botanic Garden, ph (08) 94803648 for further information.

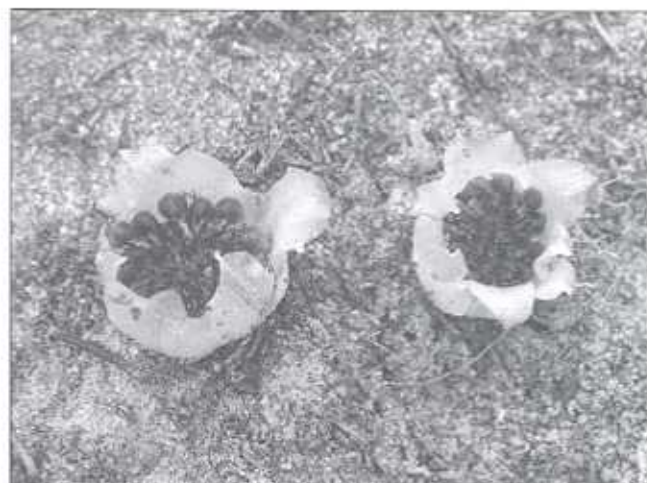


Figure 1: Two flowering underground orchids. Each inflorescence consists of 40-50 tiny maroon flowers surrounded by pinkish bracts. The leaf litter has been removed allowing the bracts to unfold exposing the flowers. Photo Mark Brundrett



Figure 3: The rhizome of *Rhizanthella gardneri* 10 months after germination. The plant is now over 4 cm long and is expected to flower in 2005. Photo Mark Brundrett

Figure 2: In order to germinate, seed of *Rhizanthella gardneri* is sown amongst the roots of *Melaleuca uncinata* colonized by the fungus that forms the essential link between orchid and shrub. Seed is inserted through windows cut in the side of the pot.



Fig 4: Jeremy Bougoure (PhD student, left), Ross Brockway (Kings Park volunteer) and Robin Campbell (Corrigin LCDC) are excited after finding one of only three flowering *Rhizanthella gardneri* plants at the base of a broombush. Photo Mark Brundrett

MEMBERS' PAGE

SACRED KINGFISHERS

YOU may have noticed the colourful Sacred Kingfishers recently as they return from their winter "break". Fred Gillings took this photo of a juvenile Sacred Kingfisher sitting on a tree hollow on his property at Bindoon. Fred says the kingfishers have visited but have not been tempted to nest in his trees.

The Sacred Kingfisher *Todiramphus sanctus* can be found in WA in the south-west, Pilbara, Kimberley, and offshore islands. They leave the colder regions between early February and mid-July to winter in the northern tropics and the lower west coast (including Rottnest Island), returning between late August and late October. They inhabit woodlands, and open forests, especially near water, mangroves, and seashores. They feed mainly on insects, but they will take marine animals, house mice and lizards. They will also take fish from the water surface, hence the name kingfisher. Sacred Kingfishers nest in tree hollows and sometimes burrow into termite nests in



Sacred kingfisher - Photo Fred Gillings

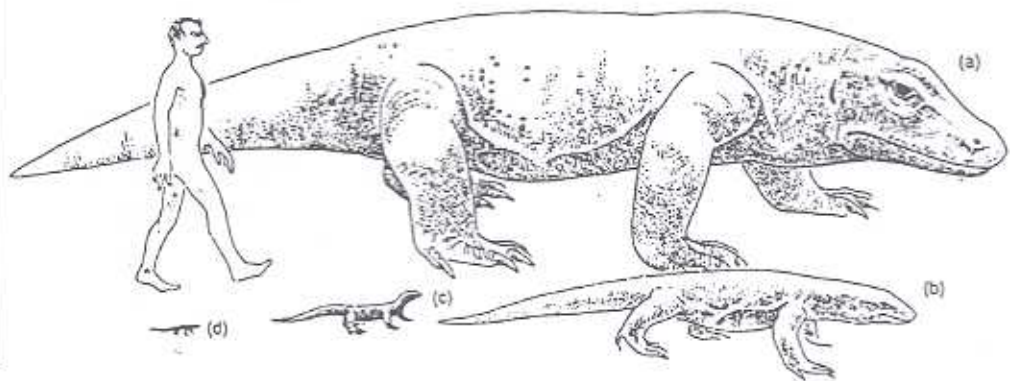
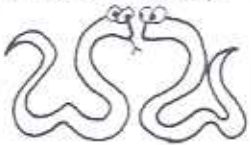
hollows or cliffs and sandbanks. A clutch of 2-6 eggs are laid from September to January in the north and October to December in the south.

Claire Hall

From a young Land for Wildlife -

Q: What do snakes do after they have a fight?

A: Hiss and make up.



Relative sizes of some varanids and a human. (a) *Megalania prisca*; (b) *Varanus komodoensis*; (c) *V. rosenbergi*; (d) *V. brevicauda*

TIGER SNAKE FOR TEA!

IN December 2003, Griselda Hitchcock of Barragup near Mandurah spotted this Gould's Monitor with a Tiger Snake in its mouth! She says "It held the struggling snake by the neck for about an hour until it got dark and next morning I saw the track where it had dragged the snake off under some bushes." Truly a top predator. Goannas are surviving quite well in good bushland, where the most obvious sign of their presence is the horseshoe-shaped burrow entrance.

For lots of fascinating facts about these animals (including the fearsome Komodo Dragon) read "Goanna: the Biology of Varanid Lizards" by Brian Green and Dennis King. (1993. NSW Uni. Press.) For example, how would you like to have met *Megalania prisca*, which reached a length of 7 metres and weighed 650 kg? The first Aboriginal settlers probably did meet them - no wonder there are some pretty scary Dreamtime stories!

Penny Hussey



photo - G Hitchcock

MEMBERS' PAGE

SLOW DOWN FOR FAUNA!

AT Stirling Range Retreat we have a number of attractive signs that urge patrons to drive slowly. Appreciating this one from the lowest hollow on the dead tree at the rear is an Australian Owlet-nightjar (arrowed) snoozing in the morning sun. Dead trees with numerous hollows such as this one provide accommodation for a number of different animals, and should be left standing wherever possible.

There are many dead trees at the Retreat - believed to have been killed by fire about 80 years ago. Instead of being a liability, these trees are in very high demand as multi-story housing apartments at nesting time.

There is frequently a lot a competition for nesting sites. Recently, several pairs of Purple-crowned Lorikeets were seen inspecting hollows in the same tree used by the Owlet-nightjar, much to the concern of the Rufous Treecreepers who always nest in that tree! Another regular visitor is a magnificent Tawny Frogmouth who likes to keep everyone guessing as to his whereabouts.

Ayleen Sands



Owlet-nightjar in tree - arrow pointing to bird



Owlet-nightjar

A GOLDFIELDS SWIFT MOTH

WHEN Steve Davies'

photograph of a frog eating a swift moth (family Hepialidae) appeared in WW Vol. 7 No.4, Matt Williams of CALMScience commented that the antennae needed to be visible for a more

detailed ID. Thus, when Grant Whiteman from the Centre for the Management of Arid Ecosystems photographed this one on "Southern Hills" station, he was careful to include the antennae.

So, this lovely hepialid is, according to Matt, a *Trictena* sp., because the antennae have three rows of combs. There are three (possibly more) species of *Trictena*. Their larvae live in vertical tunnels in the soil, feeding externally on the roots of eucalypts, emerging from the pupa to search for a mate after a good fall of rain. They may live many years as larvae, but their time as an adult is very short. They have no mouthparts, so they cannot feed, but must find a mate and lay their eggs within three days!



CARPET PYTHON RETURNS TO GIDGEGANNUP

This is a timely reminder that it is illegal to take any native fauna without authority from CALM. Many species of native fauna need special care and suffer distress and even death when removed from their usual habitat. Recently, Detectives in Perth executed a search warrant at a factory unit and found a live South West Carpet Python (*Morella spilota imbricata*). A CALM

Wildlife Officer was called in to seize the animal and interview the offender. As the python was taken from Gidgegannup, Land for Wildlife was asked if there was a suitable LFW site in the area where the python could be released. A 253 ha bushland site was chosen and the python was released on a large granite outcrop.

SOUTH-WESTERN Australia is home to a unique assemblage of freshwater fishes, with eight of the ten species being endemic to the region. Similarly, all of the freshwater crayfishes of the region are endemic. Although few in number, the species of the south-west are important in the ecology of rivers, with the diets of most of the region's fishes being dominated by terrestrial insects, but most also include nuisance species such as mosquito and midge larvae, pupae and adults in their diet. Freshwater crayfish are similarly important in that they are important in the structure and functioning of aquatic food webs as they can feed on a variety of food items, particularly detritus.

Unfortunately, due largely to loss of habitat, but also from predation by, and competition with, feral fishes (of which there are ten in WA) populations are rapidly declining. For example, many native fishes have been lost from large parts of salinised catchments such as the Swan-Avon, Murray, Blackwood, and they have also been decimated from many dams as a result of predation by redfin perch (*Perca fluviatilis*), a species that also preys heavily on marron. The 'dewatering' of the Swan Coastal Plain with drainage canals has also led to most of the original wetlands being lost.

The south-west region can be defined as including all waters between the Arrowsmith River near Dongara and roughly the Thomas River near Esperance. While the south-west region shares no fish species with the Pilbara or Kimberley, it does have two species in common with south-eastern Australia, including Tasmania, these being the trout minnow (*Galaxias truttaceus*) (Figure 1) and the spotted minnow or common jollytail (*Galaxias maculatus*) (Figure 2).

The trout minnow is the rarest freshwater fish in W.A. being restricted to the Two People's Bay area east of Albany where the State's first vertical slot fishway has recently been constructed to help the species negotiate a small weir.

The spotted minnow is common between Two People's Bay and

FAUNA

FRESHWATER FISHES OF SOUTH-WESTERN AUSTRALIA

Dave Morgan and Stephen Beatty



Fig. 1 Trout Minnow



Fig. 2 Spotted Minnow



Fig. 3 Mud Minnow



Fig. 4 Western Pygmy Perch

the Thomas River and is the only (native) freshwater fish found in the rivers east of the Pallinup River. The spotted minnow is extremely tolerant of salinity, with salinities of around 45-46 parts per thousand (ppt) being their upper limit (N.B. seawater = 35 ppt). Their ability to tolerate high concentrations of salt, together with their small size (max. 120 mm total length) makes them an ideal fish for farm dams that may be salt-affected, and, like other native fishes, are good controllers of mosquitoes and midges.

A number of others, such as the black-stripe minnow, mud minnow

(Figure 3) and Balston's pygmy perch are rare and have remnant populations scattered around the south-west. These species are likely to disappear from entire catchments, resulting in the potential loss of genetically distinct populations.

In conjunction with *Land for Wildlife*, the Department of Fisheries WA, the Water & Rivers Commission, the Water Corporation and the wider community, the Centre for Fish & Fisheries Research at Murdoch University has sought funding in order to promote the use of native fishes in farm dams and in new developments (artificial lakes), and to also restock areas from where species have been lost. The idea is to culture fish from specific catchments so that stocks are not translocated from outside catchments. For example, properties and lakes etc within the Swan-Avon catchment will only be stocked with native fish sourced from that catchment (e.g. western pygmy perch [Figure 4], nightfish and western minnows). There will also be a major focus on re-establishing populations of rarer species, and where possible, the eradication of feral fishes. Other aims are to determine habitat associations and environmental tolerances of the region's unique fishes.

Anyone interested in being involved with the project, particularly in the provision of suitable waterbodies, should contact Avril Baxter (avrilb@calm.wa.gov.au or tel. 9881 9218) from *Land for Wildlife*.

Dave Morgan is a Research Fellow at the Centre for Fish and Fisheries Research at Murdoch University and has worked extensively on the biology and distribution of freshwater fishes right throughout Western Australia. Stephen Beatty is completing his PhD at the Centre examining the biology of native freshwater crayfish and impacts of introduced fish. They can be contacted on 9360 6322 or by email on dmorgan@murdoch.edu.au, sbeatty@murdoch.edu.au.

REVEGETATION

GONDWANA LINK - ECOLOGICAL RESTORATION AT THE SCALE THIS COUNTRY NEEDS

Keith Bradby

I reckon it's been a great couple of decades. In the late 1970s, when I started getting involved in 'matters bush', the WA State Government still actively encouraged widespread clearing. Hundreds of thousands of hectares were being pushed over every year.

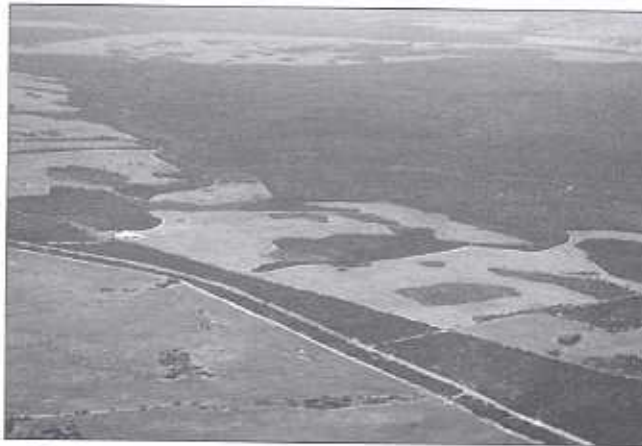
Now, not only do thousands of landholders actively protect and manage their bushland, but we have also seen the emergence of significant government based support programs, such as *Land for Wildlife*.

While it's been a long journey, it's not over yet. I am proud of the contribution I have been able to make to this era of great change, but hanging over this pride are a few 'curly questions', which I first bumped into in the very early 1980s.

Reservation is not preservation

In 1979 Steve Hopper published a wonderful journal article on the evolution of the south-west flora - the first of a number of papers Steve has written on that intriguing question 'why is the biota of the flat and dry south-west so rich?' The answer, it seems, lies in a complex interplay between the stresses of fluctuating climates across the 'transition zone' (between the wet forests and the arid interior) and the complex mosaic of soil 'islands' we have in the south west.

The work of Steve and others is opening a wonderful window on the rampant evolutionary forces we have swirling around us in south-western Australia. When I first read Steve's paper I was living at Ravensthorpe and my evolutionary knowledge was not much more than a basic understanding, thanks to Charles Darwin, of how the different finch species of the different islands of Galapagos had evolved. I suddenly realised I was living in some form of 'inland Galapagos' with islands of soils surrounded by a 'sea' made up of other soil islands, all supporting different plant species and providing different wildlife habitats. The ongoing patterns of evolution around me became very visible, such as the way *Grevillea macrostylis* becomes *Grevillea tripartita* in a 50 kilometre range across the middle of Fitzgerald River National Park. Or the way a sequence of seemingly similar, 'yet different', eucalypts I was unable to find scientific names for, were just part of the



The Australian Bush Heritage Fund's Cherininup Creek reserve, with revegetation area in foreground.
Photo: Amanda Keesing

same ongoing evolutionary processes that Darwin's finches represented.

Steve's work also left me with a much bigger question: in an area where we were unable to even properly conserve distinct species and communities, what hope did we have of conserving the evolutionary processes clearly vital to continued ecological health?

In 1980 the WA Museum published results from its biological survey of the WA wheatbelt. This was a time

when ecologists were coming to terms with "island biogeography" theories, which suggested limits to the number of species that would survive in any isolated piece of bush. For mammals the Museum scientists came to the grim conclusion that '40,000ha approximates the area of nature reserve likely to conserve that part of the regional assemblage of mammals in southern Western Australia liable to persist in the face of moderate disturbance by man and his agencies'. For birds the conclusion was even grimmer: 'Reserves of the order of 30-94,000 ha are required to conserve most of the avifauna of the wheatbelt'. While I am sure there has been lots of scientific quibbling about these numbers, I remain deeply disturbed by even the vague possibility that, across the entire wheatbelt, only the Lake Magenta Nature Reserve seems large enough to be in the long term race.

My concerns deepened in 1982 when I attended an Arid Lands Conservation conference in Broken Hill, and met a scientist called Earl Saxon. Earl presented a paper which compared the system of social apartheid, then in place in South Africa, with what he called the 'environmental apartheid' represented by the Australian nature reserve system. In his view this system had predictable consequences: 'the few biological communities which have designated reserves have no rights outside those reserves. Those reserves are physically inadequate for the officially designated purpose. Environmental apartheid gives the illusion of moral rectitude, but literally sows the seeds of ecological revolution'.

Think about this next time you fly over the wheatbelt, and look down on the boundaries of the reserve system and, despite all our efforts, the still largely ecologically inhospitable farming landscape that surrounds them.

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Then ponder the level of protection and management those reserves need, as opposed to what they receive. As Earl foresaw in 1982: 'If the network of reserves is to be our life support system, it would be fatal to design reserves which are dependant on our economy for survival. Management inputs must serve the goal of making the system less dependent on further investment'.

We are now starting to see the place for whole landscape conservation, adding to the public reserve system with private reserves, such as those managed by *Land for Wildlife* members, and recognizing the threat that forces such as salinity pose to the 'protected areas'. But these 'curly questions' still hang over all our work and all our hopes.

In addition, we now know that our biota is even richer than we thought at the time, with the wonderful work of Steve Hopper, Greg Keighery, Mark Harvey and others continually underlining that. And we get constant confirmation that, even without further clearing, biodiversity richness is continuing to decline. Scientists like Harry Recher and Denis Saunders have become chillingly prophetic in their statements that we are in the process of losing 50 per cent of bird species from most agricultural areas, with the losses peaking within the next 30-40 years.

I do not want to live in such an impoverished place.

Confronting the 'curly questions'

It's always good to confront the issues that concern you most. So, in August 2002, I was delighted to be appointed as Coordinator of the Gondwana Link project, a partnership focused on restoring fundamental ecological processes across a broad swathe of south-western Australia. We are moving beyond a single-minded focus on saving a small selection of rare species or specific areas. Our vision is: *reconnected country in south-western Australia, from Kalgoorlie to the karri, in which ecosystem function and biodiversity are restored and maintained.*

Five groups currently make up the Gondwana Link partnership: the Wilderness Society, Friends of Fitzgerald River National Park, Fitzgerald Biosphere Group, Greening Australia and the Australian Bush Heritage Fund. It's an interesting collection of groups, drawing together the wide spectrum of environmentalism in Australia, from on-ground landcare work to national advocacy for fundamental policy change. We also work closely with some international groups, particularly The Nature Conservancy from the USA, and with the south coast's regional natural resources group, SCRIPT.

While our vision is a large one, our initial focus seems readily achievable. It's only 76 kilometers between the Fitzgerald River and Stirling Range National Parks, and significant parts of this gap are still under bush, either in nature reserves or in large remnants on private property. Since 1998 there has been a large corridor project operating through the Pallinup-North Stirlings landcare group, to protect waterway vegetation and replant strategic small



Eddy (left) and Donna Wajon (second from right) with friends on the massive task of revegetating parts of Gondwana Link. Photo: Craig Keesing.

links between bushland areas. With support from the Jerramungup-based Fitzgerald Biosphere Group, a number of farmers have undertaken significant change in their farming practices, with a view to becoming much more sustainable and reducing the ecological damage that flows from their property. Many of the smaller areas of private bushland are already fenced and under some form of protection and management.

These are the essential arteries of a good conservation network. Our task now is to keep the heart pumping by focusing on the restoration of fundamental ecological processes and building strong links between the remaining bushland.

The first steps on the ground were taken in 2002, when one of our partners, the Australian Bush Heritage Fund, purchased 800 hectares of bushland and some 70 hectares of cleared land on Cherinup Creek. This is an important piece of bushland that sits between Corackerup and Peniup Nature Reserves. With support from the Commonwealth's EnviroFund, Bush Heritage and Greening Australia have worked together to re-vegetate the 70 hectares of cleared land and strengthen the link into Peniup Nature Reserve. Also that year, private conservation buyers Eddy and Donna Wajon purchased nearly 500 hectares of bushland further downstream on Corackerup Creek. This purchase consolidates an important north-south link with the Pallinup River and the coastal vegetation.

While further bushland purchases are being negotiated, the project is now turning its attention to the main game, which is building strong links across cleared land. Gondwana Link is not about building a single, narrow 'wildlife corridor' across the cleared areas. Rather, we want to achieve a much broader change of land use that not only provides greater ecological connectivity, but also enriches social and economic life in the area. This vision for rural Australia argues that such a matrix has to be achieved, particularly in an area where agriculture is not as profitable as elsewhere and, as a consequence,

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population levels and associated services are already in decline.

This year Eddy and Donna have started re-vegetating the 100 hectares of cleared land that came with their property. Greening Australia, working through the National Trust's Bush Bank revolving fund, is purchasing an 800 hectare farming property adjoining the Corackerup Nature Reserve, and over 100 hectares has already been direct seeded with local species so far. Funds are being sought to enable other strategically placed properties to be secured and restored.

While many of the plantings to date are purely ecological, we see scope to keep expanding and diversifying the Link by also developing ecologically and socially supportive commercial industries, based on the botanical bonanza the region is blessed with.

An obvious example of this is Sandalwood. Elsewhere in Western Australia we have seen the development of commercial sandalwood plantations, based on one or two acacia host species to feed the parasitic sandalwood plants. Work by Albany based researchers Geoff Woodall and Chris Robinson has identified over 700 local host species that sandalwood parasitises. The first of these biodiverse plantations has been established and we expect more to follow. On its own property, Greening Australia has already established some of this biodiverse sandalwood, as well as broom-bush plantations, for use in garden fences, and a stand of Moort poles that have a market as both fine wood and structural timbers.

Work has commenced on other sections of our ecological pathway. In the wet forests of the south-west The Wilderness Society, along with other groups, has achieved significant ecological gains through the end of old-growth logging and the establishment of the Walpole Wilderness Area. With support from donors secured through its Gondwana Link involvement, The Wilderness Society has employed Charles Roche to work towards securing the ecological values of the vast tract of mallee, woodland and heath stretching east of the wheatbelt to the Nullarbor.

This area, as large as Tasmania but with a much



The red-flowered Corackerup Moort, *Eucalyptus vesiculosa*, is one of the local endemic species being restored to their former distribution as part of the Gondwana Link revegetation effort. Photo: Nathan McQuoid.

greater level of biological richness, survived a number of attempts last century to have much of it opened up for wheat farming. Only a few small areas have ever been cleared or put under pastoral lease. While there is an increasing level of mining activity, this area is the largest reasonably intact part of south-western Australia, and the largest intact temperate woodland system in the world. It also provides a vital ecological connection into the more arid interior.

Funding at the scale our environment needs

Underlying Gondwana Link's program is a strong commitment to developing a larger and more diverse funding base for ecologically critical work. Much of the good work of the past few decades has either been done on the smell of an oily rag or been almost totally dependant on government funding programs, which are often short-term in nature. Western Australia, and its immensely valuable biodiversity, takes up an area about one-third the size of the United States of America. Our population is only 1.8 million, of which around 1.4 million live in Perth. Our economy, while strong, doesn't retain the surpluses of many western economies and we do not, yet, have a culture of private generosity to conservation causes, particularly for the dry country. Many of us are, understandably, being overwhelmed by the immensity of the urgent needs we tackle.

Gondwana Link partners have already developed good links into the philanthropic sector, and have been fortunate in gaining significant early donations. There have been fellowship exchanges with senior fundraisers, who work in the USA for The Nature Conservancy, which has helped partner groups gain essential skills.

In March this year we hosted an inspirational visit by Trustees from The Nature Conservancy's Maine Chapter. This group of committed citizens raise around \$35 million of private donor funds a year for conservation work, in a state with a population of only 1.2 million.

South-western Australia still contains many awesome landscapes, is now recognized as one of the world's 25 biodiversity hotspots, and has a level of ecological weirdness that fascinates and astounds visitors and residents alike. We are learning to turn these features into the dollars needed to restore the most damaged areas. If we do this, and can use our work to restore and underpin the most critical ecological processes, maybe our future can be one of ecological richness and personal joy, not the ecologically bleak and socially impoverished landscape that looms so dangerously close.

Keith Bradby is Coordinator of the Gondwana Link Project and can be contacted by email on: kbradby@westnet.com.au

A list of references is available from the Editor.



NEW BOOKS

Wheatbelt waterwise = saltwise

John Colwill & others

Dept. of Agriculture Bulletin 4628, July 2004.

Another one for the gardeners! Prepared in association with the Rural Towns Programme, this booklet describes in detail how you can have an attractive garden, as well as saving water and minimising the rise of salt. And it doesn't tell you that you have to get rid of your lawn! Lots of good ideas and an interesting species list.

Obtainable from Dept. of Agriculture:
enquiries@agric.wa.gov.au

The Complete Bushfire Safety Book

Joan Webster

Random House, Australia 2000, ISBN 1740510348

Do you live in a bushfire high-risk area? At this time of the year you will be starting to think about the long, dry summer ahead and taking measures to reduce the fire risk around your property. More than half of all bushfire tragedies happen in the outer suburbs of major cities. Post-bushfire scientific research has found that 90% of homes can be saved from even the fiercest wildfires when defended by one or more people over the age of 10 who know what to do. This publication gives advice on suitable safety measures for individual situations and features every known fact of preparedness and safety. The book received the Australian Fire Protection Association Community Service Award.

Avondale Reserve Walktrail Opening

Avondale Research Station and Discovery Farm is a multi-purpose historic farm in the Avon Valley that is used for agricultural research. It also has a farm museum, a tourist drive trail, and a bushland reserve that has been a *Land for Wildlife* site since 1999.

On September 4th the Avondale Reserve Walktrail was officially opened by Mrs Judy Schilling, President of the Shire of Beverley. Some of the 54 people who attended were lucky enough to hitch a ride to the reserve on a wagon pulled by a pair of Clydesdale horses that are resident at Avondale.

The Reserve sits on top of a hill that has exposed granite rock and the native vegetation is a woodland of eucalypts and sheoaks. The walktrail has markers describing various features such as tree hollows, plants, biodiversity, rocks and soils. Many colourful wildflowers were seen including pink everlasting, purple tassels and donkey spider, and blue fairy orchids. Afterwards, the historic Avondale homestead was the venue for a delicious afternoon tea provided by the Avondale volunteers.

Avondale is well worth a visit whether you are young or not so young, from the city or the country. See the Coming Events page for details of the Avondale Harvest Festival to be held in November

Claire Hall

Pasture Management for Weed Control: A grazier's guide to controlling annual weeds in southern Australian improved pastures

Jeff Burton and Peter Dowling

Weed CRC

Cost \$20, available from Orange Agricultural Institute, Tel. 1800 028 374, email: bookshop@dpi.nsw.gov.au.

Weeds in pastures are estimated to cost the nation over \$792 million per year. This book primarily focuses on the management of pastures to minimise the ecological and financial impact of weeds. It assists landowners to implement better pasture management practices and benefit from increased production and life of productive pastures, reduced weed impact, long-term sustainability through better water management, and a stable plant and animal production system. The book outlines 'key tactics' for pasture improvement and reviews the main poisonous plants found in pastures and their effects on stock. Biocontrol research and case studies are also presented. The practical information contained in this book is sure to be of value to all land managers.

Essential Bushfire Safety Tips

Joan Webster

Random House, Australia 2001, ISBN 1740510356

This book is essentially a pocket version of The Complete Bushfire Safety Book intended as a reference to keep in the kitchen, car, office, survival kit etc. Facts are set out in points style to enable quick and easy identification of any bushfire concern. Landowners are urged to be ready for summer with a plan.

COMING EVENTS

16-24 October

National Weedbuster Week

Weedbuster Week is all about getting involved and increasing public understanding about weeds and the problems they cause. All organisations, groups and individuals are encouraged to get involved in their own way. You can organise an event - or take part in one. Community input and suggestions for Weedbuster Week activities are welcome.

Weedbuster Week Event Organiser Kits are available from the WA Weedbuster Week Coordinator, Ms Sandy Lloyd at Agriculture WA, Locked Bag 4, Bentley Delivery Centre 6983, Tel. (08) 9368 3760, email: slloyd@agric.wa.gov.au.

Sunday, 21st November, 10 am to 4 pm

Avondale Harvest Festival at Avondale Research Station, Waterhatch Road, Beverley. See harvesting of crops using a variety of historic and modern machinery, landcare displays, and museum. Entry fee \$5 per car includes free bus tour of farm drive trail. For further information contact Dina Barrett-Lennard on tel. (08) 9646 1004 or email dbarrett@agric.wa.gov.au.

This Newsletter is a compendium of articles written by many different people. The views expressed are those of the authors, not necessarily those of the Department of Conservation and Land Management.

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