

# The Victorian Naturalist

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## FNCV Calendar of activities

For any enquiries about the following activities, contact the group secretaries. Addresses and contact numbers can be found on the back cover.

### May

- NOTE: There will be no meeting of any group at The National Herbarium in May.
- Wed 1 Geology Group meeting.
- Sat 4 Leadbeaters Possum watch. Contact Ray Gibson (874 4408)
- Sun 5 General excursion. Ferns at Mt Worth State Park. Transport by bus. Leader Rod Hill.
- Tues 7 Fauna Survey Group meeting. 'Some aspects of the identification and ecology of Victorian bats'. Lindy Lumsden (Arthur Rylah Institute).
- Thurs 9 Botany Group meeting. 'An introduction to fungi'. Mrs Hilary Weatherhead.
- Sat 11- Fauna Survey Group. Werribee Water Rat survey. Contact Julian Grusovin  
Sun 12 (543 8627) or Alex Kutt (419 0752).
- Mon 13 Annual General Meeting. At the Astronomers Residence.
- Wed 15 Microscopical Group meeting. 'Mounting in glycerine and glycerine jelly'. Dan McInnes. At the Astronomers Residence.
- Sat 25 Botany Group excursion. Fungi at FNCV Kinglake property. Leader: Tom May.

### June

- Sun 2 General excursion. Fungi at Blackwood Range. Leader: Tom May.
- Tues 4 Fauna Survey Group meeting. To be announced.
- Wed 5 Geology Group meeting.
- Sat 8- Fauna Survey Group. Queens Birthday campout. To be announced.
- Mon 10 General meeting. Microscope work and social evening at the Astronomers Residence.
- Thurs 13 Botany Group meeting. Members night.
- Sat 15- Werribee Water Rat survey. Contact Julian Grusovin (543 8627) or Alex  
Sun 16 Kutt (419 0752).
- Wed 19 Microscopical Group meeting. Display of old microscopes. John Dawes and Geoff O'Loughlin.
- Sat 22 Botany Group. Morning: The work of the Herbarium. Leader: Tim Entwisle. Afternoon: Rainforest trees of northern Australia. Mary Doery.

### August

Proposed tour to Binna Burra Mountain Lodge, Lamington National Park, Qld, in August for 1 week. Approximate cost: cabins, twin share \$597-\$821 each excluding transport. Camping available. The excursion secretary would like an indication of the number of people interested in going. Further information will be available soon.

## Election of FNCV office-bearers

Election of office-bearers will take place at the Annual General Meeting on Monday May 13 at 8.00 p.m. in the Astronomer's Residence. All currently held positions will be vacated and we urge members to forward their nominations for office-bearers to the Secretary, Julian Grusovin, prior to this meeting. The nominations should be sent c/- the FNCV address on the back cover.

# The Victorian Naturalist

Volume 108 (1) 1991

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Editors: Tim Ofor and Robyn Watson

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Cover photo: What is it? See page 6 to find out.  
(photo J.H. Hawking)

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## A note on the longevity of the Mountain Brushtail Possum, *Trichosurus caninus* in the montane ash forests of the Central Highlands of Victoria

D. B. Lindenmayer<sup>1</sup>, R. M. Warneke<sup>1</sup>, R. A. Meggs<sup>1</sup>, T. Linga<sup>2</sup>, and J. H. Seebeck<sup>1</sup>.

The Mountain Brushtail Possum, *Trichosurus caninus* is a species of arboreal marsupial confined to forest habitats in eastern Australia (How 1983, Smith and Winter 1984, Lindenmayer *et al.* 1990). It is common in montane ash-type eucalypt forests in the Central Highlands of Victoria (Lindenmayer 1989, Lindenmayer *et al.* 1990) where the plant communities are dominated by *Eucalyptus regnans*, *E. delegatensis* or *E. nitens*.

Detailed studies of the diet of *T. caninus* were completed at Cambarville (37°33'S latitude and 145°53'E longitude) in the montane ash forests of the Central Highlands of Victoria between 1980 and 1982 (Seebeck *et al.* 1984). A total of thirty (30) animals were ear tattooed with chisel point numbers and green dye during this study (Warneke and Seebeck unpublished data). A radio tracking program has recently commenced at Cambarville (Lindenmayer *et al.* unpublished data) and this has involved extensive and intensive trapping of arboreal marsupials in the area. Several *T. caninus* were captured in late August and early September 1990. Of these, two (2) adult *T. caninus* were trapped that had been ear-marked during studies by Seebeck *et al.* (1984) and Warneke and Seebeck (unpublished data). One of these animals (male #45) was first captured in March 1982 and weighed 2.55 kg. This animal weighed 2.40 kg when it was recaptured in September 1982. The body weight of male #45 when caught in September 1990 was

2.79 kg. The other individual (male #32) weighed 2.60 kg in June 1981 and 2.88 kg when captured again in 1990. Changes in observed body weight in the interval between captures were relatively small (< 400g). As *T. caninus* completes maturation at three (3) years of age (How 1981) these differences in body weight are more likely to be associated with seasonal variation in (Warneke and Seebeck unpublished data) than increases in body size. Data on body weight indicate that the two *T. caninus* were adult when first captured and were therefore at least 10 or more years old when recaptured in spring of 1990.

Information from previous studies (Warneke and Seebeck unpublished data) also showed that these animals were trapped within approximately 250 m from where they were first caught and marked.

How (1972, 1978) found that some adult *T. caninus* lived in excess of 10 years which is a similar result to those reported here. Our findings show that *T. caninus* has strong range affinity remaining in, or close to the area where the animals were first trapped. These data support the results of How (1978, 1981) who proposed that post-dispersal adult *T. caninus* are both long lived and relatively sedentary.

Our findings indicate that fluorescent dye used to mark the external ear-conch of mammals remains legible for a long period. Thus the technique has considerable merit for use in long term studies of wildlife particularly those where animals need to be readily and regularly identified in the field. Furthermore, the age of animals marked in this manner can be relatively accurately determined when re-captured. This has an advantage over

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techniques of age determination based on external body characteristics such as head, pes and ear length used by How (1976). These allowed older animals to be categorised as only those 3 or more years old (How 1976).

### Acknowledgements

S.A. Craig provided many useful suggestions for incorporation in the manuscript. This project was supported by the Department of Conservation and Environment.

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# The first record of the dragonfly *Dendroaeschna conspersa* from Victoria

J. H. Hawking\*

## Introduction

The larva of the dragonfly *Dendroaeschna conspersa* (Tillyard 1906) was described by Tillyard (1916) from specimens collected from streams near Sydney, New South Wales. Watson (1974) expanded the known distribution to include north-east and south-east New South Wales, and south-east Queensland (Watson 1977).

This paper reports the first record of *Dendroaeschna conspersa* in Victoria, a discovery which necessitates some modification to the odonate larval key (Hawking 1986). A new couplet is provided for inclusion in the key along with additional information on specific characters to assist in identification of the larvae.

Four larvae of *Dendroaeschna conspersa* were collected from the La Trobe River at Rosedale (38°10'S., 146°47'E.). A specimen was collected by D. P. Robinson on 6.1.1983 and three more by J. H. Hawking on 4.2.85. The larvae were found in crevices on submerged logs, in a slow flowing section of the stream. The larvae were compared with Tillyard's original material (Australian National Insect Collection, Canberra) and positive identification was confirmed by G. Theischinger. The specimens are held at the Murray-Darling Freshwater Research Centre.

## Addendum to Hawking (1986)

The second half of couplet 26 (25) of Hawking (1986) should now go to a new couplet, 31.1.

31.1 (26) Posterior corner of head with large postocular lobes (Fig. 1)  
           .....*Dendroaeschna conspersa*  
           Posterior corner of head rounded (Fig. 2) or jagged (Fig. 3) .....32

## Specific characters

Head with prominent eyes; posterior corner of head with large postocular lobes. Labium flat; palps with 24-26 teeth (final instar larvae), end tooth short, movable hook strong; lateral margin of prementum and mentum with stout setae. Strong lateral abdominal spines on segments 6-9. No dorsal abdominal hooks. Epiproct marginally longer than half the paraproct length; cerci short, c. 1/3 length of the paraprocts.

## Discussion

*D. conspersa* is presently the only known Victorian aeshnid whose larvae have large postocular lobes. The lobes are very distinctive, being produced into pointed projections which extend out from the posterior lateral margins of the head. This feature plus the other characters should be adequate to identify the larvae.

## Acknowledgements

Thanks are extended to Dr J. A. L. Watson for his comments on this paper, D. P. Robinson for collecting larval material, G. Theischinger for checking the identity of the dragonfly larvae and an unknown referee for constructive comments.

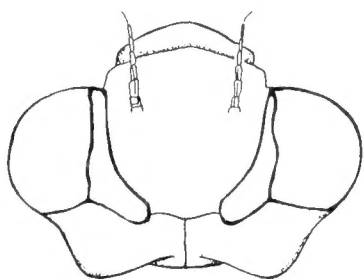
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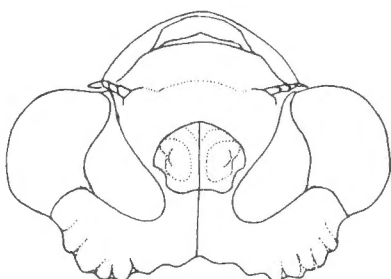
\* Murray-Darling Freshwater Research Centre, P.O. Box 921, Albury, NSW 2640



**Fig. 1.** *Dendroaeschna conspersa*, dorsal view of the head



**Fig. 2.** *Austroaeschna pulchra*, dorsal view of the head



**Fig. 3.** *Telephlebia brevicauda*, dorsal view of the head

Watson, J. A. L. (1977). The distributions of the Australian dragonflies (Odonata): first supplement. *J. Aust. Entomol. Soc.* **16**: 277-79.

## A guide to the echinoids of the Middle Miocene Rutledge Marl, Victoria

K. J. McNamara\*

### Abstract

Six species of echinoids (sea urchins) are described from the Middle Miocene Rutledge Marl Member of the Port Campbell Limestone in the vicinity of the mouth of the Sherbrooke River. In addition to discussing their diagnostic characters, an attempt is made to reconstruct the life habits of the different echinoids, particularly with regard to the depth to which they buried in the sediment.

### Introduction

The coastal cliffs of southwestern Australia, between Portland in the west and the Otway Ranges to the east consist mainly of sedimentary rocks of Tertiary age. Some of these marine limestones which form the spectacular cliffs in regions such as the Port Campbell National park, and the vicinity of Anglesea and Torquay are locally quite fossiliferous, being dominated by echinoids and, to a lesser extent, molluscs, bryozoans, brachiopods and crustaceans.

It is well over one hundred years since the first species of echinoid was described from this part of Victoria. Since that time, a number of other species have been described in a variety of scientific journals. While there is an interest in echinoids among many professional palaeontologists and amateur naturalists, there is a dearth of general guides to the rich fossil faunas of the southern Victorian coast, and none dealing with the rich echinoid faunas. The aim of this guide is to remedy this to a small degree by providing a practical field guide to the echinoids of the most fossiliferous unit within the Port Campbell Limestone: the Rutledge Marl. Because detailed descriptions of the echinoids which are to be dealt

with have been provided in a number of scientific papers (detailed below), only descriptions of the diagnostic characters of each of the species found in the Marl will be given. Particular reference will be made to features that allow them to be distinguished from one another.

In addition to providing a guide to the identification of the species, this guide also sets out to show how the comparison of a number of morphological characteristics of the fossil species with their living counterparts allows aspects of their life history and habitats to be analysed. The most significant feature that can be determined is the depth to which the echinoids burrowed in the sediment.

### Stratigraphy

The Rutledge Marl Member of the Port Campbell Limestone is a 9 m thick unit of bluish-grey, fossiliferous, calcareous clay, marl and clayey limestone (Abele *et al.* 1976). It is Middle Miocene in age (about 15 million years old) and forms a distinctive band in the coastal cliffs east of Port Campbell, showing up as a darker layer in an otherwise creamy-yellow cliff. Because of a gentle dip of the strata, this unit is only accessible at beach level in the vicinity of the mouth of the Sherbrooke River (Baker 1944). While the Port Campbell Limestone as a whole is a relatively fossiliferous unit, yielding bryozoans, molluscs, echinoids and brachiopods, the Rutledge Marl contains a fauna overwhelmingly dominated by echinoids. Furthermore, all of these echinoids belong in the order Spatangoida: the so-called 'heart urchins'.

While this echinoid fauna shows some similarities to that found in the coarser-grained parts of the Port Campbell Limestone (known as the Peterborough Member), there are important differences. Analysis of the morphological character-

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## Contributions

istics of the Rutledge echinoids reveals that many of these differences arise from distinctive morphological features possessed by the echinoids, that enabled them to inhabit the finer-grained muds.

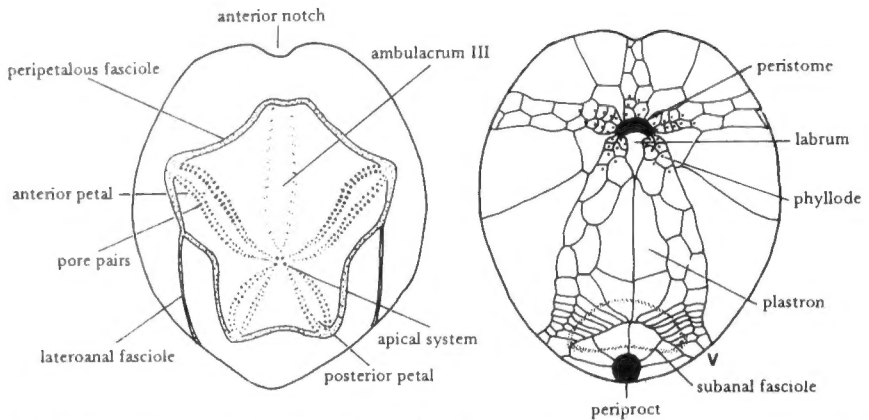
### History of Research

A total of seven echinoid species have been described from the Rutledge Marl. All are spatangoid echinoids (heart urchins). Duncan (1877) described *Maretia anomala* and *Eupatagus laubei*. These have since been redescribed as *Eupatagus anomalus* and *Spatagobrissus laubei*, by Kruse and Philip (1985) and McNamara *et al.* (1986), respectively. Hall (1907) described two further species, *Brissopsis tatei* and *Schizaster sphenoides*. The former species has been redescribed by McNamara *et al.* (1986), the latter by McNamara and Philip (1980a). The other three species described from the Rutledge Marl are *Peraspatagus depressus* Philip and Foster (1971), *Pericosmus quasimodo* McNamara and Philip (1984) and *Hemiasster (Bolbaster) callidus* McNamara (1987).

### Identifying the echinoids

To aid in the identification of species, line drawings of the aboral (dorsal) and lateral surfaces are presented. With these it is often possible to identify species from fragments of specimens. Many of the echinoids have suffered post-mortem damage due to crushing of their very thin tests by the weight of the overlying sediment. Furthermore, because the echinoids are found jutting out of the cliffs in the intertidal zone in a very soft sediment, mechanical damage by wave action frequently causes damage to the echinoids. It should be borne in mind that virtually all of the accessible localities of the Rutledge Marl lie within the Port Campbell National Park. Consequently, under Department of Conservation and Environment regulations, fossils cannot be collected without a permit.

Like many other echinoderms, echinoids possess an outer shell (known as the test) that is made up of a series of plates. These are arranged in columns of five ambulacra, between which are five interambulacra. Each ambulacrum and interambulacrum comprises (generally) 2 rows of plates. In regular echinoids, the test shows radial symmetry, and the mouth (peristome) is ventral in a central position, while the anus (periproct) is dorsal, also in a central position. However, heart urchins are characterised by the possession of an anteriorly positioned peristome which is situated on the ventral surface, and a periproct that is either on the posterior margin of the test or, if ventral, is close to the margin. Behind the peristome is a single plate, the labrum, which is followed by a pair of large plates known as sternal plates. These combine to form the plastron (Fig. 1). This bears tubercles that support spines adapted for locomotion and burrowing. Around the peristome are pore pairs arranged in a phyllode. These pore pairs support highly adapted, mucus-secreting tube feet that are used in feeding. The lateral areas support tubercles that carry spines adapted just for burrowing. The dorsal (aboral) surface of most heart urchins has an anterior and posterior pair of sunken petals. Pore pairs in these petals support respiratory tube feet. The anterior ambulacrum (ambulacrum III) may be sunken or not. Its pore pairs carry tube feet adapted either for sensory purposes or for secreting mucus to line a funnel that connects the sunken burrow with the sediment/water interface. Heart urchins are also characterised by their possession of fascioles (Fig. 1). These are discrete linear areas of minute tubercles that bear tiny spines. Their function is to increase current flow over particular areas of the test, and to secrete mucus that completely envelops the echinoid in its burrow. This prevents sediment from coming into contact with the test and clogging up the respiratory tube feet. The fascioles occur on specific areas of the test. Four types



**Fig. 1.** Basic heart urchin (spatangoid echinoid) morphology; left, dorsal surface, right, ventral surface.

occur in the Rutledge heart urchins: peripetalous, lateroanal, subanal and marginal.

## Descriptions of the echinoids

Order Spatangoida

Family Hemiasteridae

Genus *Hemiaster*

*Hemiaster (Bolbaster) callidus* McNamara (1987) (Fig. 4 I,J)

**Description.** Test small, never more than 35 mm in length. Spherical in shape, with very high posterior; almost as wide as long. No anterior notch. Apical system with four genital pores and situated slightly anterior of centre. Petals short, straight, broad and shallow. Peripetalous fasciole broad. No other fascioles present. Labrum with prominent lip.

**Horizon.** Only known from the Rutledge Marl.

**Remarks.** Of all the Rutledge Marl echinoids, *Hemiaster (Bolbaster) callidus* is the smallest. The other Rutledge Marl echinoids with which it might be confused are the small species *Brissopsis tatei* and *Spatagobrissus laubei*. But *H.(B.) callidus* can be distinguished from *B. tatei* by its more spherical shape, its straighter petals, which are not confluent towards the apex, and the absence of a subanal fasciole. It differs from *S. laubei* in lacking the overall scattering of primary tubercles, having

sunken petals, a prominent labrum and no subanal fasciole.

*Hemiaster (Bolbaster) callidus* is the youngest species in a lineage of five species of this genus that is found in Eocene to Miocene rocks of South Australia and Victoria. It can be distinguished from the other species by its deeper, shorter petals; apical system set closer to the anterior margin of the test; its broader and higher test; and longer labrum.

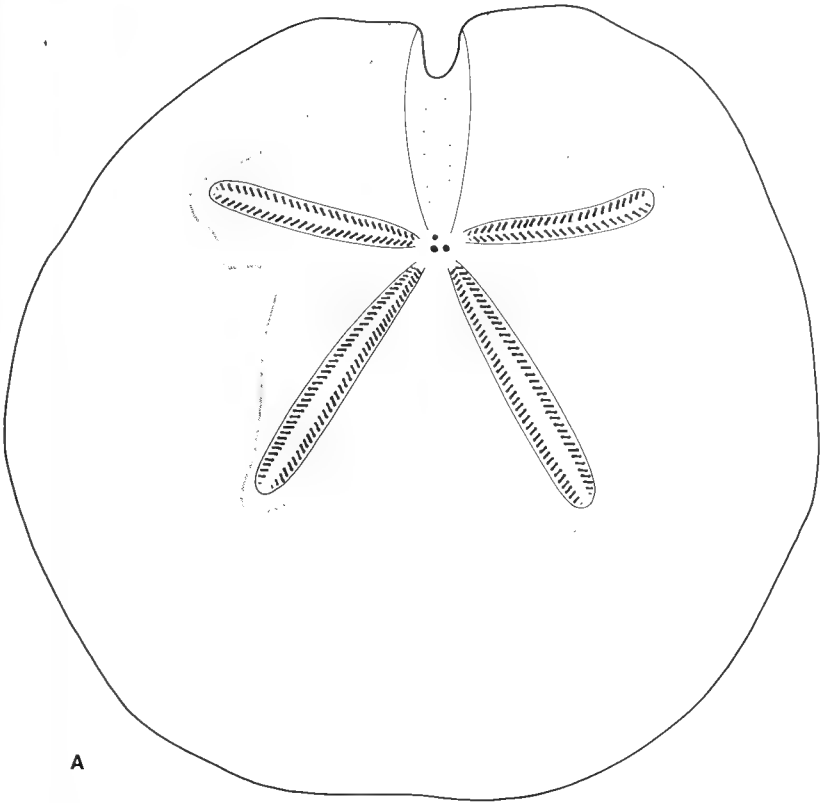
## Family Pericosmidae

Genus *Pericosmus*

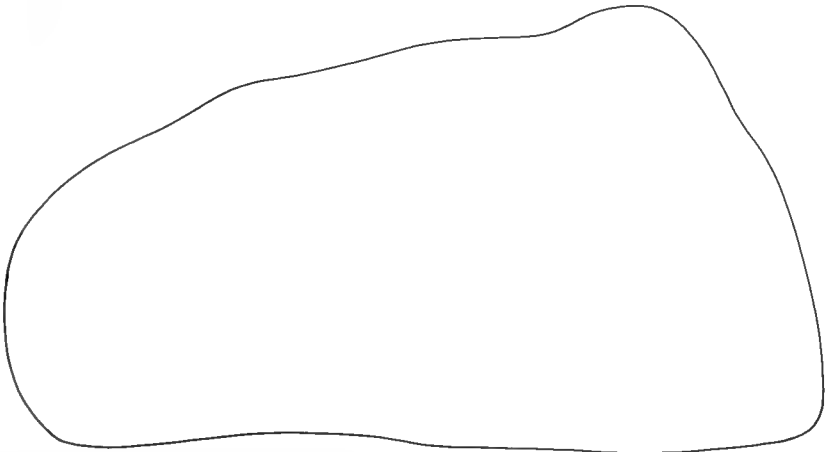
*Pericosmus quasimodo* McNamara and Philip (1984) (Fig. 2)

**Description.** Test very large, up to 130 mm in length; strongly vaulted with steep anterior. Apex and apical system set close to anterior of test. Apical system with three genital pores. Anterior notch very deep and narrow. Petals deep, straight and narrow. Possesses irregular peripetalous fasciole plus a marginal fasciole. Peristome sunken with labrum projecting most of the way across it.

**Horizons.** This species occurs in both the Rutledge Marl and in the Peterborough Members of the Port Campbell Limestone. In this latter member it has been found in the coastal cliffs at Portland.

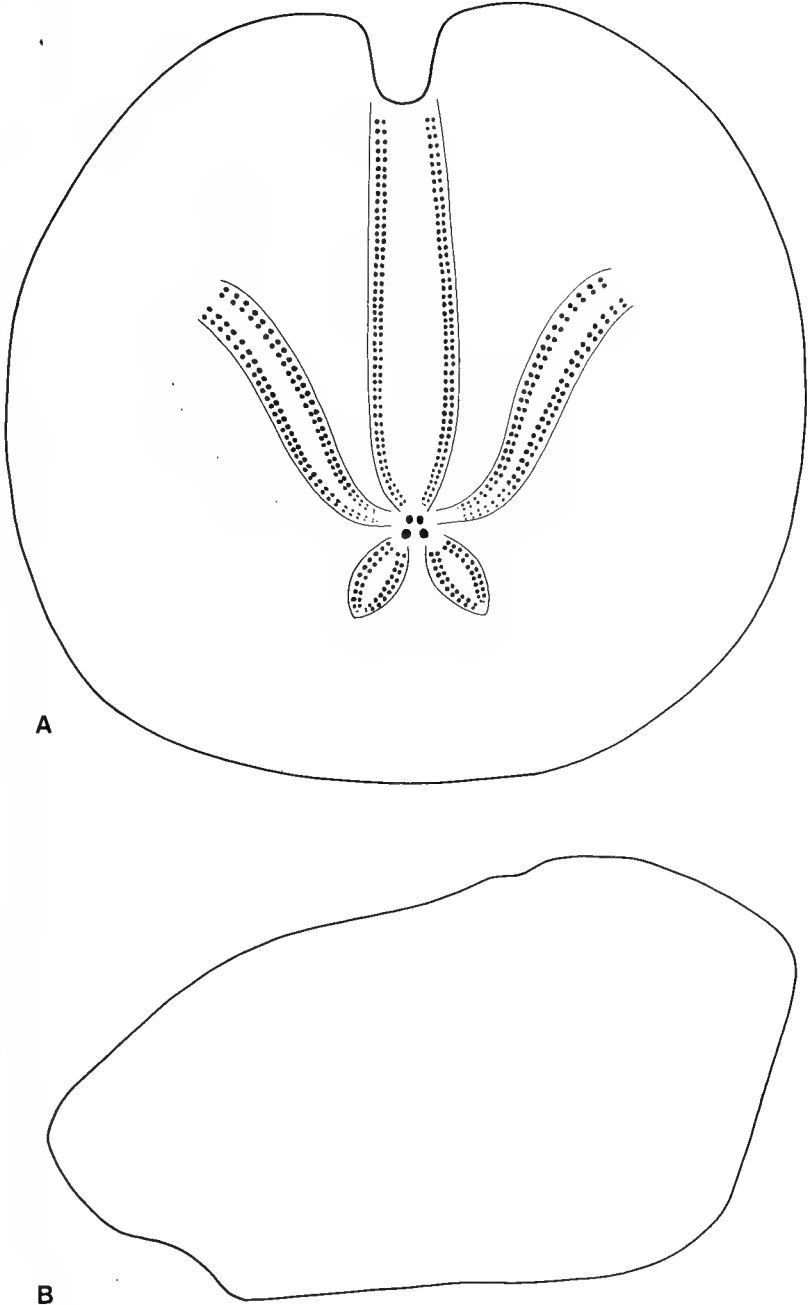


A



B

**Fig. 2.** *Pericosmus quasimodo* McNamara and Philip, 1984; A, dorsal view, B, side view; x1.



**Fig. 3.** *Schizaster sphenoides* Hall, 1907; A, dorsal view, B, side view; x1.

## Contributions

*Remarks.* The only other echinoid from the Rutledge Marl with which *Pericosmus quasimodo* could be confused is the other large echinoid, *Schizaster sphenoides*. But *P. quasimodo* can be differentiated by its anteriorly positioned apex, apical system and petals; its marginal fasciole and possession of only three genital pores.

*Pericosmus quasimodo* is the youngest species in a lineage of five species of *Pericosmus* that ranged from the late Oligocene to Middle Miocene in Victoria and South Australia (McNamara and Philip 1984). It can be distinguished from all other species by its deeper anterior notch; steeper anterior face of the test; deeply sunken peristome and strongly projecting labrum.

### Family Schizasteridae

#### Genus *Schizaster*

*Schizaster sphenoides* Hall (1907) (Fig. 3)

*Description.* Large, subcircular test up to 100 mm long; low anteriorly, but rises steeply posteriorly. Apical system with four genital pores and set well posterior of centre. Ambulacrum III and anterior notch very deep. Anterior petals long, narrow, deep and gently curved. Posterior petals very short. Peripetalous and latero-anal fascioles present. Plastron strongly raised. Labrum projects across mouth.

*Horizon.* This species has only been found in the Rutledge Marl.

*Remarks.* This large echinoid is hard to confuse with any of the other Rutledge Marl echinoids, principally in its possession of a very long, deep, trench-like ambulacrum III. This is the largest of all known fossil and living species of *Schizaster* to occur in Australia. The oldest is found in Paleocene strata in Western Australia (McNamara and Philip 1980a). The deep anterior notch and ambulacrum III attain depths not seen in any other species of this genus. Some specimens have been found in which the spines are still preserved. These show it to have had stout paddle-shaped spines on the plastron, and finer spines on the

ventro-lateral parts of the test. On the dorsal surface the spines were very much smaller and more slender.

### Family Brissidae

#### Genus *Brissopsis*

*Brissopsis tatei* Hall (1907) (Fig. 4 C,D)

*Description.* Test ovoid and small up to 50 mm in length; highest posteriorly. Apical system with four genital pores situated centrally. Ambulacrum III quite deep and narrow. Apical notch shallow. Petals sunken and strongly curved, anterior and posterior on each side curving to form an arc. Inner rows of pore pairs in posterior petals confluent close to apical system. Peripetalous fasciole curves in between petals. Small subanal fasciole present. Plastron narrow and labrum projecting only slightly across peristome, which is set about one-quarter test length from anterior border.

*Horizons.* This species has also been found in the Peterborough Member of the Port Campbell Limestone and in the Morgan Limestone (which is slightly older than the Port Campbell Limestone) in the river cliffs of the Murray River, near Morgan in South Australia.

*Remarks.* The strongly curving petals that form a sweeping arc are the most characteristic feature of this species. This is the youngest of three Australian fossil species of *Brissopsis* (McNamara *et al.* 1986). Differences between the species are relatively slight, but involve differences in degree of divergence of petals, depth of petals and ambulacrum III and shape of the labrum.

#### Genus *Eupatagus*

*Eupatagus anomalus* (Duncan 1877) (Fig. 4 A,B)

*Description.* Relatively large species of *Eupatagus*, up to 75 mm in length, with flattened test. Apical system with four genital pores and situated anterior of centre. Petals broad, not sunken, but tapering. Ambulacrum III and anterior notch very shallow. Thin peripetalous fasciole demarcates area of dorsal surface

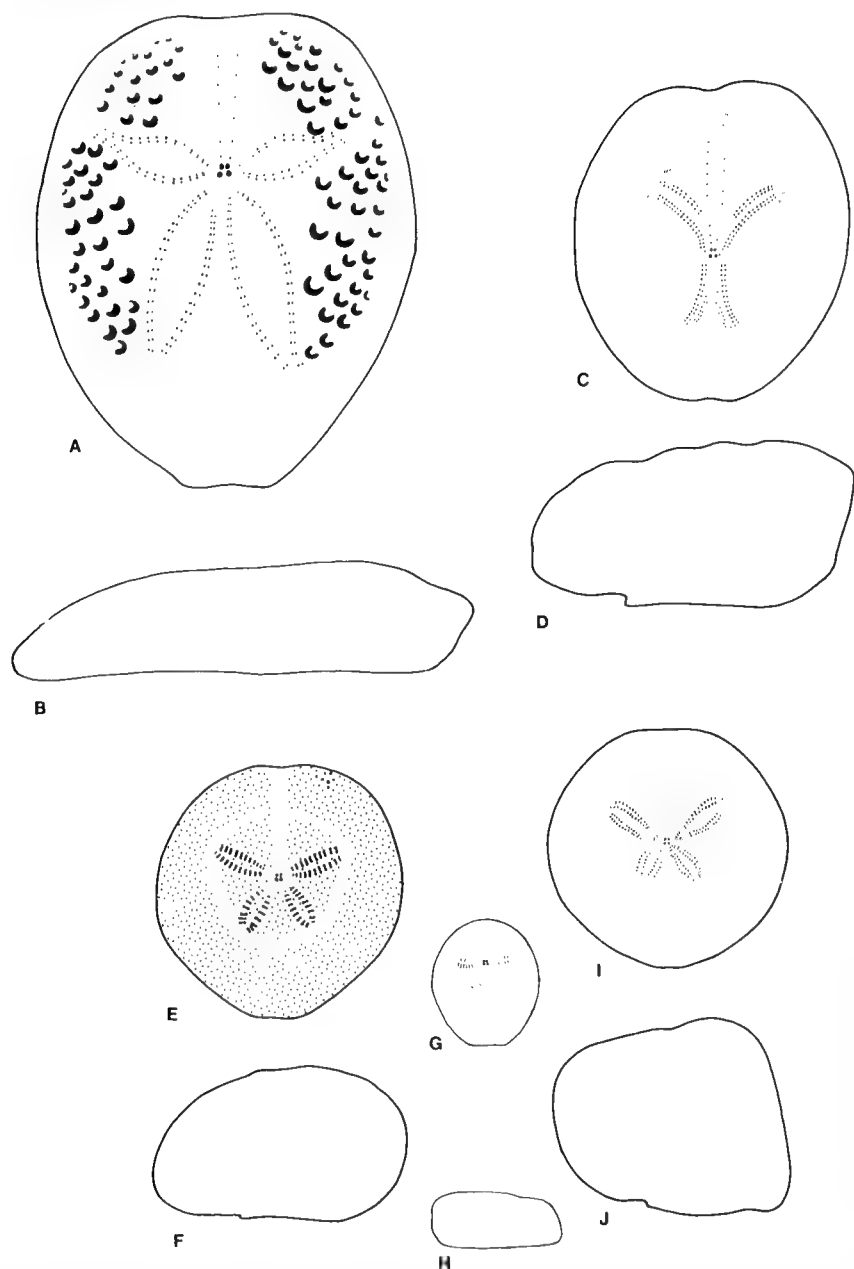


Fig. 4. A, dorsal view, B, side view of *Eupatagus anomalus* (Duncan, 1877); C, dorsal view, D, side view of *Brissopsis tatei* Hall, 1907; E, dorsal view, F, side view of *Spatagobrissus laubei* (Duncan, 1877); G, dorsal view, H, side view of *Peraspatus depressus* Philip and Foster, 1971; I, dorsal view, J, side view of *Hemiaster (Bolbaster) callidus* McNamara, 1987; all  $\times 1$ .

## Contributions

of test covered by large, primary tubercles. Ventral surface flat, with small plastron and broad, adjacent untuberculated areas. Subanal fasciole present.

**Horizons.** In addition to its occurrence in the Rutledge Marl, this species is also known from slightly younger strata at Beaumaris, Victoria, where it occurs in the Black Rock Sandstone (Kruse and Philip 1985).

**Remarks.** *Eupatagus anomalus* can be distinguished from all the other Rutledge Marl echinoids by its possession of large tubercles in the area of the test between the peripetalous fasciole and the petals, and by its broad, but not sunken, petals. *Eupatagus* is probably the commonest, most widespread genus to occur in Tertiary rocks in Australia, eight species in all having been recognised (Kruse and Philip 1985). *E. anomalus* differs from all the others in its large size, flat test, combined with the large number of primary tubercles, and very broad petals.

### Genus *Spatagobrissus*

*Spatagobrissus laubei* (Duncan 1877) (Fig. 4 E,F)

**Description.** Small, globose echinoid, less than 50 mm in length. Apical system with four genital pores, situated slightly anterior of centre. Petals, short, straight not sunken. Ambulacrum III not sunken. No anterior notch. Test entirely covered by small primary tubercles. Peripetalous fasciole circular in outline. Peristome and plastron small. Subanal fasciole narrow.

**Horizon.** In addition to its occurrence in the Rutledge Marl, this species also occurs rarely in the Peterborough Member of the Port Campbell Limestone.

**Remarks.** *Spatagobrissus laubei* can be distinguished from all other Rutledge Marl echinoids by its densely tuberculate, globose test, combined with short, straight petals that are not sunken, and narrow, circular peripetalous fasciole. Prior to the assignment of this species to *Spatagobrissus* by McNamara *et al.* (1986) the genus had only been known from a single, living species from the western Indian Ocean (Mortensen 1951).

### Family Spatangidae

#### Genus *Peraspatangus*

*Peraspatangus depressus* Philip and Foster 1971 (Fig. 4 G,H)

**Description.** Test small (15 mm long), ovate, with no anterior notch. Ambulacral petals not sunken and poorly defined, with few pore pairs; none near apical system. Apical system anterior of centre. Some specimens, interpreted as female, have a broad shallow depression, known as a marsupium, in the centre of the dorsal surface of the test. On ventral surface peristome with well-defined labrum; peristome set only a little anterior of centre. Subanal fasciole present.

**Horizon.** This species is only known from the Rutledge Marl.

**Remarks.** The marsupium possessed by this echinoid indicates that it was a direct developer. In other words, instead of eggs being released into the water to be fertilized, the echinoid exuded large, yolky eggs into this depression on its upper surface, where they were fertilized *in situ*. The young echinoids would then have been brooded in this marsupium until they were large enough to fend for themselves. Today such marsupiate echinoids are known mainly from cold, Antarctic waters. *P. depressus* probably represents the youngest marsupiate echinoid preserved in Australia's fossil record. In its small size, weakly developed petals and presence of a marsupium in the females it cannot be confused with any other echinoid from the Rutledge Marl.

### Palaeoecology of the Rutledge Marl echinoids

Of the seven genera of heart urchins that occur in the Middle Miocene Rutledge Marl, all, except *Peraspatangus*, are still living today. Of these living forms, all, except *Spatagobrissus*, are found in the seas around Australia. What is known about the ecology of each of these genera varies considerably. For some we know the type of sediment into which they burrow; the depth to which they burrow in the

sediment; the depth of water they inhabit; how they feed; how they respire; and so on. For others our knowledge of their life habits is poorly known, and so interpretations of the life styles of their fossil representatives are based on analyses of the nature of their morphologies, and interpretations of their functions. By using the information gleaned from living species, combined with morphological details, and sediment characteristics, it is possible to build up a picture of the depth in the sediment to which the various species burrowed.

On a broad scale, one can see that species lacking large spines and possessing only a dense array of fine spines were relatively deep burrowers, whereas those with large dorsal spines were shallow or non-burrowers, the spines serving a defensive role. In both cases the adaptation was one of defence from predators: the burrowers by seeking a refuge in the sediment, the spinose forms by the development of primary defensive structures, notably the large spines. The depth of the petals and the width of the fasciole are morphological characters that enable us to interpret the depth of burial of the various heart urchin species. Generally speaking, the deeper the petals and the broader the fascioles, the deeper the urchins burrowed.

The deepest burrower was probably *Hemiaster callidus* (Fig. 5G). McNamara (1987) has suggested that it burrowed to a depth similar to that of living species of *Hemiaster*. The living species *Hemiaster expergitus* Lovén from the Atlantic Ocean is known to burrow to a depth of about 12 cm in mud, in water depths between 950 m and 3200 m (Gage *et al.* 1985). Compared with its ancestral form in Australia that inhabited coarser grained sediment (McNamara 1987), *H. callidus* has deeper petals and a broader fasciole. Almost certainly *H. callidus* would have built a funnel to form a connection to the sediment-water interface.

The burrowing behaviour of living

species of *Brissopsis* has been studied in some detail by Chesher (1968). He found that *Brissopsis alta* inhabits muddy sediments and burrows to such a depth that its dorsal surface is about 5 cm below the sediment surface. A funnel connects the echinoid to the surface. Morphologically *B. alta* is very similar to the Rutledge Marl *Brissopsis tatei*, indicating that this fossil species burrowed to a similar depth in the sediment (Fig. 5D). Living species, such as *B. alta*, have been collected from depths between 90 and 310 (Chesher 1968).

Species of *Schizaster* are also known to be adapted to living in muddy sediment (McNamara and Philip 1980a,b). An Australian species of *Schizaster*, *S. (Ova) myorensis* McNamara and Philip, has been found living in burrows up to 10 cm below the sediment surface. The deep petals, ambulacrum III and anterior notch possessed by *Schizaster sphenoides* from the Rutledge Marl are all adaptations to inhabiting relatively deep burrows in mud (Fig. 5F), as they optimise the flow of water that comes down the funnel and flows over the echinoid's test. Living species of *Schizaster* have been collected from water depths between the littoral zone and 365 m (Mortensen 1951).

While species of *Pericosmus* have been found living in muddy sediment in water depths between 200 m and 420 m off the north-west Australian coast (McNamara 1984), no information is available concerning the depth to which species in this genus burrow. However, as the pore pairs in ambulacrum III are characteristically very small, and quite unlike those found in spatangoids that are mucus-secreting and used in funnel building (Smith 1980), it is unlikely that species of *Pericosmus* burrowed to any appreciable depth (Fig. 5C). The presence of both a marginal and peripetalous fasciole indicates that it did burrow, but probably to only just below the sediment surface.

Again, nothing is known of the depth to which *Eupatagus* burrows. However,

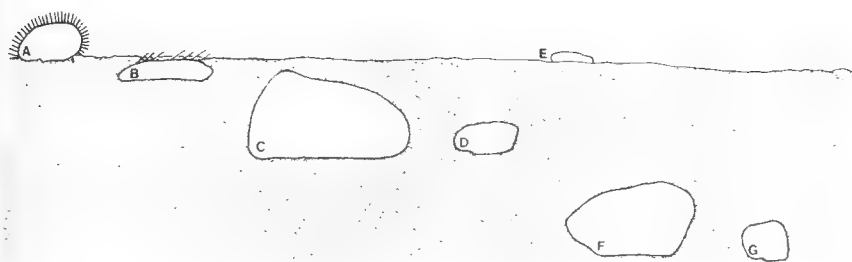


Fig. 5. Variations in depth of burrowing in the Rutledge Marl echinoids: A, *Spatagobrissus laubei*; B, *Eupatagus anomalus*; C, *Pericosmus quasimodo*; D, *Brissopsis tatei*; E, *Peraspatagus depressus*; F, *Schizaster sphenoides*; G, *Hemiaster (Bolbaster) callidus*.

closely related genera, such as *Lovenia* and *Breynia*, that also have primary spines on the dorsal surface of the test, do not burrow any deeper than just below the surface of the sediment (Ferber and Lawrence 1976). It can be presumed that *Eupatagus anomalus* was likewise a shallow burrower (Fig. 5B). The only species of this genus still living around Australia, *Eupatagus valenciennesi* Agassiz, is a relatively shallow water inhabitant, occurring between about 10 and 65 m (Mortensen 1951).

Nothing is known of the life habits of *Spatagobrissus*. However, it is similar in morphology to a number of outer shelf echinoids, such as *Linopneustes* and *Heterobrissus*. These forms have reverted to the possession of a complete covering of primary spines. *Linopneustes* is known to live fully exposed on muddy substrates (Ohta 1983). The complete covering of *Spatagobrissus* with relatively large tubercles, which support large, defensive spines, argues that this genus may not burrow into the sediment, or if it does it was unlikely to burrow completely (Fig. 5A).

In order to assess the life habits of the extinct *Peraspatagus*, it is likewise necessary to interpret the functional significance of its morphological features. In lacking an anterior notch, sunken petals and a peripetalous fasciole *Peraspatagus* is unlikely to have burrowed in the sediment at all (Fig. 5E). This is supported by the fact that it was a marsupiate echinoid.

Thus, on the basis of a combination of a comparison with living genera and assessment of morphological characters, it is proposed that the seven Rutledge Marl echinoids existed in 4 depth zones (Fig. 5):

1. Surface dwellers.  
*Spatagobrissus*, *Peraspatagus*  
(Fig. 5A,E);
2. Shallow burrower:  
*Eupatagus* (Fig. 5B);
3. Moderate burrowers:  
*Pericosmus*, *Brissopsis* (Fig. 5C,D);
4. Deep burrowers:  
*Schizaster*, *Hemiaster* (Fig. 5F,G).

**Table 1.** Distribution of echinoid species in the Rutledge Marl and the Peterborough Member of the Port Campbell Limestone

Species	Rutledge Marl	Peterborough Mbr
<i>Hemiaster callidus</i>	X	
<i>Pericosmus quasimodo</i>	X	X
<i>Schizaster sphenoides</i>	X	
<i>Brissopsis tatei</i>	X	X
<i>Eupatagus anomalus</i>	X	
<i>Spatagobrissus laubei</i>	X	X
<i>Peraspatagus depressus</i>	X	
<i>Lovenia</i> sp. nov.		X
<i>Amoraster paucituberculata</i>		X

It is interesting to see that in the reconstruction of burial depths (Fig. 5), although *Pericosmus* and *Brissopsis* have their dorsal surfaces at quite different depths below the sediment-water interface, because of their different body sizes their ventral surfaces (and thus depth in the sediment at which they feed) are at similar depths (about 8 cm). Similarly for *Schizaster* and *Hemiaster*, which both have their ventral surfaces about 15 cm below the sediment surface.

The Rutledge Marl, because of the characteristic fine-grained nature of the sediment and its fauna, is likely to represent deposition on the middle to outer shelf, perhaps at depths of between about 200 m and 300 m. Compared with the Peterborough Member of the Port Campbell Limestone, which is a coarser-grained calcarenite unit that was probably deposited in shallower water, the Rutledge

Marl echinoid fauna shows some distinctive differences. *Eupatagus*, *Schizaster*, *Hemiaster* and *Peraspatangus* are all confined to the Rutledge Marl (Table 1). *Pericosmus* and *Brissopsis* also occur in the Peterborough Member, while *Spatagobrissus*, a common element of the Rutledge Marl, occurs only rarely in the Peterborough Member. In contrast, *Lovenia* and *Amoraster* (McNamara and Ah Yee 1989) are confined to the Peterborough Member of the Port Campbell Limestone.

#### Acknowledgements

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## Dorrigo Daisybush, *Olearia flocktoniae*, re-discovered D. J. Murray\*

In their review of extinct and endangered plants in Australia, Leigh, Boden and Briggs (1983) list the Dorriggo Daisybush *Olearia flocktoniae*, family Asteraceae as extinct (status 2X). Of the 279 species discussed in this book, the Dorriggo Daisybush is the only one where "forestry" is listed as a cause of extinction, with agricultural clearing also regarded as having contributed to its demise (though in another 19 cases forestry is thought to have contributed to the current status of endangered species).

Dorrigo Daisybush was first collected in 1909 by J. Boorman about 3 km east of Dorriggo. It was found in clearings in rainforest dominated by Antarctic Beech (*Nothofagus moorei*), created either by logging or following land clearing for agriculture. It was named *Olearia flocktoniae* in honour of Margaret Lillian Flockton (1862-1953), a botanical artist who worked for more than 40 years on the staff of what is now the National Herbarium of the Royal Botanical Gardens, Sydney. The plant was collected a number of times in the same general area between 1909 and 1916 but not subsequently, so that more than 60 years later Leigh *et al* could justifiably comment "The species now appears to be extinct".

However in April 1984 Dr J.B. Williams, of the University of New England's Botany Department, found Dorriggo Daisybush growing adjacent to the Dorriggo-Coramba Road near Coopernook Creek, about 21 kilometres northeast of Dorriggo. About 20 plants, with abundant white flowers, were noted growing in a small cleared area adjacent to the road. This area had been cleared in the warm temperate rainforest by earth-

moving machinery in order to improve visibility for traffic.

Early in 1987 members of the Coffs Harbour Ulitarra Society found a second viable population of the Dorriggo Daisybush in, of all places, a quarry on Wild Cattle Creek State Forest near the Bobo River, approximately 8 kilometres north of the 1984 finding. This population has been monitored since the first sighting and plants have been observed in flower, bearing seed and young seedlings have developed. Following this finding the secretary of the Society, M. Lamont, described the species as a "remarkably inefficient opportunistic species which needs recently disturbed soil".

During the remainder of 1987, Dorriggo Daisybush was found at three other locations, all several kilometres apart, within State Forest. The environment at all three sites had been manipulated by routine forest operations: two sites involved roadside disturbance as a result of road grading, while the third site was within an area where Brush Box (*Lophostemon confertus*) trees had been harvested adjacent to a rainforest fringe. The distance between localities suggests that sites suitable for the plant may be relatively widespread, requiring some disturbance for regeneration of the species.

The plant grows as a non-woody shrub, reaching a height of 2 metres. It usually has a number of stems arising from near the base. Leaves are slender, about 5 mm wide and 50 to 100 mm long with a prominent mid rib, petals are predominantly white although lightly tinged with purple. The fruit is the typical one-seeded cypsella of the family; it is silky, small, and surmounted by a bristly pappus of about equal length. The longevity of the seed,

\* Forestry Commission of N.S.W., Dorriggo

and its capacity for storage in the soil, are not known, but would appear to be topics worthy of some investigation.

The initial re-discovery site was recently revisited after 4 years, and the site had been taken over by Callicoma (*Callicoma serratifolia*) and Tickbush (*Helichrysum diosmifolium*), suggesting that the Daisybush is relatively shortlived, occupying suitable sites after disturbance of the soil but disappearing after 2 to 3 years.

It is now apparent that Dorrigo Daisybush, which has been dubbed locally the "Lazarus Daisybush" (having come back from extinction), requires disturbed sites to survive: in fact forest activities, far from being a cause of its extinction, would seem to have assisted in the survival of the species. It also seems likely that, had it not been for the exposure given to *Olearia flocktoniae* by Leigh *et al*, the correct status of this undoubtedly rare plant would still not be known. The life history of this species is currently the subject of a research study by the Forestry Commission of N.S.W.

## Reference

Leigh, J, Boden, R and Briggs, J. (1983). *Extinct and Endangered Plants of Australia*. (Macmillan: Melbourne).

## EDITORIAL POLICY

### Title

*The Victorian Naturalist* is the bi-monthly publication of the Field Naturalists Club of Victoria.

### Scope

*The Victorian Naturalist* publishes articles on all facets of natural history. Its primary aims are to stimulate interest in natural history and to encourage the publication of articles in both formal and informal styles on a wide range of natural history topics.

### Research

A succinct and original scientific communication. Preference is given to reports on topics of general interest.

### Contributions

Contributions may consist of reports, comments, observations, survey results, bibliographies or other material relating to natural history. The scope is broad and little defined to encourage material on a wide range of topics and in a range of styles. This allows inclusion of material that makes a contribution to our knowledge of natural history but for which the traditional format of scientific papers is not appropriate.

### Naturalist Notes

Short and informal natural history communications. These may include reports on excursions and talks.

### Commentary

Informative articles that provide an up-to-date overview of contemporary issues relating to natural history. Whilst commentary articles are invited, the editors welcome discussion of topics to be considered for future issues.

### Book Reviews

Priority is given to major Australian publications on all facets of natural history. Whilst reviews are commissioned, the editors welcome suggestions of books to be considered for review.

### News

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### Diary

Notice of coming events including activities of FNCV groups and any other activities of interest to *Vic. Nat.* readers.

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## Abbreviations and Units

SI units (metre, kilogram, etc.) should be used wherever possible. Statistics and measurements should be given in figures (i.e. 10 mm) except where the number begins a sentence. When a number does not refer to a unit of measurement it is spelt out, unless the number is greater than nine. The word 'figure' should be abbreviated to Fig. unless starting a sentence.

## Tables and Figures

All illustrations (including photographs) are considered as figures. All figures should be referred to in the text. Original figures or high quality photographic copies should be provided with the manuscript. Each figure should bear the figure number and author's name on the back in pencil. Line drawings should be in black Indian ink on stout white paper or high quality tracing paper. Lettering should be added bearing in mind legibility after reduction. Bar scales are preferred to numerical scales. Figure captions should be numbered consecutively (Fig. 1, Fig. 2, etc.) and provided on a separate page at the end of the manuscript.

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Gill, A. M. (1981). Adaptive responses of Australian vascular plant species. In 'Fire and the Australian Biota'. Eds A. M. Gill, R. H. Groves and T. R. Noble, pp. 243-72. (Australian Academy of Science: Canberra).

Leigh, J., Boden, R. and Briggs, J. (1984). 'Extinct and Endangered plants of Australia'. (MacMillan: Australia).

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A research report is a succinct, formal, original scientific communication. Preference will be given to reports that make a significant contribution to natural history literature and are of general appeal. The manuscript should consist of an abstract not exceeding 250 words, an introduction, methods, results, discussion, acknowledgements and references.

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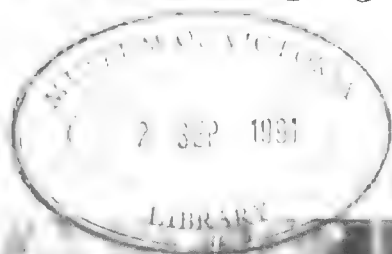
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# The Victorian Naturalist

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# CALENDAR OF CLUB ACTIVITIES

NOTE: All meetings are held at the Herbarium at 8pm, except the Microscopy Group, which meets at the Astronomer's Residence.

## August

- Sun 4 General Excursion. Cape Schanck.  
Leave from Batman Avenue at 9 am Birds, botany and geology.
- Tues 6 Fauna Survey Group – To be announced.
- Wed 7 Geology Group – “Victorian Volcanoes – After and Before” Dr Chris Gray.
- Thurs 8 Botany Group – “Reproductive Biology of Orchids” Malcolm Calder.
- Sun 11 Geology Excursion – Contact Graham Love.
- Mon 12 General Meeting – “The Sky at Night” Norman Plever.
- Sat 17 Fauna Survey Group – Frog Census: Eastern Otway Ranges. (Contact: 481 4926 or 419 0752).
- Sun 18 481 4926 or 419 0752).
- Wed 21 Microscopy Group – “Video and the Microscope”.
- Sat 24 Botany Excursion – 10.30am. Wattles at 100 Acres, leader Cecily Falkingham, Melways 35 F10.

## September

- Sun 1 General Excursion – Hosted by the Fauna Survey Group – Royal Zoological Gardens – meet at Education Centre at 11am where we will be addressed by the Curators of the Butterfly House and the Reptile House. No bus, ring 617 0900 for information on public transport times.
- Tues 3 Fauna Survey Group – To be announced.
- Wed 4 Geology Group meeting. Speaker: Dr Gordon Samson. Kangaroos and Diet. A study on the evolution of form and function.
- Sun 8 Geology Excursion – Contact Graham Love.
- Mon 9 General Meeting – “Nature Photography” Wendy Clark and Arthur Farnworth.
- Thurs 12 Botany Group – “Biology and Conservation of Spider Orchids” Geoff Carr.
- Wed 18 Microscopy Group – Address by Mr Slocum. Title to be announced.
- Sat 28 Botany Excursion – 10am Courtney's Road, leaders: Ilma Dunn and Hillary Weatherhead. Melways 84 E6.

## October

- Tues 1 Fauna Survey Group – To be announced.
- Wed 2 Geology Group – “New Work on Permian Faunas from Australia and Asia” Neil Archbold.
- Sun 6 General Excursion – Hosted by Geology Group to Mt ?ooyoora, near Inglewood, by bus.
- Thu 10 Botany Group – To be announced.
- Sun 13 Geology Excursion – contact Graham Love.
- Mon 14 General Meeting – To be announced.
- Wed 16 Microscopy Group – “Pathology” Brian Waldron.
- Sat 26 Botany Excursion – Orchids at Anglesea with Mary White.

# The Victorian Naturalist

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Editor: Robyn Watson

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*Cover photo: Diuri's fragrantissima, Sunshine Diuris, an endangered plant endemic to the basalt plains near Melbourne. The latest recommendations for the Flora and Fauna Guarantee Act are on p.39. Photo, courtesy of Doug Frood.*

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# Changes in bird abundance between summer and autumn in East Gippsland montane forests.

Doug Robinson\*

## Introduction

Many fauna surveys conducted in south eastern Australia allude to seasonal changes in bird species composition and abundance at particular sites (Chesterfield *et al.* 1983; Carr *et al.* 1984; Horrocks *et al.* 1984; Opie *et al.* 1984; Chesterfield *et al.* 1988; Henry *et al.* 1988)), but few actually document the extent of the changes, or which species move. Notable exceptions have been studies of bird dispersal in eucalypt forest in the Brindabella Range (Lamm and Wilson 1966; Tidemann *et al.* 1988), population studies in open forest on the Southern Tablelands of New South Wales (Recher *et al.* 1983; Recher and Holmes 1985), and studies of bird populations in Mountain Ash (*Eucalyptus regnans*) forest (Loyn 1985a).

Each of these studies showed that approximately 50% of the breeding bird community was absent in winter. Species which migrated were aerial insectivores, insectivores that fed on foliage-dwelling arthropods and several honeyeaters. Species which stayed included birds that fed on ground-dwelling invertebrates, birds that fed on bark substrates of trees and wattles, and some nectarivores. Winter influxes of some of these latter species were recorded from each study site.

These studies all were done at altitudes of 600 to 1000 m above sea level. During the course of other work, the opportunity was taken to supplement their findings by conducting surveys of birds in montane and wet sclerophyll forests at similar or higher altitude, in a different region of southeastern Australia.

## Study area and methods

The study area forms the northern portion of the Goolengook Forest Block in Victoria, and is located approximately 55 km northeast of Orbost, in East Gippsland. It lies below the southern edge of the Errinundra Plateau and was surveyed in January and February, 1989. Repeat censuses were performed at 13 of the summer bird census sites in early May, 1989.

Unmarked strip-transects of variable length and width were sampled over a 20 minute period, during which all birds seen or heard within the prescribed area were recorded. Birds flying through or over the transect were not recorded, with the exception of raptors and aerial feeders. The width of transects varied between 25 and 50 m either side of the transect line, depending on the density of surrounding vegetation. The length of transects varied between 200 and 600 m. Knowing these values, bird numbers were later converted to numbers/ha. Censuses were done mostly in the morning and late afternoon.

Census sites were categorized by altitude (above or below 800 m) and vegetation community. Communities were defined according to the classification of vegetation communities for the block (Lobert *et al.* in prep.). Vegetation communities sampled were Montane Sclerophyll Forest, Wet Sclerophyll Forest and Damp Sclerophyll Forest. Montane Sclerophyll Forest was characterized by the presence of *Eucalyptus nitens*. Wet Sclerophyll Forest and Damp Sclerophyll Forest were characterized by *E. fastigata*, *E. obliqua* and *E. cypellocarpa*. These latter two communities are considered together here as Wet Sclerophyll Forest.

Data were tested by Welch's t-test (Ferguson 1976), which adjusts degrees

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of freedom to compensate for unequal variances between two samples. Because the surveys in May were done incidentally to other work, the results presented here should only be considered as preliminary. More extensive surveys are needed to corroborate some of the patterns reported below.

## Results

An average of 16 species was recorded from each census site in summer, and 13 species from the same sites in May (Table 1). Average bird densities decreased from 22 birds/ha in summer to 18 birds/ha in May. These seasonal differences in bird abundance and species' densities were most marked in Montane Forest and at higher altitudes (Table 1). No overall differences were apparent at lower altitudes or in Wet Sclerophyll Forests. Nonetheless, significant seasonal changes in abundance were recorded for individual bird species from each vegetation community and altitude class.

Altogether, 41 species of bird were recorded from the study area in summer, 31 (76%) of which were recorded in May (Table 2). Eight species were reported significantly more often in summer than May, notably: Eastern Yellow Robin ( $P < 0.05$ ), Black-faced Monarch ( $P < 0.01$ ), Rufous Fantail ( $P < 0.01$ ), Grey Fantail ( $P < 0.05$ ), Pilotbird ( $P < 0.01$ ), Crescent Honeyeater ( $P < 0.05$ ), Eastern Spinebill ( $P < 0.05$ ) and Silvereye ( $P < 0.01$ ) (Table 2). A further eight species were reported more often or only in summer. These comprised: Gang-gang Cockatoo, Fan-tailed Cuckoo, Shining Bronze-Cuckoo, White's Thrush, Rose Robin, Flame Robin, New Holland Honeyeater and Satin Bowerbird (Table 2).

Five other species conversely were recorded more often in May than summer. These comprised: Yellow-faced Honeyeater ( $P < 0.05$ ), White-

eared Honeyeater ( $P < 0.01$ ), White-naped Honeyeater ( $P < 0.05$ ), Spotted Pardalote ( $P < 0.001$ ) and Striated Pardalote ( $P < 0.01$ ). Laughing Kookaburra, Superb Fairy-wren, White-eared Honeyeater, White-naped Honeyeater and Striated Pardalote were recorded from the study area only in May (Table 2).

In addition to such large-scale, seasonal changes in individual species' densities, some other species showed local changes in density within a vegetation community or altitude class. For example, Pink Robins ( $P < 0.05$ ) and Brown Thornbills ( $P < 0.05$ ) were recorded significantly more often in Montane Forest in summer than May. Neither species showed any significant change in abundance in Wet Sclerophyll Forest between summer and May. Nevertheless, it is noteworthy that four Pink Robins were recorded from ridge-line Wet Sclerophyll Forest in May, but none in summer. Two other rainforest species, Olive Whistler and Large-billed Scrubwren, similarly were recorded from ridgeline Wet Sclerophyll Forest only in May. The Brown Gerygone, another rainforest species, was recorded more often from lower altitudes in May than summer ( $P < 0.10$ ).

Golden Whistlers likewise appeared to show some local movements to lower altitudes in May. They were recorded more often below 800 m than above 800 m in May ( $P < 0.10$ ), whereas they showed no altitudinal difference in abundance in summer. By contrast, Pied Currawongs became more abundant in the study area in May, particularly in Montane Forest ( $P < 0.10$ ). They showed no changes in abundance at lower altitudes or in Wet Sclerophyll Forest.

## Discussion

Results from this study were similar to those obtained from other forest bird communities in southeastern Australia

**Table 1.** Overall densities ( $\bar{x}/\text{ha} \pm \text{s.d.}$ ) of species and individuals recorded from the study area in February and May. Habitat and altitude classes are defined in Methods. Sample sizes are given in brackets.

	February	May	P
Pooled (13)			
No. of species	16.2 $\pm$ 3.0	14.2 $\pm$ 3.2	< 0.05
No. of individuals/ha	21.9 $\pm$ 8.3	17.5 $\pm$ 6.1	n.s.
Above 800 m (7)			
No. of species	16.4 $\pm$ 3.5	13.1 $\pm$ 2.3	< 0.10
No. of individuals	22.2 $\pm$ 10.5	15.7 $\pm$ 4.1	n.s.
Below 800 m (6)			
No. of species	16.0 $\pm$ 2.8	15.0 $\pm$ 4.1	n.s.
No. of individuals	21.4 $\pm$ 5.7	19.6 $\pm$ 7.7	n.s.
Montane Forest (6)			
No. of species	17.7 $\pm$ 3.3	12.7 $\pm$ 2.9	< 0.05
No. of individuals	24.0 $\pm$ 9.3	13.7 $\pm$ 3.7	< 0.05
Wet Sclerophyll Forest (7)			
No. of species	15.0 $\pm$ 2.3	15.1 $\pm$ 3.3	n.s.
No. of individuals	20.0 $\pm$ 7.5	20.8 $\pm$ 6.0	n.s.

(Lamm and Wilson 1966; Recher *et al.* 1983; Loyn 1985a; Tidemann *et al.* 1988). Many species present during the summer had migrated or dispersed from the study area by early May. A further group of species such as the pardalotes, Yellow-faced Honeyeater, White-naped Honeyeater and Pied Currawong appeared to be passage migrants through the study area in May (cf. Lamm and Wilson 1966; Recher *et al.* 1983; Tidemann *et al.* 1988). Some other species remained in the study area but appeared to move into different habitats, for example Pink Robin, Golden Whistler, Olive Whistler, Brown Gerygone and Large-billed Scrubwren.

Summer migrants notably included foliage-snatching and hawking insectivores such as the cuckoos, Rose Robin, Black-faced Monarch, Grey Fantail and Rufous Fantail. Gang-gang Cockatoos also appeared to be summer visitors to the area, especially to sites above 800 m.

Lamm and Wilson (1966) similarly found Gang-gang Cockatoos to be a summer migrant to their study site in the Brindabella Ranges, ACT, and it is probable Gang-gang Cockatoos in Goolengook Forest Block dispersed to lower altitudes in winter in search of food (Emison *et al.* 1987; Recher *et al.* 1987).

The three species of honeyeater found to be significantly more common in summer presumably also had to disperse from higher altitudes once their food resources disappeared there. New Holland Honeyeater, Crescent Honeyeater and Eastern Spinebill are nectarivores. During the summer surveys, they were recorded feeding on flowering mistletoe on mature *E. nitens*, and on flowers of *Correa lawrenciana*. However, these plants had finished flowering by early May, and no other plants were recorded flowering then. The honeyeaters hence had dis-

appeared. One further species, Australian King-Parrot, also foraged on the flowering mistletoe and subsequently became less common in May. Possibly, it dispersed to lower altitudes (Emison *et al.* 1987).

Several other species of honeyeater became more abundant in the study area during May. The influx of Yellow-faced and White-naped Honeyeaters into the area was probably part of a more-extensive, annual migration northwards (Lamm and Wilson 1966; Keast 1968), and individuals probably did not remain long. Similar autumn influxes of White-naped and Yellow-faced Honeyeaters have been recorded at high altitudes in other forests (Loyn 1985a; Recher and Holmes 1985; Tidemann *et al.* 1988). The influx of White-eared Honeyeaters may have been related to seasonal availability of a carbohydrate resource. White-eared Honeyeaters forage extensively on carbohydrates and invertebrates deposited behind peeling bark (Recher and Holmes 1985), a food resource that becomes accessible in autumn as eucalypts shed their bark (Recher and Holmes 1985; Kavanagh 1987). Thus, White-eared Honeyeaters were recorded foraging on the bark of *E. nitens* and *E. cypellocarpa* in May. Two other bird species recorded more often in May than summer - Grey Shrike-thrush and Pied Currawong - also were recorded foraging on the peeling bark of *E. nitens*.

Overall, results from this study appeared to show less seasonal variation in bird species' densities than reported from other mountain-forest sites (Recher *et al.* 1983; Loyn 1985a). This difference partly may have been due to the comparatively large proportion of fruiting plants at the Goolengook site (Lobert *et al.* in prep.). It probably was also due to the brevity of the summer/autumn surveys, small sample sizes and comparison of summer/autumn counts rather than summer/winter ones. None-

theless, it is clear that many species (24% of those recorded in summer) departed from the study area for the non-breeding season and that other species showed smaller, more local movements.

Appropriate management of native forests needs integration of wildlife conservation and timber harvesting demands (Loyn 1985b; Recher *et al.* 1987; State Conservation Strategy 1987). This requires knowledge of resources and habitats needed by wildlife in different seasons. Sadly, though, recommendations for wildlife conservation have too often been based on brief surveys done in a single season (see references in Introduction). Results from this and other studies of forest bird communities in southeastern Australia (Lamm and Wilson 1966; Recher *et al.* 1983; Loyn 1985a; Tidemann *et al.* 1988) indicate, however, that: (1) many birds disperse seasonally between different habitats; (2) seasonal movements may be on a local or long-distance scale; and (3) the fauna of a particular vegetation community changes through the year as some species emigrate and others immigrate.

It is essential that forest managers recognize these seasonal changes in bird species' distributions and respond to migratory species' conservation needs. Forest management plans should provide for retention of large, interlinked forest patches through the State Forest system. They should provide for habitat continuity on a local and long-distance scale (Recher *et al.* 1987; Recher and Lim 1990). More specifically, research is needed on the feeding ecology and dispersal patterns of forest migrants - for example of Yellow-tailed Black-Cockatoo, Gang-gang Cockatoo, Australian King-Parrot, honeyeaters and bark-feeding birds. Without such information, and without continuity and protection of native vegetation, populations of forest migrants may

soon disappear (Lynch 1987; Recher and Lim 1990).

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**Table 2.** Mean densities of individual species recorded from the study area in February and May ( $\bar{x}/\text{ha} \pm \text{s.d.}$ ).  $N = 13$  for both seasons' data.

Common Name	Scientific Name	Density ( $\bar{x}/\text{ha} \pm \text{s.d.}$ )	
		February	May
Brush Bronzewing	<i>Phaps elegans</i>	0.08 $\pm$ 0.28	0.08 $\pm$ 0.28
Yellow-tailed Black-Cockatoo	<i>Calyptorhynchus funereus</i>	0.04 $\pm$ 0.14	0.15 $\pm$ 0.38
Gang-gang Cockatoo	<i>Callocephalon fimbriatum</i>	0.12 $\pm$ 0.30	0.00 $\pm$ 0.00
Australian King-Parrot	<i>Alisterus scapularis</i>	0.46 $\pm$ 1.03	0.06 $\pm$ 0.16
Crimson Rosella	<i>Platycercus elegans</i>	0.85 $\pm$ 0.72	0.56 $\pm$ 0.61
Fan-tailed Cuckoo	<i>Cuculus pyrrhophanus</i>	0.04 $\pm$ 0.14	0.00 $\pm$ 0.00
Shining Bronze-Cuckoo	<i>Chrysococcyx lucidus</i>	0.08 $\pm$ 0.28	0.00 $\pm$ 0.00
Laughing Kookaburra	<i>Dacelo novaeguineae</i>	0.00 $\pm$ 0.00	0.15 $\pm$ 0.38
Superb Lyrebird	<i>Menura novaehollandiae</i>	0.27 $\pm$ 0.33	0.49 $\pm$ 0.71
Black-faced Cuckoo-shrike	<i>Coracina novaehollandiae</i>	0.02 $\pm$ 0.08	0.08 $\pm$ 0.19
White's Thrush	<i>Zoothera dauma</i>	0.19 $\pm$ 0.33	0.00 $\pm$ 0.00
Rose Robin	<i>Petroica rosea</i>	0.15 $\pm$ 0.38	0.00 $\pm$ 0.00
Pink Robin	<i>Petroica rodinogaster</i>	0.27 $\pm$ 0.44	0.12 $\pm$ 0.42
Flame Robin	<i>Petroica phoenicea</i>	0.25 $\pm$ 0.48	0.00 $\pm$ 0.00
Eastern Yellow Robin	<i>Eopsaltria australis</i>	1.10 $\pm$ 0.78	0.49 $\pm$ 0.46
Crested Shrike-tit	<i>Falcunculus frontatus</i>	0.12 $\pm$ 0.42	0.05 $\pm$ 0.19
Olive Whistler	<i>Pachycephala olivacea</i>	0.27 $\pm$ 0.60	0.08 $\pm$ 0.19
Golden Whistler	<i>Pachycephala pectoralis</i>	0.64 $\pm$ 0.72	0.29 $\pm$ 0.32
Grey Shrike-thrush	<i>Colluricincla harmonica</i>	0.15 $\pm$ 0.32	0.25 $\pm$ 0.32
Black-faced Monarch	<i>Monarcha melanopsis</i>	0.42 $\pm$ 0.40	0.00 $\pm$ 0.00
Rufous Fantail	<i>Rhipidura rufifrons</i>	0.69 $\pm$ 0.60	0.00 $\pm$ 0.00
Grey Fantail	<i>Rhipidura fuliginosa</i>	0.98 $\pm$ 1.21	0.10 $\pm$ 0.28
Eastern Whipbird	<i>Psophodes olivaceus</i>	0.23 $\pm$ 0.48	0.22 $\pm$ 0.25
Superb Fairy-wren	<i>Malurus cyaneus</i>	0.00 $\pm$ 0.00	0.36 $\pm$ 0.78
Pilotbird	<i>Pycnophilus floccosus</i>	0.60 $\pm$ 0.51	0.12 $\pm$ 0.22
Large-billed Scrubwren	<i>Sericornis magnirostris</i>	0.08 $\pm$ 0.28	0.29 $\pm$ 0.40
White-browed Scrubwren	<i>Sericornis frontalis</i>	2.27 $\pm$ 1.27	1.78 $\pm$ 0.97
Brown Gerygone	<i>Gerygone mouki</i>	0.02 $\pm$ 0.08	0.14 $\pm$ 0.22
Brown Thornbill	<i>Acanthiza pusilla</i>	2.71 $\pm$ 1.17	2.08 $\pm$ 0.86
Striated Thornbill	<i>Acanthiza lineata</i>	2.50 $\pm$ 1.00	3.11 $\pm$ 2.17
White-throated Treecreeper	<i>Climacteris leucophaea</i>	0.73 $\pm$ 0.33	0.65 $\pm$ 0.25
Red-browed Treecreeper	<i>Climacteris erythrops</i>	0.52 $\pm$ 0.62	0.27 $\pm$ 0.39
Lewin's Honeyeater	<i>Meliphaga lewinii</i>	0.12 $\pm$ 0.30	0.24 $\pm$ 0.24
Yellow-faced Honeyeater	<i>Lichenostomus chrysops</i>	0.04 $\pm$ 0.14	0.99 $\pm$ 1.18
White-eared Honeyeater	<i>Lichenostomus leucotis</i>	0.00 $\pm$ 0.00	0.22 $\pm$ 0.25
Brown-headed Honeyeater	<i>Melithreptus brevirostris</i>	0.52 $\pm$ 0.69	0.22 $\pm$ 0.38
White-naped Honeyeater	<i>Melithreptus lunatus</i>	0.00 $\pm$ 0.00	1.77 $\pm$ 2.17
Crescent Honeyeater	<i>Phylidonyris pyrrhoptera</i>	1.27 $\pm$ 1.29	0.27 $\pm$ 0.33
New Holland Honeyeater	<i>Phylidonyris novaehollandiae</i>	0.38 $\pm$ 1.39	0.00 $\pm$ 0.00
Eastern Spinebill	<i>Acanthorhynchus tenuirostris</i>	0.68 $\pm$ 0.60	0.22 $\pm$ 0.32
Mistletoebird	<i>Dicaeum hirundinaceum</i>	0.15 $\pm$ 0.32	0.27 $\pm$ 0.34
Spotted Pardalote	<i>Pardalotus punctatus</i>	0.18 $\pm$ 0.31	0.91 $\pm$ 0.59
Striated Pardalote	<i>Pardalotus striatus</i>	0.00 $\pm$ 0.00	0.35 $\pm$ 0.38
Silvereye	<i>Zosterops lateralis</i>	1.46 $\pm$ 1.49	0.60 $\pm$ 0.95
Satin Bowerbird	<i>Ptilonorhynchus violaceus</i>	0.04 $\pm$ 0.14	0.00 $\pm$ 0.00
Pied Currawong	<i>Strepera graculina</i>	0.08 $\pm$ 0.19	0.35 $\pm$ 0.99

# Comparison of the diets of foxes, dogs and cats in an urban park

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## Introduction

Predator scat analysis is a convenient method used to analyse the diets of predators. The limitations and advantages of this technique have been summarized by Brunner and Wallis (1986) who also reviewed the dietary studies that had been conducted in Australia. They found that dogs *Canis familiaris* tended to take larger prey than foxes *Vulpes vulpes* and cats *Felis catus*, but that all three species were opportunistic showing only minor selectivity in their choice of prey.

Most comparative studies of the diets of foxes, dogs and cats have been conducted in non-urban or undisturbed environments (Brunner 1978; Triggs *et al.* 1984; Brown and Triggs 1990). In this report we present data from scat analysis in a large urban park in Melbourne.

## Methods

Predator scats were collected from all parts of Dandenong Valley Metropolitan Park (DVMP), a linear reserve in Melbourne's eastern suburbs divided into fragmented areas of bushland and parkland by a network of roads, and surrounded by houses, industries, market gardens, grazing paddocks, sporting facilities and a garbage transfer station. The Park stretches for about 9 km along Dandenong Creek between Boronia Rd to the north and Wellington Rd to the south and occupies about 736 ha. The Park is managed by the Board of Works and was one of the first of its metropolitan parks to be established. This study forms part of a comprehensive vertebrate fauna survey of the Park which was undertaken by Wallis *et al.* (1990).

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Scats were mainly collected on paths and tracks. They were identified using smell, size and shape characteristics (Triggs 1984; Triggs *et al.* 1984; Lunney *et al.* 1990) and placed in small manilla envelopes on which was recorded details of predator, site and date. Since predator scat analysis was used as a vertebrate survey tool in the larger study, only scats that contained what appeared to be remains of vertebrate prey were collected. About half the dog scats encountered contained the remains of processed pet food; these scats were not collected. A few fox scats which only contained the remains of fruit were also not collected.

The scats were sterilized at 100°C for at least 24 hours to destroy parasites. They were then washed through a fine sieve into a large white tray. Presence of various food categories was then recorded.

Mammalian remains were removed, dried and identified. Skeletal remains were compared with reference collections held at Victoria College (Rusden) and hair was microscopically analysed and the mammal species identified using the keys in Brunner and Coman (1974) as well as comparing the specimens with hair from known mammals. Scat collections covered all seasons from December 1988 to October 1990.

## Results and Discussion

A total of 391 scats were analysed of which many individual scats contained a combination of mammal, bird, invertebrate and vegetation remains. The purpose of the scat collection was to provide supplementary data for the vertebrate fauna survey of DVMP, especially its mammals. Not surprisingly, therefore, mammals were the most common item in the predators' scats – hair and/ or bone occurred in 68% of all scats (see Table 1). The percentage occurrence of

**Table 1.** Food types identified from scats of foxes, dogs, cats and unknown Carnivora in the DVMP. The number is the number of scats of that predator collected and which had that particular food type; the percentage (in parenthesis) is the % this represents of the total scats collected for this predator which had identifiable foods.

PREDATOR	FOX		DOG		CAT		UNKNOWN		Total
	No.	%	No.	%	No.	%	No.	%	
FOOD TYPE									
MAMMALS	162	(75)	38	(84)	46	(54)	22	(50)	268
BIRDS	45	(21)	2	(4)	14	(16)	5	(11)	66
VEGETATION	139	(64)	28	(62)	45	(53)	22	(50)	234
OTHER	65	(30)	4	(8)	17	(20)	6	(14)	82
Number of scats	217		45		85		44		391

mammalian prey items was greatest for dogs (84% of scats) and least for unidentified predators (i.e. scats which could not be assigned to any particular predator). Remains of birds were found in 21% of fox scats, 16% of cat scats but in only 4% of dog scats. Vegetation often included just a few pieces of grass as well as blackberries, apples and other fruits. Insects were more common in fox scats than in scats of the other predator species. Other items found in the scats included the remains of lizards, molluscs and crustaceans, as well as pieces of foil, plastic and garbage. Rubbish was commonly found in DVMP alongside Dandenong Creek, especially after its frequent flooding.

Table 2 shows the specific mammals consumed by each of the three predators. Overall the most common mammal species were the Black Rat *Rattus rattus* (60 scats contained its remains), Common Ringtail Possum *Pseudocheirus peregrinus* (53), House Mouse *Mus musculus* (51), Dog *C. familiaris* (48), Common Brushtail Possum *Trichosurus vulpecula* (26) and Cattle *Bos taurus* (23).

All three predators appeared to be feeding on similar mammal species. These included Common Brushtail Possum, Black Rat, Rabbit *Oryctolagus cuniculus* and Cattle. There were, however, some notable differences in the occurrence of certain species taken by the predators; for instance, many more dog hairs were found

in dog scats (compared with fox and cat scats) suggesting that these may have been grooming hairs. Comparatively more dogs and cats than foxes consumed Common Ringtail Possums, whereas House Mouse was more common in the scats of foxes and cats. Why more Common Ringtail Possums were taken than Common Brushtail Possums may well be due to the higher abundance of ringtails relative to other possums in the area.

Twenty two fox scats contained hair from dogs. Furthermore, some dog scats contained such large quantities of dog hair that not all could have come from grooming. Two dog carcasses were found by us during the study; we believe that all three predators consumed dogs which could have died from car accidents or other causes. Cattle carcasses were also observed during our survey; there is little doubt that foxes consumed these as carrion.

Our results support the findings of other workers (e.g. Seebeck 1978; Triggs *et al.* 1984) in that smaller prey species (e.g. House Mouse, rats) were important dietary items of the fox and cat. In addition, all three species appear to be opportunistic as they take a wide range of foods depending on their availability, including carrion, rubbish, fruit and insects.

Although the consumption of birds by dogs in the Park was minimal, birds

formed an important component in the diets of both foxes and cats. Two hundred and six bird species have been recorded from DVMP, including 40 which warrant special conservation attention (Wallis *et al.* 1990). Especially important are the Park's water birds – details on the bird species taken by mammalian predators are not tabulated; however, we believe that a significant number of bird prey were aquatic species.

Well over half of the dog scats collected from the Park contained mammalian remains. The majority of these consisted of only the dog's own grooming hairs suggesting that the relative numbers of native mammalian prey taken by dogs is lower than those taken by foxes and cats. This is not to say, however, that dogs have little impact on the fauna in the Park. Of the dog scats which contained mammal remains, 21% contained Common Ringtail Possum and 5% contained Common Brushtail Possum. Also, we have often observed dogs in DVMP, many not on a leash, and several in the Conservation Areas where dogs are prohibited. Dogs can have a negative impact on native vertebrates by harassing them, and by spreading disease and odour. It is possible that young cattle and sheep were harassed by dogs and drowned in Dandenong Creek. (Two carcasses of calves were found in Dandenong Creek during our survey). The likelihood of feral (non-domestic) dogs in the Park is tenuous because substantially few areas in the Park provide affordable cover, suggesting that those dogs which are feeding on the Park's wildlife would be domestic pets.

The presence of feral cats in the Park, however, cannot be dismissed. Our data from DVMP suggest cats have a greater immediate impact on native fauna than dogs, particularly in terms of native prey consumed. One quarter of cat scats analysed contained the remains of possums and gliders. For species which are uncommon in the Park (e.g. Sugar Glider *Petaurus breviceps*), even low predation can have an undesirable effect on the

species' long-term survival and ultimate elimination from the Park. The role of cats in transmitting disease to other mammals has been well documented (Barker *et al.* 1963; Attwood *et al.* 1975; Kerr 1981; Presidente 1984; Obendorf and Munday 1990), suggesting that diseases such as Toxoplasmosis, which are transmittable by cats via their faeces, could have devastating effects on the Park's marsupial hosts that become exposed to the protozoan parasite.

Of interest was the occurrence of Common Wombat *Vombatus ursinus* and Human *Homo sapiens* hair in the scats of cat and fox respectively. Wombats were last reported from DVMP in 1984 (Wallis *et al.* 1990). One wombat guard hair was found in a cat scat, which also contained hair from the Black Rat and some plant material. We believe wombat remains may have been washed down from upstream in Dandenong Creek, and subsequently been fed upon. The presence of human hairs in the fox scats are believed to have been of incidental occurrence; foxes may have ingested hair remains while they fed on household garbage.

The fragmented nature of DVMP makes it a special area important for providing habitat to a complement of native vertebrate species in an urban environment. Unfortunately, the survival of many native vertebrates, particularly those which are locally uncommon (e.g. Sugar Gliders, waterbirds) suffer because of the impact of predators such as dogs, foxes and cats, whose diet appears to concentrate around those mammal, bird and no doubt, reptile and amphibian species inhabiting the Park. Consequently, efforts to reduce the impact of predators on native animals need to be implemented by combined predator control and public education programmes. Our findings present evidence which suggests that dogs, foxes and cats are feeding on a variety of native vertebrates within the DVMP; predation on these wildlife is undesirable and should therefore be controlled.

## Acknowledgements

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**Table 2.** Mammalian prey identified in predator scats from the three species of Carnivora, including those of scats in which the predator could not be identified.

$\Sigma$  = Total. The data represent the actual number of scats which contained that species of prey. Numbers in parenthesis indicate the percentage occurrence of mammal species found in each predator scat containing mammal remains.

PREDATOR Prey species	FOX	DOG	CAT	UNKNOWN	$\Sigma$
<i>Pseudocheirus peregrinus</i>	21 (13)	8 (21)	19 (41)	5 (23)	53
<i>Petaurus breviceps</i>	-	-	1 (2)	-	2
<i>Trichosurus vulpecula</i>	15 (9)	2 (5)	3 (7)	6 (27)	26
<i>Vombatus ursinus</i>	-	-	1 (2)	-	1
<i>Rattus rattus</i>	35 (22)	5 (13)	15 (33)	5 (23)	60
<i>Mus musculus</i>	33 (20)	1 (3)	16 (35)	1 (5)	51
<i>Oryctolagus cuniculus</i>	9 (6)	1 (3)	2 (4)	1 (5)	13
<i>Lepus capensis</i>	1 (1)	1 (3)	-	5 (23)	7
<i>Canis familiaris</i>	22 (14)	20 (53)	1 (2)	5 (23)	48
<i>Vulpes vulpes</i>	14 (9)	-	-	-	14
<i>Felis catus</i>	2 (1)	-	5 (11)	-	7
<i>Homo sapiens</i>	7 (4)	-	-	2 (9)	9
<i>Ovis aries</i>	6 (4)	2 (5)	-	-	8
<i>Bos taurus</i>	15 (9)	1 (3)	3 (7)	4 (18)	23

# **Recommendations for listing of taxa, communities and potentially threatening processes under the FFG Act**

## **Flora and Fauna Support Group\***

The following list comprises the first series of recommendations released by the Scientific Advisory Committee. The Committee has made recommendations supporting the nomination for listing of the following 126 taxa, communities and potentially threatening processes.

Many more taxa, communities and processes still require listing, and we encourage interested people to contact the Flora and Fauna Guarantee Unit (03-4124567) or Flora and Fauna Guarantee Officers in their DCE region for more information about the procedure.

Under the Flora and Fauna Guarantee Act (1987), native taxa and communities may be nominated for inclusion in Schedule 2 of the Act (a list of threatened taxa and communities). Potentially threatening processes likewise may be nominated for listing in the Act, in this case in Schedule 3. These are defined as processes "which may have the capability to threaten the survival, abundance or evolutionary development of any taxon or community of flora or fauna".

A taxon or community is eligible to be listed if "it is in a demonstrable state of decline which is likely to result in extinction or if it is significantly prone to future threats which are likely to result in extinction".

"A potentially threatening process is eligible for listing if in the absence of

appropriate management it would pose a significant threat to a range of flora and fauna."

Criteria for determining the eligibility of taxa, communities or processes are the responsibility of the Flora and Fauna Guarantee Scientific Advisory Committee. This Committee meets regularly to discuss nominations for listing. Its preliminary recommendations either supporting or not supporting a nomination are released periodically for public comment. After a period of 30 days, and after considering any public comments received, the Committee may make a recommendation to the Minister that the nomination should be supported or not supported and give reasons for its recommendation. The Minister then may decide whether or not to recommend to the Governor in Council that the taxon, community or potentially threatening process be added to or repealed from Schedule 2 or 3. Once a taxon, community or process is listed, the Director General of the Department of Conservation and Environment (DCE) must prepare an action statement for that taxon, community or process. The action statement must set out what has been done to conserve and manage that taxon or community or process and what is intended to be done.

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# Recommendations of the Flora and Fauna Guarantee Scientific Advisory Committee

## Items for addition to Schedule 2

<i>Abutilon fraseri</i>	Dwarf Lantern-bush
<i>Acacia glandulicarpa</i>	Hairy-pod Wattle
<i>Acacia pendula</i>	Weeping Myall
<i>Acrodipsas brisbanensis</i>	Large Ant-blue Butterfly
<i>Acrodipsas myrmecophila</i>	Small Ant-blue Butterfly
<i>Adiantum diaphanum</i>	Filmy Maidenhair
<i>Aepyprymnus rufescens</i>	Rufous Bettong
<i>Agrostis adamsonii</i>	Adamson's Bent
<i>Allocasuarina huehmannii</i>	Buloke
<i>Ambassis agassizii</i>	Agassiz's Chanda Perch
<i>Aprasia aurita</i>	legless lizard
<i>Archaeophylax canarus</i>	caddisfly
<i>Ardeotis australis</i>	Australian Bustard
<i>Astelia australiana</i>	Tall Astelia
<i>Austrogammarus australis</i>	freshwater amphipod
<i>Bettongia gaimardi</i>	Tasmanian Bettong
<i>Bettongia penicillata</i>	Brush-tailed Bettong
<i>Burramys parvus</i>	Mountain Pygmy-possum
<i>Caladenia audasii</i>	Audas' Spider-orchid
<i>Caladenia calcicola</i>	Limestone Spider-orchid
<i>Caladenia rosella</i>	Rosella Spider-orchid
<i>Calochilus richiae</i>	Bald-tip Beard-orchid
<i>Calyptorhynchus magnificus</i>	Red-tailed Black-Cockatoo
<i>Carex cephalotes</i>	Wire-head Sedge
<i>Casuarina obesa</i>	Swamp Sheoke
<i>Chaeropus ecaudatus</i>	Pig-footed Bandicoot
<i>Comesperma polygaloides</i>	Small Milkwort
<i>Cyathea leichhardtiana</i>	Prickly Tree-fern
<i>Dasyornis broadbenti</i>	Rufous Bristlebird
<i>Dasyurus maculatus</i>	Tiger Quoll
<i>Dasyurus viverrinus</i>	Eastern Quoll
<i>Delma impar</i>	Striped Legless Lizard
<i>Dendrobium speciosum</i>	Rock Orchid
<i>Dillwynia capitata</i>	Slender Parrot-pea
<i>Discaria nitida</i>	Shining Anchor Plant
<i>Discaria pubescens</i>	Hairy Anchor Plant
<i>Diuris punctata</i>	Purple Diuris
<i>Edelia obscura</i>	Yarra Pigmy Perch
<i>Eragrostis trachycarpa</i>	Rough-grain Love-grass
<i>Eubalaena australis</i>	Southern Right Whale
<i>Eucalyptus cadens</i>	Warby Swamp Gum
<i>Eucalyptus crenulata</i>	Buxton Gum
<i>Eucalyptus froggattii</i>	Kamarooka Mallee
<i>Euphrasia scabra</i>	Rough Eyebright
<i>Eusthenia nothofagi</i>	Otway Stonefly

## Species

*Galaxias cleaveri*  
*Galaxias olidus* var. *fuscus*  
*Galaxiella pusilla*  
*Geijera parviflora*  
*Grevillea barklyana*  
*Grus rubicundus*  
*Gymnobelideus leadbeateri*  
*Heleioporus australiacus*  
*Hemichroa diandra*  
*Hemiphysalia mirabilis*  
*Lagorchestes leporides*  
*Lepidium hyssopifolium*  
*Leporillus apicalis*  
*Lichenostomus melanops*  
*cassidix*  
*Litoria spenceri*  
*Maccullochella macquariensis*  
*Maccullochella peelii*  
*Macquaria australasica*  
*Manorina melanotis*  
*Megascolides australis*  
*Melaleuca halmaturorum*  
*Myoporum floribundum*  
*Myrmecia* sp. 17  
*Nannoperca variegata*  
*Neophema chrysogaster*  
*Ogyris otanes*  
*Olearia astroloba*  
*Onychogalea fraenata*  
*Paralucia pyrodiscus lucida*  
*Pedionomus torquatus*  
*Perameles bougainville*  
*Perameles gunnii*  
*Petaurus norfolcensis*  
*Petrogale penicillata*  
*Phascogale calura*  
*Phascogale tapoatafa*  
*Philora frosti*  
*Planigale gilesi*  
*Platydoris galbana*  
*Polytelis swainsonii*  
*Potamalosia richmondia*  
*Potorous longipes*  
*Prototroctes maraena*  
*Psophodes nigrogularis*  
*leucogaster*  
*Psoralea parva*  
*Psoralea tenax*

Tasmanian Mudfish  
 Brown Galaxias  
 Dwarf Galaxias  
 Wilga  
 Gully Grevillea  
 Brolga  
 Leadbeater's Possum  
 Giant Burrowing Frog  
 Mallee Hemichroa  
 Hemiphysalia Damsel  
 Eastern Hare-wallaby  
 Small Pepper-creep  
 Lesser Stick-nest Rat

Helmeted Honeyeater  
 Spotted Tree Frog  
 Trout Cod  
 Murray Cod  
 Macquarie Perch  
 Black-eared Miner  
 Giant Gippsland Earthworm  
 Salt Paperbark  
 Slender Myoporum  
 bull-ant  
 Ewens Pigmy Perch  
 Orange-bellied Parrot  
 Small Brown Azure Butterfly  
 Marble Daisy-bush  
 Bridled Nailtail Wallaby  
 Eltham Copper Butterfly  
 Plains-wanderer  
 Western Barred Bandicoot  
 Eastern Barred Bandicoot  
 Squirrel Glider  
 Brush-tailed Rock-wallaby  
 Red-tailed Phascogale  
 Brush-tailed Phascogale  
 Baw Baw Frog  
 Paucident Planigale  
 marine opisthobranch  
 Superb Parrot  
 Freshwater Herring  
 Long-footed Potoroo  
 Australian Grayling  
  
 Western Whipbird  
 Small Psoralea  
 Tough Psoralea

## Species

<i>Pterostylis baptistii</i>	King Greenhood
<i>Pterostylis cucullata</i>	Leafy Greenhood
<i>Pterostylis truncata</i>	Brittle Greenhood
<i>Pterostylis woollsii</i>	Long-tail Greenhood
<i>Pultenaea graveolens</i>	Scented Bush-pea
<i>Rhinolophus megaphyllus</i>	Eastern Horseshoe-bat
<i>Rhodope</i> genus	marine opisthobranch
<i>Riekoperla darlingtoni</i>	Mount Donna Buang Wingless Stonefly
<i>Rulingia pannosa</i>	Clustered Kerrawang
<i>Rutidosia leptorrhynchoides</i>	Button Wrinklewort
<i>Sarcochilus falcatus</i>	Orange-blossom Orchid
<i>Senecio macrocarpus</i>	Large-fruit Groundsel
<i>Sterna albifrons</i>	Little Tern
<i>Sterna nereis nereis</i>	Fairy Tern
<i>Stictonetta naevosa</i>	Freckled Duck
<i>Swainsona plagiotropis</i>	Red Swainson-pea
<i>Swainsona stipularis</i>	Purple Swainson-pea
<i>Thaumatoperla flaveola</i>	stonefly
<i>Thelymitra epipactoides</i>	Metallic Sun-orchid
<i>Thesium australe</i>	Austral Toad-flax
<i>Thylogale billardieri</i>	Tasmanian Pademelon
<i>Tympanocryptis lineata lineata</i>	Lined Earless Dragon
<i>Tympanocryptis lineata pinguicolla</i>	earless dragon
<i>Tyto novaehollandiae</i>	Masked Owl
<i>Tyto tenebricosa</i>	Sooty Owl
<i>Westringia crassifolia</i>	Whipstick Westringia

## Communities

- Butterfly Community No. 1.
- San Remo Marine Community.
- Limestone *Pomaderris* Shrubland Community.
- Montane Swamp Complex Community.
- Western (Basalt) Plains Grassland Community.

## Potentially threatening processes for addition to Schedule 3

- Loss of hollow-bearing trees from Victorian native forests.
- Predation of native wildlife by the introduced Red Fox *Vulpes vulpes*.
- Removal of Wood Debris from Victorian streams.
- Use of *Phytophthora*-infected gravel in construction of roads, bridges and reservoirs.

# A provisional classification of Australian terrestrial geoplanid flatworms (Tricladida: Terricola: Geoplanidae)

By L. Winsor\*

## Abstract

A provisional classification of Australian geoplanid terrestrial flatworms is provided, and is placed in context with earlier and current studies. The genus *Caenoplana* is emended, and the heterogeneous genus *Artioposthia* divided into five groups. Diagnoses are provided for six new genera: *Australoplana* gen. nov.; *Parakontikia* gen. nov.; *Reomkago* gen. nov.; *Fletchamia* gen. nov.; *Lenkunya* gen. nov. and *Tasmanoplana* gen. nov.

## Introduction

Terrestrial flatworms (or land planarians as they are also known) are entirely free-living carnivorous members of the phylum Plathelminthes. Normally nocturnal in habit, they frequent dark, humid, but generally not wet microhabitats beneath fallen rotting logs and leaf litter. They occur in a variety of habitats ranging from tropical rainforest to arid semi-desert.

The first record of these flatworms in Australia was made by Charles Darwin during the *Beagle* voyage in 1836 who collected specimens of one species from Hobart, Tasmania. Interest in the group increased with the majority of species in Australia being described between 1888 and 1901. The Terricola worldwide were monographed by Graff (1899), the preparations for which undoubtedly provided impetus for much of the research on the group undertaken in the colony. Apart from Wood (1926) and Fyfe in New Zealand (1956) there was little scientific interest expressed in the Australian terrestrial flatworms until the 1970s. The Australian terrestrial flatworm fauna presently comprises over 82 species and seven varieties belonging to two principal

families, the Rhynchodemidae and the Geoplanidae.

There are a number of problems which confront the modern taxonomist working on Terricola. Many early species descriptions were published in obscure journals and are thus difficult to obtain and correlate, if indeed workers are aware of them. Type specimens are often in European or other overseas museums and are difficult to trace and obtain. Early species descriptions rest almost entirely upon external morphology. Modern taxonomy of the Terricola is based upon a combination of external morphology, and internal anatomy revealed by histological investigations. As terrestrial flatworms can exhibit considerable external morphological intra-specific variation and inter-specific similarities it is essential that type specimens are histologically examined and that these form the basis of modern descriptions and classifications.

The immense task of indexing the Terricola of the World is currently being undertaken by R.E. Ogren and M. Kawakatsu (1987, 1988, 1989, 1990). However in the forthcoming "Index to the species of the family Geoplanidae - Part II", modern taxonomic treatment of Australasian taxa is hampered as published anatomical descriptions are only available for some 12% of described species. This has already unfortunately resulted in problems in the genus *Caenoplana*, reinstated without reference to the type specimens by Ogren & Kawakatsu (1988a,b). When histologically examined, the types of species in the genus were found to represent two genera (Winsor, 1991).

Both type and other specimens of a large portion of Australian taxa have been examined by the author within the context of taxonomic revisionary studies on the terrestrial flatworms. Unfortunately this work is still some way from completion

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and publication. It is therefore appropriate that a provisional classification of the Australian Terricola is provided now. This synopsis should assist in the higher classification of Australian taxa to be listed in the forthcoming "Index to the species of the family Geoplanidae – Part II" (Ogren & Kawakatsu, MS in press).

The purpose of this paper is to (1) re-define the genus *Caenoplana* and erect a new genus to accommodate the resulting excluded species as foreshadowed (Winsor, 1991) and (2) provide a provisional classification of the Australian geoplanid Terricola (and where appropriate, New Zealand taxa).

### Explanatory notes

The types examined are held by State and overseas museums. Additional material was obtained from the author's collection. Histological methods employed have been indicated elsewhere (Winsor, 1983). Terminology for dorsal regions follows Graff (1899) and for anatomical structures Cannon (1986). The cutaneous muscular index (CMI) is the thickness of cutaneous musculature relative to the body height (the mch index of Froehlich (1955). The parenchymal musculature index (PMI) (Winsor, 1983) is similarly calculated from the sum of the heights of the dorsal and ventral ring zone, or the ventral muscular plate, whichever is present. In the genus *Artioposthia* accessory auxiliary organs are termed adenodactyls (finger like glandular organs that project into the genital atria), adenochiren (comb-like organs in which the multiple adenodactyls are embedded in muscular flaps) and adenomuralia, a new term coined here (Greek – aden, a gland + Latin – muralis, of walls) to describe glandulo-muscular organs that are embedded in the walls of the copulatory organs.

### Generic diagnoses

Genus *Caenoplana* Moseley, 1877

The original definition: Body long and wormlike, much rounded on the back,

flattened on the under surface, without an ambulacral line. External longitudinal muscular bundles largely and evenly developed over both dorsal and ventral regions. Lateral organs distinct and isolated as in *Rhynchodemus*, and, as in it, connected by a transverse commissure. Eyes absent from the front of the anterior extremity and scattered sparsely on the lateral margins of the body for its entire extent. Mouth nearly central, pharynx cylindrical.

Emended: Geoplanidae of elongate body form, cylindrical to sub-cylindrical; mouth situated just posterior of mid venter; gonopore closer to mouth than to posterior end; creeping sole 60% or more of body width; eyes mostly small in a single row around the anterior tip, crowded antero-laterally in an irregular cluster, and extending posteriorly in a staggered submarginal row; cutaneous circular and paired diagonal muscle layers are mostly poorly differentiated, presenting as a circulo-oblique layer; cutaneous longitudinal muscles very weak and equally developed dorsally and ventrally; CMI ranges from 1.6 – 4.5%; parenchymal longitudinal muscles present as single fibres or as small isolated bundles embedded within circulo-oblique muscle fibres arranged in a distinct ring zone, PMI (for ring zone) 20 – 28.5%; anterior glandulo-muscular organs and sensory papillae absent; cylindrical pharynx; testes and sperm ducts ventral; penis of the eversible type, without papilla; vagina enters ventrally or horizontally; ovovitelline duct enters vagina ventrally; copulatory organs without adenodactyls or adenomuralia.

Localities: principally in south-eastern Australia and New Zealand, with species introduced into urbanized areas of the United States of America, New Zealand and the United Kingdom.

Type species: *Caenoplana coerulea* Moseley, 1877; designated by Ogren & Kawakatsu, 1988a.

Note: Two groups are recognized here.

The *coerulea* group: *C. coerulea* Moseley, 1877; *C. spenceri* (Dendy, 1890); *C. walhallae* (Dendy, 1891); *C. dendyi* (Spencer, 1891), characterized by the presence of blue-green pigmented rhabdoids; inner and outer and pharyngeal musculature comprised of longitudinal muscles underlain by circular fibres, internal to which is a layer of interwoven longitudinal and circular muscle fibres; musculature of the copulatory organs comprises interwoven longitudinal and circular fibres. Cutaneous circular and diagonal musculature of *C. dendyi* are well differentiated.

The *subviridis* group: *C. sub-viridis* Moseley, 1877; *C. variegata* (Fletcher & Hamilton, 1888); *C. sulphurea* (Fletcher & Hamilton, 1888); *C. hoggii* (Dendy, 1891); *C. bicolor* (Graff, 1899); *C. dubia* (Dendy, 1892a); *C. citrina* (Wood, 1926); *C. barringtonensis* (Wood, 1926). Most of the members of this group are yellow or brown in colour with green or dark brown longitudinal stripes. The musculature of the body wall, pharynx and copulatory organs of species within this group exhibit greater differentiation than those of the *coerulea* group.

The following species are provisionally placed within *Caenoplana*: *G. viridis* (Fletcher & Hamilton, 1888); *C. hillii* (Steel, 1897); *C. ponderosa* (Steel, 1897); *C. albolineata* (Steel, 1987) and *Geoplana daemeli* (Graff, 1899), in part. Two New Zealand species, *G. purpurea* (Dendy, 1895b); *G. tenuis* (Dendy, 18985b) are also assigned to the genus.

Genus: *Australoplana* gen. nov.

Body elongate, strap-like; broadly convex dorsally, flat ventrally; mouth situated in posterior third of body; gonopore closer to mouth than to posterior end; creeping sole less than 25% of body width; eyeless, or with a single row of minute eyes around the anterior tip and laterally to the posterior tip; cutaneous

musculature comprised of circular, diagonal and longitudinal muscle layers, with the longitudinal muscles equally developed dorsally and ventrally; CMI ranges from 10 – 16%; parenchymal longitudinal muscles very weak or absent; anterior glandulomuscular organs and sensory papillae absent; pharynx cylindrical or bell-form (glockenförmig); testes and sperm ducts ventral; ventro-posterior diverticulum may be present in copulatory organs; intra-antral papilla present in penis of some species; vagina enters horizontally; ovovitelline ducts open ventrally into vagina; adenodactyls and adenomuralia absent.

Localities principally in eastern Australia and New Zealand. Two or three species have been introduced into New Zealand and Great Britain.

Type species: *Caenoplana sanguinea* Moseley, 1877, here designated.

The generic epithet is derived from *austral* (Latin – southern), and *plana* (Greek – roaming; a wanderer) often used in the names of flatworms.

Note: Three groups are recognized here. The first two are Australian, the third a New Zealand group (species of which have been introduced into Great Britain).

The *sanguinea* group: *A. sanguinea* (Moseley, 1877); *A. rubicunda* (Fletcher & Hamilton, 1888); *A. alba* (Dendy, 1891); *A. alba* var. *roseolineata* (Dendy, 1892a). *A. minor* (Dendy, 1829b) may also be referred to this group. All species in this group have eyes, and a cylindrical pharynx. An intra-antral penis papilla is present in the first three species.

The *typhlops* group: *A. typhlops* (Dendy, 1984); together with undescribed species. All are eyeless, with bell-form pharynx. A ventro-posterior diverticulum is present only in *A. typhlops*.

The New Zealand group: *A. sanguinea* var *alba* (Jones, 1981); and undescribed species. They are characterized by the presence of small bundles of ventro-lateral parenchymal muscles, and bell-form pharynx.

Genus *Parakontikia* gen. nov.

Body elongate, cylindrical to subcylindrical; mouth situated just posterior to mid venter; gonopore closer to mouth than to the posterior end; creeping sole ranges, from 54–84% body width; eyes generally large, in a single row around the anterior tip and in a submarginal row posteriorly without antero-lateral crowding; cutaneous musculature comprised of circular, diagonal and longitudinal muscles, the latter layer strong and generally equally developed bundles dorsally and ventrally; CMI ranges from 6.7–13.1%; parenchymal longitudinal muscles present in a ventral plate or ring-zone; PMI for ring zone or plate ranges from 5.5–13.8%; anterior glandulomuscular organs and sensory papillae absent; pharynx cylindrical; testes and sperm ducts ventral; penis of the eversible type without a papilla; vagina enters horizontally; ovovitelline ducts open ventrally into vagina; adenodactyls and adenomuralia absent.

Localities: eastern and Western Australia; Papua-New Guinea.

Type species: *Geoplana ventrolineata* Dendy, 1892a, here designated.

Etymology: The generic epithet alludes to the similarities between this genus (*para*, Greek – beside) and the Indo-Pacific genus *Kontikia*.

The genus includes *P. ventrolineata* (Dendy, 1892a); *P. atrata* (Steel, 1887); *P. coxii* (Fletcher & Hamilton, 1888); *P. melanochoa* (Steel, 1901a) and *P. lyra* (Steel, 1901b). In the Papua-New Guinea species *P. chapmani* (Ogren & Kawakatsu, 1988b) there are only 16 eyes present around the anterior tip and for a short distance laterally. However other characters accord with this genus to which the species is transferred.

Genus: *Reomkago* gen. nov.

Body elongate, quadrangular in cross section with rounded corners; dorsal and ventral surfaces flat; lateral surfaces inwards sloping; mouth posterior of mid-

venter; gonopore half way between mouth and posterior end; creeping sole less than 50% of body width; small eyes in a single row around the anterior tip and in a staggered sub-marginal row posteriorly without anterolateral crowding; cutaneous musculature strong, comprising circular, diagonal and longitudinal muscles; with greater development of the longitudinal muscle layer ventrally than dorsally; CMI 18%; longitudinal parenchymal musculature weak, generally confined to a ventral plate; PMI 8.5%; very strong laterally situated dorso-ventral muscles (largely responsible for the quadrangulate shape); anterior glandulomuscular organs and sensory papillae absent; pharynx cylindrical; testes and sperm ducts ventral; copulatory organs complex; with penis papilla; prostatic region anterior of penis bulb; ducts rise dorsally before entering penis bulb horizontally; vagina enters horizontally; ovovitelline duct enters vagina ventrally; adenodactyls and adenomuralia absent.

Localities: eastern Australia (mainland and Tasmania)

Type species: *Geoplana quadrangulata* Dendy, 1891, here designated.

Etymology: The generic epithet is a combination of the initials of R. E. Ogren and M. Kawakatsu with the suffix *-ago*, from the Greek *ago* – to lead, guide, stimulate, promote. The gender is masculine. It honours the industry and magnificent achievement of these two compilers in indexing the species of the Terricola, thus greatly facilitating future taxonomic studies.

Note: the genus includes *R. quadrangulatus* (Dendy, 1891); *R. ventropunctatus* (Dendy, 1892d); *R. wellingtoni* (Dendy, 1892d) and *R. flynni* (Dendy, 1915). These agile species have a pale ground colour with distinctive brown mottling.

Genus: *Fletchamia* gen. nov.

Body elongate, sub-cylindrical; mouth approximately central; gonopore generally nearer mouth than the posterior end;

creeping sole ranges from 50–70% body width; eyes equally large and small, in a single row around the anterior tip, crowded antero-laterally, then continued posteriorly in two to three staggered submarginal rows; antero-lateral eye patch lens-shaped extends to the lateral region of the dorsal surface; cutaneous musculature weak, with circular, diagonal and longitudinal muscles, the latter in bundles; CMI ranges from 2.3–6.2%; parenchymal musculature weak, comprised chiefly of a loose ring zone of circulo-oblique fibres; parenchymal longitudinal muscles present as isolated fibres largely confined to a weak ventral plate; PMI for plate ranges from 2.3–4.3%; anterior glandulomuscular organs and sensory papillae absent; pharynx cylindrical; testes and sperm ducts ventral; copulatory organs complex; prostatic region anterior to penis bulb; ducts enter prostatic region dorsally; penis of eversible type; rudimentary intra-antral papilla present in penis of some species; female atrium elongate, the posterior end communicating with a diverticulum; vagina horizontal, enters floor of atrium anterior to the diverticulum; ovovitelline ducts enter vagina ventrally or horizontally; adenodactyls and adenomuralia absent.

Localities: eastern and Western Australia; possibly introduced into New Zealand.

Type species: *Geoplana quinquelineata* Fletcher & Hamilton, 1888, here designated.

Etymology: The generic epithet is derived from the surnames of J.J. Fletcher and A.G. Hamilton. It commemorates the valuable contributions of these two colonial naturalists to our knowledge of the native terrestrial flatworms.

Notes: Included in this genus are *F. quinquelineata* (Fletcher & Hamilton, 1888); *F. m'mahoni* (Dendy, 1891); *F. sugdeni* (Dendy, 1891); *F. mediolineata* (Dendy, 1891); *F. quinquelineata* var *accentuata* (Steel, 1897) and *Fletcheria* sp. (Winsor, 1977). The species *F. fusco-*

*dorsalis* (Steel, 1901a); *F. mediolineata* var *simularis* (Steel, 1901a); *F. dakini* (Dendy, 1915) and *F. flavilineata* (Dendy, 1915) may also be referred to the genus.

#### Genus: *Lenkunya* gen. nov.

Robust body, broadly convex dorsally, flat ventrally; mouth central; gonopore closer to the mouth than to the posterior end; creeping sole ranges from 70–80%; eyes in a single row around the anterior tip, crowd antero-laterally, then continue posteriorly in a staggered submarginal row to the level of the pharynx; very sparse thereafter; antero-lateral eye patch lens-shaped and extends to the lateral region of the dorsal surface; cutaneous musculature weak, with circular, diagonal and longitudinal muscles, the latter in small bundles; CMI ranges from 3.6–5.5%; parenchymal longitudinal muscles strong, present as isolated fibres in a ring zone of circular and diagonal muscles; PMI ranges from 12–28%; anterior glandulomuscular organs and sensory papillae absent; pharynx cylindrical; testes and sperm ducts ventral; copulatory organs simple with well developed penis papilla, vagina enters horizontally; ovovitelline duct approaches ventrally; adenodactyls and adenomuralia absent.

Localities: south eastern and Western Australia.

Type species: *Geoplana munda* Fletcher & Hamilton, 1888, here designated.

Etymology: The generic epithet is an aboriginal word meaning beautiful. The dialect and language group are unknown. The species in this genus are most attractively marked.

Notes: In the genus are included: *L. munda* (Fletcher & Hamilton, 1888); *L. adae* (Dendy, 1891); *L. frosti* (Spencer, 1891); *L. adae* var *extralineata* (Dendy, 1892c) and *L. adae* var *fusca* (Dendy, 1894). The species *L. ornata* (Fletcher & Hamilton, 1888); *L. virgata* (Fletcher & Hamilton, 1888) and *L. arenicola* (Steel, 1901a) may also be referred to the genus.

Genus: *Tasmanoplana* gen. nov.

Body elongate, sub-cylindrical, flat ventrally; mouth just posterior of mid venter; gonopore nearer to mouth than to posterior end; creeping sole over two thirds of body width; eyes small, in a single row around the anterior tip extending posteriorly in a single staggered sub-marginal row without antero-lateral crowding; cutaneous musculature strong with circular, diagonal and longitudinal muscles, the latter in bundles; CMI 6.6–9.7%; parenchymal musculature mainly comprised of very strong, compact longitudinal muscle fibres in a ring zone; PMI 11.5–20%; anterior glandulomuscular organs and sensory papillae absent; pharynx cylindrical; testes and sperm ducts ventral; copulatory organs simple with small penis papilla; vagina enters horizontally; ovovitelline duct enters vagina ventrally; ventro-posterior diverticulum present ventral to the female atrium, opening into copulatory canal; adenodactyls and adenomuralia absent.

Localities: south eastern and south western Australia.

Type species: *Planaria tasmaniana* Darwin, 1844, here designated.

Etymology: The generic epithet alludes to the first record of terrestrial flatworms in Australia. Charles Darwin collected the type species during the visit of H.M.S. Beagle to Hobart, Tasmania, 2nd–17th February, 1836.

Notes: The genus includes: *T. tasmaniana* (Darwin, 1844) and *T. tasmaniana* var *flavicincta* (Steel, 1901b). The species *T. balfouri* (Graff, 1899) and *T. comitatis* (Dendy, 1915) may also be referred to the genus.

Genus: *Artioposthia* Graff, 1896

Original definition (translated from German): Geoplanidae without creeping ridge and glandular margin, of elongate form, with body apertures on the ventral surface, and with at least a pair of accessory auxiliary organs in addition to the male copulatory organ.

Emended: testes and sperm ducts ventral

Graff assigned six species to the genus. Since then numerous species, chiefly New Zealand taxa investigated by Marion Fyfe during the period 1937–1956, have been included in the genus on the basis of the presence of accessory auxiliary organs in the copulatory organs. Unfortunately the majority of descriptions are incomplete and lack details of body musculature.

Full anatomical studies on several species of *Artioposthia* undertaken by the author reveal that the genus is heterogeneous. At least five groups, at this stage chiefly based upon musculature, can be recognized. All have ventral testes and sperm ducts, and most taxa have a penis papilla.

Formal re-definition and restriction of *Artioposthia*, and subsequent allocation of excluded species into new genera should only be undertaken following examination of type material. At present few relevant type specimens of Australian taxa have been examined. Sectioned type specimens of New Zealand taxa need to be augmented by new material.

The following groups are present within *Artioposthia*. As these data, including that provided by Graff, 1899, have mostly been derived from non-type specimens, the assignment of species of these groups must be regarded as provisional.

#### *Artioposthia* Group 1.

Body elongate, broad, convex dorsally, flat ventrally; with weak cutaneous longitudinal muscles in bundles, evenly developed dorsally and ventrally. Parenchymal longitudinal muscles weak, comprised of isolated fibres arranged in a very loose ring zone.

Included in this group: *A. fletcheri* (Dendy, 1891) (this species was the first species assigned to the genus); *A. fletcheri* var *borealis* (Dendy, 1895a).

#### *Artioposthia* Group 2.

Body elongate, broad, convex dorsally, flat ventrally; with weak cutaneous

longitudinal muscles, equally developed dorsally and ventrally. Parenchymal longitudinal muscles strong, not firmly united in bundles but exhibiting grouping of fibres, present in a ring zone.

Included in this group: *A. lucasi* (Dendy, 1891); *A. adelaidensis* (Dendy, 1893) and *A. diemenensis* (Dendy, 1894). The species *A. mortoni* (Dendy, 1894); *A. grubei* (Graff, 1899); *A. nicholli* (Dendy, 1915) and the Adelaide specimens of *Caenoplana daemeli* (Graff, 1899) may also be referred to this group.

#### *Artioposthia* Group 3.

Body small, elongate, sub-cylindrical; with strong cutaneous longitudinal musculature, equally developed dorsally and ventrally; parenchymal longitudinal muscles in ring zone or ventral plate.

Included in this group: *A. alfordensis* (Dendy, 1896), a New Zealand species.

#### *Artioposthia* Group 4.

Body small, elongate, cylindrical to sub-cylindrical; cutaneous longitudinal muscles weak, more developed ventrally than dorsally; parenchymal musculature weak, largely confined to a ventral plate.

Included in this group: *A. grammicola* (Steel, 1901a) and *Artioposthia* sp. (Winsor, 1979), both Australian species, and *A. polyadoides* (Fyfe, 1956), a New Zealand species.

#### *Artioposthia* Group 5.

Body robust, elongate; convex dorsally, slightly concave ventrally; with strong cutaneous longitudinal muscles, the ventral muscles slightly more developed than those dorsally; parenchymal longitudinal muscles very weak or absent.

Included in this group: *A. howitti* (Dendy, 1892c); *A. howitti* var *obsoleta* (Dendy, 1892c) and *A. robusta* (Steel, 1897). *A. regina* (Dendy, 1892b); *A. parva* (Steel, 1897); *A. warragulensis* (Graff, 1899); *A. scaphoidea* (Steel, 1901a); *A. dovei* (Steel, 1901b). *A. harrisoni* Wood, 1926 may also be referred to this group.

Localities: *Artioposthia* species have been described from the Philippines, Australia and New Zealand. One species has been introduced into Great Britain from New Zealand.

#### Acknowledgments

A considerable portion of the author's collection of terricola used in part as a basis for this work, was obtained with the willing help of members of the F.N.C.V. Field Survey Group to whom I am most grateful. Dr Lester Cannon, Queensland Museum, kindly read the manuscript and his advice and support are deeply appreciated. Support for these taxonomic studies by the C.S.I.R.O. Science and Industry Endowment Fund and the Australian Biological Resources Study is gratefully acknowledged.

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## Botany Group excursion to the Skipton area, on 27th October, 1990.

The Botany Group visited Mooramong, north west of Skipton, to see efforts being made to re-establish rare and endangered plants of the Western Volcanic Plains. Mooramong is a National Trust owned grazing property where a substantial area of land is being converted to a nature reserve. The reserve is centred on areas that contain remnants of native grassland vegetation, and where experiments in re-establishment are being conducted.

Our leaders were Neville Scarlett (Botany Dept., Latrobe University), and Laurie Lees, the ranger at Mooramong. Neville is primarily responsible for the re-establishment efforts. His work is mainly financed by the World Wide Fund for Nature (WWF). Laurie is responsible for the property on a day to day basis.

Seed from rare plants is collected from the nearest known source – often from small vegetation remnants on road or rail reserves. This seed is either grown to the seedling stage and then planted out, or is sown directly into prepared plots in the reserve. It is hoped that, in time, the rare plants will become self perpetuating. This will depend on the ability to restore the remaining areas of native grassland to a more natural state (i.e. reducing the amount of exotic vegetation cover), and establishing large enough populations of rare plants to provide an adequate seed source.

Various techniques are being tested in an effort to improve the condition of the grassland remnants, and to provide plots suitable for growing the rare plants. These include burning at various intervals and during different seasons, placement of straw containing seed harvested from nearby grassland remnants, hand weeding, removal of top soil containing weed seeds, use of weed mats, limited use of herbicides on problem weeds and selective planting to enrich and strengthen existing stands of plants.

Problems noted include predation by destructive pests – slugs, nematodes and caterpillars, and grazing by sheep which occasionally invade the reserve many of the rare species are very palatable so are preferentially grazed. Severe climatic and soil conditions make re-establishment difficult e.g. exposed wind-swept plains with hard cracking clays. High nutrient levels in the soil, due to the application of fertilisers, favours rank weed growth. There is a tendency for native plants to be smothered once grazing ceases. (Some native plants that are still present in grazed areas are being lost when stock is excluded. Experiments in maintaining limited grazing prior to more active management are being conducted in an effort to overcome this problem.

It is too early to know whether the re-establishment programme at Mooramong will be successful. Everyone was concerned about the apparent difficulties being faced by those involved in the project.

Rare plants planted in the reserve and seen on the excursion include *Senecio macrocarpus*, *Rutidosis leptorrhynchoides*, *Lepidium hyssopifolium*, and an apparently undescribed *Podolepis*. Non-endangered species which had been planted include *Acacia retinodes* and *Helipterum anthemoides*. Unfortunately many of the endangered species are either inconspicuous or unspectacular and consequently lack general horticultural appeal. For that reason, reserves like Mooramong are important for their continued existence.

The day finished with an inspection of the planted exotic garden around the homestead, before the group moved on to Maryborough for the second day of the excursion.

– John Eichler

## CALENDAR OF CLUB ACTIVITIES

### November

- Sun 3      General Excursion – To be announced.  
Tues 5    Fauna Survey Group – To be announced.  
Wed 6    Geology Group – To be announced.  
Sun 10    Geology Excursion – Contact Graham Love.  
Mon 11    General Meeting – Australian Natural History Medallion presentation.  
Thurs 14   Botany Group – “Banksias” Ron Pearson.  
Wed 18    Microscopy Group – “Bacteria”.  
Sat 23    Botany Excursion – To be announced.

### December

- Sun 1      General Excursion – To be announced.  
Tues 3    Fauna Survey Group – To be announced.

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## FNCV Calendar of Activities

### November

- Thur. 14 Botany Group - 'Banksias' Ron Pearson.  
 16-17 FSG - Water Rat study, MMBW Farm, Werribee. Julian Grusovin (H) 571 4997
- Wed. 20 Microscopy Group - 'Bacteria'.  
 Sat. 23 Botany Excursion - Labertouche. Mett at 10 am on Princes Hwy at Labertouche signpost on left side of road. Members of Latrobe valley Field Naturalists will join us. Mel. 284 T/U 6
- Sat. 30 FSG - Leadbeater's Possum survey. Contact Ray Gibson (H) 874 4408.

### December

- Sun. 1 General Excursion - A stroll, not a hike, for all the family, along Gardiner's Creek Valley, from Glen Iris Railway Station to Hughesdale Railway Station. Leader Dan McInnes.
- Tues. 3 Fauna Survey Group - Members night and Christmas breakup.  
 Wed. 4 Geology Group - Members night.
- Sat 7 - Sun 8 FSG - Frog survey Eastern Otway Ranges. Contact Laurie Conole on (H) 481 4926.
- Mon. 9 General Meeting - Members night - members bring along your slides and exhibits.
- Thu. 12 Botany Group - Members night and Annual General Meeting.  
 Sat. 14 FSG - Leadbeater's Possum survey. Contact Ray Gibson (H) 874 4408.  
 Wed. 18 Microscopy Group - no meeting until January, 1992.

### January

- Wed. 15 Microscopy Group - Members night.

### February

- Sun. 2 General Excursion.

### March

- 6-9 Assoc. of Field Naturalists Clubs of Victoria Annual Camp, The Basin.

## New Members

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- |                      |                                  |
|----------------------|----------------------------------|
| Ms Maggie Allmand    | 58 Hornby St, Windsor, 3181      |
| Mr Scott Brunton     | 24 Kingston, St Yarraville, 3013 |
| Mr Kevin Edgar       | 4 Weafgreen Court, Burwood, 3125 |
| Ms Cathy Molnar      | 6 Warriem Rd, Croydon, 3136      |
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| Mrs Patricia Grey | 8 Woonah Court, Yallambie, 3085 |
|-------------------|---------------------------------|

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| Mrs Jacquelyn Stump | Lot 2 Tucks Rd, Main Ridge, 3928 |
|---------------------|----------------------------------|

# The Victorian Naturalist

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Cover photo: *Themeda triandra*, Kangaroo Grass, illustrated by Jim Watson. See page 56 for Ian Lunt's article on the management of grasslands.

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# Management of remnant lowland grasslands and grassy woodlands for nature conservation: a review

Ian D. Lunt\*

## Abstract

A review is presented of recent literature relevant to the conservation management of remnant lowland grasslands and grassy woodlands, two of the most threatened ecosystems in temperate Australia. The long-term conservation of both ecosystems is dependent upon increased reservation and informed management. Issues discussed include grazing by stock and native herbivores, burning, ploughing, grading, mowing, trampling, tree regeneration and planting, herbicides, fertilizers, rehabilitation and ecosystem re-creation.

## Introduction

Lowland (non-alpine) grasslands and grassy woodlands are among the most threatened ecosystems in Australia, with few examples in conservation reserves (Specht 1981). These communities originally covered vast areas of the lowland plains of temperate, south-eastern Australia. However, the fertile plains were the first areas to attract European settlement, and agriculture and associated development rapidly transformed the native ecosystems to pastures, crops and towns.

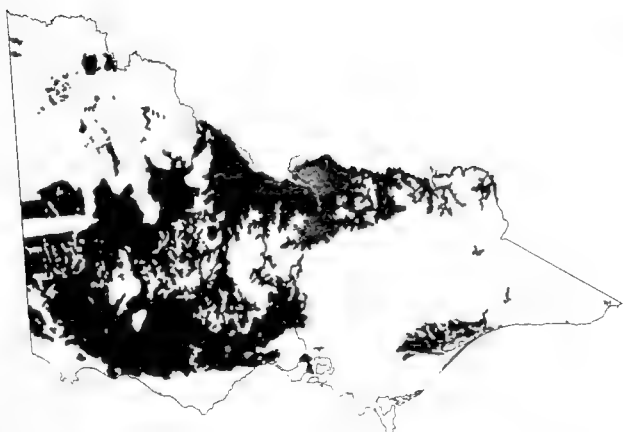
Throughout south-eastern Australia, native grasslands and grassy woodlands are now restricted to small, fragmented remnants, the best examples of which commonly occur on rail and road easements (Groves 1979, Scarlett and Parsons 1982, Frood and Calder 1987). In Victoria, native grasslands and grassy woodlands originally dominated the Wimmera and Northern Plains, Dundas Tablelands, Western Volcanic Plains, Gippsland Plains and other, smaller areas.

Collectively, they encompassed about a third of the State (Fig. 1). Sadly, the destruction of grassy ecosystems has been so complete that today less than 0.5 percent remain (Ministry for Planning and Environment 1989). The situation is similar in New South Wales (Sim and Urwin 1984), the Australian Capital Territory (Groves 1979), South Australia (Davies 1982, Williams and Goodwins 1988) and Tasmania (Kirkpatrick *et al.* 1988). The decimation of grassy ecosystems is not a peculiarly Australian phenomenon, but echoes the loss to agriculture of the indigenous grasslands of other continents, including the prairies of North America, the pampas of South America and the chalk grasslands of Europe (Koopowitz and Kaye 1983, Davis *et al.* 1986, Murphy and Ehrlich 1989). Mack (1989) observed that:

'In less than 300 years (and in most cases, little more than 100 years) much of the temperate grassland outside Eurasia . . . has been irreparably transformed by human settlement and the concomitant introduction of alien plants. Few other changes in the distribution of the earth's biota since the end of the Pleistocene have been as radical . . . or as swift.'

Unless remedial action is undertaken promptly, many of the distinctive communities of lowland grasslands and grassy woodlands in Victoria, and many of the rare and threatened species they contain, will soon become extinct. A comprehensive conservation program must immediately be implemented if these threatened ecosystems and species are to survive. To succeed, such a program must include (1) the protection and maintenance of intact remnants, including those containing rare or threatened species, (2) the establishment, in all regions of the

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**Fig. 1.** Probable distribution of lowland grasslands and grassy woodlands prior to European settlement of Victoria. The mapped area in the Raak Plain in north-west Victoria comprises a mosaic of grasslands and saline shrublands. Additional areas may occur in south Gippsland. Based on land-system maps prepared by Rowan (1988) for the Land Conservation Council (1988), see text for details.

state, of reserves large enough to remain viable, and (3) the restoration of plant communities and the re-establishment of rare plants and animals within these secure reserves (Frood and Calder 1987, Lunt in press).

Although a comprehensive network of large reserves is vital, reservation is but the first step in conserving these threatened ecosystems. Ultimately, their conservation depends upon appropriate management. This problem is graphically illustrated in Hattah-Kulkyne National Park, where intensive grazing by large populations of Western Grey Kangaroos (*Macropus fuliginosus*) continues to degrade 'protected' plant communities such as Pine-Buloke woodland, by consuming and preventing the regeneration of many species, including a number of rare plants (Cheal 1986, Mueck 1988).

The aim of this paper is to review recent literature relevant to the conservation management of lowland grasslands and grassy woodlands. The paper is not intended to provide pithy prescriptions for site management. Attention is focussed on flora and vegetation rather than fauna

management; the latter topic deserves a review of its own. The paper is an extended version of one presented earlier (Lunt 1990a). Plant names follow Ross (1990).

Unlike many vegetation types, lowland grasslands and grassy woodlands often require intensive management to maintain their biological values. Most *Themeda* grasslands, for instance, require burning (or some other form of canopy removal) every three to five years to prevent the vigorous Kangaroo Grass (*Themeda triandra*) from smothering smaller native herbs (Stuwe and Parsons 1977, McDougall 1989a).

### Ecosystem definition

Lowland grasslands and grassy woodlands are non-alpine ecosystems, in which mature trees are absent or scattered (generally with less than 30% cover). The ground layer is dominated by native grasses, and herbaceous plants predominate. Few ferns occur, and small-leaved 'heathy' shrubs are typically uncommon. 'Typical' Australian families such as Myrtaceae, Proteaceae and Epacridaceae are poorly represented. Lowland

grasslands and grassy woodlands are most extensive in flat to gently undulating landforms, on relatively fertile, heavily-textured soils. Collectively, 'lowland grasslands and grassy woodlands' correspond to the 'Savannah' land systems, which Specht (1972) described from South Australia. In Victoria, these ecosystems are almost totally confined to the lowland plains below 500 m altitude, except for a series of isolated occurrences in inter-montane basins in the east of the State, as at Buchan, Benambra and Omeo.

### Original distribution

It is difficult to accurately map the pre-European distribution of lowland grasslands and grassy woodlands due to the paucity of historical records and the near total destruction of the ecosystems. The lack of recent vegetation surveys compounds the problem. Recent maps of Victorian vegetation (e.g. Paine 1982, Forests Commission Victoria 1984, Land Conservation Council 1988) either fail to distinguish lowland grasslands from cleared pastures or fail to distinguish grassy woodlands from sclerophyllous forests, particularly in central Victoria. The map of lowland grasslands and grassy woodlands shown in Fig. 1 is derived from land-system maps prepared by Rowan (1988) for the Land Conservation Council (1988). It shows those areas which are most likely to have supported grassy ecosystems prior to settlement: principally, Rowan's (1988) 'plains' land-forms of fine-textured soils. Relevant vegetation maps (e.g. Land Conservation Council 1987) and regional land system reports (e.g. Gibbons and Downes 1964) were also consulted. As shown in Fig. 1, lowland grasslands and grassy woodlands occupied about eight million hectares, over a third of Victoria, prior to European settlement.

### Grazing by stock

Grazing by domestic stock has had an incalculable impact on the composition and structure of lowland grasslands and

grassy woodlands. Within four years of European settlement, Robinson (in Bride 1898, Conley 1984) reported that Kangaroo Grass was replaced by a 'silk-grass' (thought by Moore (1959) to be the exotic Squirrel-tailed Fescue, *Vulpia bromoides*).

The ecological effects of grazing increase exponentially with grazing intensity (Robinson and Dowling 1976). Morcom (1990) demonstrated a progressive reduction in the number of native plant species and a concomitant increase in the cover and percentage of exotic species, with increasing grazing intensity.

As grazing pressure increases, tall, native perennial grasses such as Kangaroo Grass and Silky Blue-grass (*Dichanthium sericeum*) are replaced by small tussock-grasses such as Spear-grasses (*Stipa* species) and Wallaby-grasses (*Danthonia* species), and then by introduced, annual grasses and herbs (Moore 1962, 1964; Robinson and Dowling 1976). The overall change is from tall, summer-growing, perennial, native grasses to short, winter-growing, annual, introduced species. Such changes are accentuated by soil disturbance and the application of fertilizers (Robinson and Dowling 1976). Grazing may also cause genotypic changes within grazing-tolerant species, for example, by selecting for short over tall Wallaby-grasses (Scott and Whalley 1984). Grazing by sheep is more destructive than grazing by cattle (Moore and Biddiscombe 1964) as sheep are more selective of palatable plant species and graze more uniformly and closely than cattle (Wells 1969).

Although Kangaroo Grass is sensitive to grazing, and may rapidly decline under grazing pressure, it is not particularly palatable to stock except when it is young (Leigh and Holgate 1978, Whalley *et al.* 1978). Thus, initial grazing pressure is often directed, not at the dominant grasses such as Kangaroo Grass, but at less common components of the flora, particularly forbs (Leigh and Holgate 1978). Species such as Yam Daisy (*Microseris*

*lanceolata*) are particularly palatable and sensitive to grazing (Farrington and Mitchell 1966). Thus, stock grazing even at low intensities can have a major impact on the grassland flora, with little obvious effect on the dominant grasses. This process is well documented in alpine grasslands. Alpine Tussock-grasses (*Poa* species) are of low nutritional quality, and, to maintain an adequate diet, cattle rely upon less abundant, but more nutritious herbs, including the composites, Snow Daisy (*Celmisia asteliifolia*), Billy-Buttons (*Craspedia* sp.) and Alpine Podolepis (*Podolepis robusta*) (van Rees 1982, van Rees and Holmes 1986). Grassland remnants on grazed private properties on the western plains typically have fewer native species than ungrazed (and regularly burnt) sites on railway reserves (Stuwe and Parsons 1977). Stock rarely graze a site uniformly, and areas such as drainage lines tend to be grazed most intensively. Grazing pressure in these areas is usually considerably higher than in the site as a whole. Pugging of the moist soil causes further damage.

Nevertheless, *Themeda* grasslands in particular require periodic disturbance of the vegetation (not the soil) to prevent the vigorous Kangaroo Grass from smothering smaller plants (Stuwe and Parsons 1977). Many remnants that have not recently been grazed, burnt or otherwise 'disturbed' possess dense Kangaroo Grass with few other native species (McDougall 1987, 1989a).

Management techniques such as burning are not always suitable or possible to implement, particularly on agricultural land, and, in some instances, grazing by stock may be preferable to no management at all (Scarlett and Parsons 1982, Fensham and Kirkpatrick 1989). The conservation value of lowland grasslands and grassy woodlands that form unimproved pastures on private properties are unlikely to degrade rapidly if the current management regime (including stocking rates and fertilizer usage) remains

unaltered. Deferred and rotational grazing regimes, in which stock are allowed to graze in sensitive areas from late summer to mid-winter only (when few native plants are flowering or rapidly growing), may enhance the conservation of lowland grasslands and grassy woodlands in some cases. However, grazing by stock is clearly inappropriate in conservation reserves and in intact grassy ecosystems on public land as, at best, it may maintain the quality of a lowland grassland or grassy woodland, but it can rarely, if ever, improve it. The grazing of high quality remnants that previously have escaped grazing will rapidly, and probably irreversibly, lead to a deterioration in vegetation quality.

### Grazing by native herbivores

Prior to European settlement, native herbivores, including kangaroos and smaller macropods, undoubtedly played an important role in the ecology of lowland grasslands and grassy woodlands. Grazing, browsing, trampling and digging all influenced plant survival and reproduction. The mammalian fauna of lowland grasslands and grassy woodlands has been grossly depleted since European settlement, and many of the smaller mammals are now extinct (Bennett 1982, Seebeck 1984). Nevertheless, native mammals still play an important role in many grassy woodlands.

Robertson (1985) studied the impact of Eastern Grey Kangaroos (*Macropus giganteus*) in a grassy woodland with a *Themeda* understorey at Gellibrand Hill near Melbourne. Grey Kangaroos were found to be highly selective grazers, feeding almost exclusively on monocotyledons, particularly grasses and the exotic irid, Common Onion-grass (*Romulea rosea*). Forbs and woody plants were not significantly grazed, despite their higher nutritive value. Such grazing had a greater selective impact on the vegetation than did burning, and promoted herbs that kangaroos found unpalatable, such as the

exotic Cape Weed (*Arctotheca calendula*) and clovers (*Trifolium* species). Grazing by Eastern Grey Kangaroos in the Tidbinbilla Nature Reserve (ACT) was found to deplete a number of herbs including Kangaroo Grass, and to favour species such as the native Red-leg Grass (*Bothriochloa macra*) and the exotics, Soft Brome (*Bromus hordeaceus* ssp. *molli-formis*), Cat's-car (*Hypochoeris radicata*) and clovers (*Trifolium* species) (Neave and Tanton 1989).

By contrast, Swamp Wallabies (*Wallabia bicolor*) browse rather than graze, and generally eat woody and broad-leaved plants, plus a proportion of grasses. The dominant food plants of Swamp Wallabies at Gellibrand Hill are eucalypt seedlings, Hedge Wattle (*Acacia paradoxa*) and the exotic forb, Ribwort (*Plantago lanceolata*) (Allen 1987).

The impact of kangaroo grazing depends upon the population density of kangaroos. Neave and Tanton (1989) concluded that kangaroo populations in Tidbinbilla Nature Reserve should be diminished in order to maintain a *Themeda*-dominated understorey. More dramatically, large populations of Western Grey Kangaroos (*Macropus fuliginosus*) pose a serious threat to Pine-Buloke woodlands in Hattah-Kulkyne National Park. As mentioned earlier, high population levels severely degrade vegetation and restrict the regeneration of many rare and threatened plants (Cheal 1986, 1988, Coulson and Norbury 1988, Mueck 1988).

### Burning

Lowland grasslands and grassy woodlands were frequently burnt by Aborigines before European settlement (Nicholson 1981). Fire still plays an important ecological role in many grassland remnants, particularly those on railway reserves. A number of endangered plants of lowland grasslands and grassy woodlands depend on specific burning regimes for regeneration, particularly late-flowering native legumes (e.g. *Psoralea*

species), which require fires in autumn, rather than late spring or early summer, in order to permit flowering and seed production (Scarlett and Parsons 1982). Regular burning in *Themeda* grasslands maintains the diversity of native plants by preventing the vigorous Kangaroo Grass from outcompeting smaller native plants (Stuwe and Parsons 1977, Robertson 1985). However, burning also promotes many exotic species, particularly in degraded remnants (Lunt 1990b).

McDougall (1989a) provides a comprehensive review of recent literature on burning in *Themeda* grasslands, and the reader is referred to that document for further discussion. McDougall's (1989a) major conclusions were:

'Fire is necessary to prevent build-up of *Themeda* litter and maintain species diversity in natural and restored grasslands.'

'Burning should be done at least every five years but will probably not be detrimental if done as frequently as every two years. The amount of fuel produced by a grassland in the first year after burning will generally not be enough to warrant control burning for fire protection.'

'The time of burning is probably not critical unless burning is done annually. It will most often be regulated by ease of burning. Late summer and autumn fires will therefore be most common.'

A primary aim of management at many sites will be to protect rare or threatened plants. In such instances, burning should only be conducted after such plants have flowered and shed seed. Since most native herbs in lowland grasslands and grassy woodlands flower in mid-spring (Groves 1965) this may necessitate burning in late summer or autumn.

It must be emphasised, however, that the conclusions above have been made on the basis of the limited data available, and that further research on fire regimes in lowland grasslands and grassy woodlands is urgently required. Furthermore, should

these conclusions prove correct, they may apply only to *Themeda* grasslands; species-rich Red Gum (*Eucalyptus camaldulensis*) and Yellow Box (*E. melliodora*) woodlands in the Grampians (Lunt 1990c), and Sandplain Grassland in the Mallee, for instance, do not appear to need fire to maintain their diversity.

### Ploughing and grading

Ploughing, grading, ripping, and other soil disturbances are antithetical to the conservation of lowland grasslands and grassy woodlands. Hobbs and Atkins (1988) demonstrated that soil disturbance greatly favours the establishment of introduced species. As noted by Stuwe (1986), 'ploughing or grading cause rapid, often virtually complete, removal of native vegetation and its replacement by introduced species'.

### Mowing

Little research has been undertaken on the effects of mowing or slashing in lowland grasslands and grassy woodlands. Stuwe (1986) believed that 'slashing or mowing adds to plant litter and favours the ingress of introduced species via disturbances caused by the machinery used and aggregated litter'. Similarly, (equivocal data in) Kirkpatrick (1986) suggested that mowing may diminish the diversity of native plants. Regular mowing of grassy woodlands prevents tree regeneration.

Chan (1980) found that Kangaroo Grass, Wallaby-grasses (*Danthonia carphoides* and *D. auriculata*) and Kneed Spear-grass (*Stipa bigeniculata*) declined when mown every three months or more often. Such frequencies also promoted a number of exotics, including Squirrel-tail Fescue (*Vulpia bromoides*), Hair-grasses (*Aira* species), Rib-wort (*Plantago lanceolata*), Clovers (*Trifolium* species), Garden Dandelions (*Taraxacum* sect. *Vulgare*) and Cat's-ear (*Hypochoeris radicata*). McDougall (1989a) noted that regular mowing led to a marked reduction

in *Themeda* cover, but concluded that intact, although somewhat degraded, *Themeda* grasslands were 'reasonably tolerant' of mowing. As a general rule, mowing is probably less favourable to native grasslands than is burning (Kirkpatrick *et al.* 1988). However, annual or biennial mowing of *Themeda* grasslands may be preferable to no management at all. Chan (1980) recommended that native grasslands not be mown between early October and late January, to promote the growth, carbohydrate accumulation and flowering of the dominant grasses. Grassy ecosystems should not be mown to less than 10 cm high, in order to permit the survival of native herbs (Lodder *et al.* 1986).

### Trampling and vehicular impact

The small herbs of many lowland grasslands and grassy woodlands are often susceptible to trampling, both by foot and vehicular traffic. Damage is most marked when vehicles drive over soft, moist soil, leaving indelible wheel ruts. Kangaroo Grass is very susceptible to trampling, particularly when old and unburnt (McDougall 1989a), and can be eliminated from wheel ruts after a single drive over soft, wet ground (Lunt 1987).

### Tree regeneration

The density of trees in many areas of Victoria has declined considerably since European settlement (Woodgate and Black 1988) and many of the original woodlands are now treeless or only sparsely treed. Woodlands of Silver Banksia (*Banksia marginata*) were cleared so soon after settlement that they were omitted from many of the earliest surveyors maps (Powell 1967). Prior to European settlement, tree densities were controlled by a range of factors, including climate, soil-type, drainage, burning by Aborigines and browsing by native herbivores. In some areas, the distribution of trees at the time of settlement may have

represented only a temporary phase in a shifting mosaic, affected by burning, browsing and weather conditions, rather than a static pattern determined by climate or edaphic factors.

Stock grazing has prevented the regeneration of trees in many grassy woodlands. However, where trees remain, considerable regeneration may occur after stock are removed. In such instances (e.g. at Gellibrand Hill Park, and on many unburnt roadsides in eastern and western Victoria) dense regeneration may conflict with the desire to retain an open woodland with scattered trees, as dense trees can cause dramatic changes in the composition of the grassy ground layer (Robertson 1985, McDougall 1989a). Such regeneration may be controlled by burning or grazing by wallabies. Robertson (1985) found that regeneration of tree seedlings was severely curtailed by burning every six years, and Allen (1987) reported that browsing by Swamp Wallabies controlled tree and shrub regeneration.

### Tree planting

Lowland grasslands have, by definition, few or no trees, and grassy woodlands have an open canopy of scattered trees. Consequently, dense plantings of trees or shrubs will dramatically alter the original structure of these ecosystems. Tree planting has a dramatic effect on ground plants as well. Distinctive zones occur in the gaps between trees, in 'haloes' surrounding trees, and beneath the canopies (Robertson 1985). Kangaroo Grass does not compete well beneath trees, where it is replaced by Spear-grasses (*Stipa* species) and Wallaby-grasses (*Danthonia* species) (McDougall 1989a). This effect may extend up to 30 m beyond the tree canopy (McDougall 1989a).

Although tree planting is undesirable in native grasslands, it may have a positive role in grassy woodlands in which the original tree cover has declined, by promoting plant diversity by enhancing

habitat variability. Obviously, trees should not be planted at densities greater than that of the original woodland.

### Herbicides and fertilizers

Herbicides can dramatically alter the composition of lowland grasslands and grassy woodlands. Herbicides are often used to control grass growth for fire protection. However, their indiscriminate use typically kills native plants and results in vigorous stands of exotic species, such as Canary-grasses (*Phalaris* species), Cocksfoot (*Dactylis glomerata*) and Yorkshire Fog (*Holcus lanatus*), which are of greater fire hazard than the original natives (Stuwe 1981). However, selective application of herbicides can play an important role in controlling weeds in lowland grasslands, including woody weeds such as Briar Rose (*Rosa rubiginosa*) and dense infestations of exotics such as Chilean Spear-grass (*Stipa neesiana*) and Canary-grasses (*Phalaris* species). Research is currently underway on the use of selective herbicides to deplete exotic species without adversely affecting native grasses (Shears 1988, McDougall 1989a,b, Morgan 1989). However, research has not yet been conducted on the susceptibility of native forbs, most of which are considerably rarer than the dominant native grasses.

Most Australian plants are adapted to low nutrient levels. Many exotic grasses show a greater response to additional nutrients than do native grasses such as Kangaroo Grass and Wallaby-grasses (Groves *et al.* 1973, Fisher 1974, Culvenor 1981). Consequently, fertilizers give exotic grasses a competitive advantage over native plants, and may promote dense stands of exotics which can smother and out-compete native plants. Exotic species may be benefited most greatly when fertilizers are applied to disturbed soil (Hobbs and Atkins 1988). Fertilizers should never be applied to native grasslands and grassy woodlands.

### Rehabilitation and re-creation

Due to the ubiquitous impact of European land use, particularly agriculture, all remnant lowland grasslands and grassy woodlands are degraded to some degree. As noted by Stuwe (1986), 'it could be argued that **pristine** native grasslands on the western plains, and probably throughout lowland Victoria generally, are extinct.' Consequently, some degree of vegetation management is required at all remnant sites.

Management of degraded ecosystems invariably involves rehabilitation - the introduction (or reintroduction) of depleted plants or animals to protected remnants. The intensity of rehabilitation may vary greatly, depending upon the level of past and continuing degradation and the aims of management. Minimal rehabilitation may involve the introduction of rare and endangered species into intact lowland grasslands and grassy woodlands. Maximal rehabilitation includes attempts to re-create entire grassland and grassy woodland ecosystems from scratch.

A popular myth persists that grasslands are 'simple' ecosystems, which are simple to create, by virtue of their seemingly simple structure (i.e. one apparent layer). However, grassland structure may be extremely complex at the small scale (e.g. Mitchley 1988). Moreover, the complexity of these ecosystems arises not merely from their structural form, but from their floristic and faunal composition and interactions. Some grassy woodlands in western Victoria that are structurally 'simple' are among the richest vegetation communities in the temperate world, with up to 45 species in a single square metre (Lunt 1990c). Their re-creation is, for all intents and purposes, impossible. There is no evidence to suggest that lowland grasslands or grassy woodlands are any easier to construct than are other ecosystems, such as rainforests, forests or heathlands. Artificial grasslands and grassy woodlands are rarely, if ever, likely to approximate the ecological integrity of natural ecosystems.

It is important to remember that a native grassland is an ecosystem containing a wide variety of plants and animals. A re-created, mono-specific stand of Kangaroo Grass is not a grassland ecosystem. As noted by McDougall (1989a) 'grassland restoration ... is not an alternative to preservation of remnants.'

Notwithstanding the above criticisms, the long-term conservation of many grassland ecosystems may rely upon the use of re-created sites to augment small and isolated natural remnants. Reconstructed ecosystems may be used for *ex situ* plant conservation and to propagate species for re-establishment in natural ecosystems. They may also have value for horticultural, landscape and educational reasons.

### Summary

Conservation of lowland grasslands and grassy woodlands is dependent upon re-creation and informed vegetation management. Although further research on most aspects of vegetation management is urgently required, some generalisations can be made.

Introduced stock eat palatable species (e.g. many daisies) in preference to most dominant grasses (including Kangaroo Grass) and will invariably diminish the conservation value of grassy ecosystems.

Most importantly, stock should not graze remnant grasslands and grassy woodlands that have not previously been grazed (e.g. rail-lines and some roadsides).

Any action that breaks the soil surface, including ploughing, grading, mowing and ripping, will degrade lowland grasslands and grassy woodlands. Fertilizers should never be applied.

An appropriate burning program appears to be the most suitable form of management for intact *Themeda* grasslands. In general, *Themeda* grasslands should be burnt at least every five years.

*Themeda* grasslands should be burnt rather than mown. However, if mown, native grasslands should not be mown

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more than once every three months, and preferably not more than once a year.

Trees should not be planted in native grasslands. Trees should not be planted in grassy woodlands at densities greater than that of the original woodland.

A native grassland is an ecosystem containing a wide variety of plants and animals. A reconstructed, mono-specific stand of *Themeda* is not a grassland ecosystem. Attempts to re-create lowland grasslands and grassy woodlands 'from scratch' are supplements, not alternatives, to the conservation of intact remnants.

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# Threatened birds in Victoria: their distributions, ecology and future

Doug Robinson\*

## Abstract

This paper documents the distributions, habitat preferences, nest-site characteristics and diets of threatened landbird species in Victoria. Most threatened species occur in the western and northern regions of the State. Most are dependent on grassy woodlands, mallee or box-ironbark forests. Grassy woodland and box-ironbark habitats have been extensively cleared in Victoria and the remainder occurs as comparatively small, isolated fragments. It is envisaged that continuing fragmentation and loss of native vegetation will cause local extinctions and a decline in the status of now-common species. Species most at risk comprise ground-feeders, large predators, ground-nesters and hollow-nesters, particularly those that occur in woodland, dry forest or grassland habitats. Protection of remnant patches of native vegetation is urgently needed to conserve these birds. Habitat protection is needed not only on public land but also on private land to retain any vestige of once-widespread ecosystems. Conservation and restoration of roadside reserves may be critical for the long-term survival of some threatened species.

## Introduction

Since European colonization of Victoria, land has been cleared at a startling rate (Fig. 1). Almost 60% of the original cover of forests and woodlands has been cleared for agriculture, mining or settlement (Woodgate and Black 1988). Ninety-five percent of native grasslands have been eliminated or degraded. Seventy percent of the remaining forest cover is severely modified (State Conservation Strategy 1987).

Habitat modification has been greatest in those areas most suitable for grazing and agriculture (Frood and Calder 1987; Woodgate and Black 1988). These comprise the western, Wimmera and northern plains, parts of the mallee and the coastal plains (Frood and Calder 1987). Between 3 and 40% of the original tree cover remains in these areas. By contrast, some 50 to 93% of original cover remains in the more mountainous, northeastern and eastern districts of Victoria (Woodgate and Black 1988).

Patterns of mammal extinctions in Victoria have paralleled patterns of habitat loss. Twenty-one species of native mammal are considered to have become extinct in Victoria (Menkhorst 1987). Eighteen of these occurred mostly in the mallee, northern plains or western plains (Strahan 1983; LCC 1987). Only one extinct species, the Tasmanian Bettong *Bettongia gaimardi*, was restricted to southern Victoria. Of 60 species of native mammal recorded from the mallee since European settlement, 20 have become extinct (LCC 1987; Bennett *et al.* 1989). Ten of 18 species of native mammal recorded from the western plains are also extinct locally (Bennett 1982). By contrast, only two of 48 species of native mammal recorded from East Gippsland in historical times have become extinct (LCC 1985a).

Comparable data have not been compiled for patterns of bird species' loss, perhaps because fewer species have become extinct. Nevertheless, population sizes of many bird species in Victoria have decreased markedly since European settlement and some local populations have become extinct (Middleton 1974; Emison *et al.* 1987; Robinson in prep.). This paper thus attempts to identify the

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Fig. 1. Changes to forest cover in Victoria 1869-1987 (from Woodgate and Black 1988).

habitat preferences, food requirements and nest-site requirements of birds considered to be at risk in Victoria.

## Methods

Forty species of landbird are listed as threatened in Victoria (Baker-Gabb 1990). These comprise species listed as endangered, vulnerable, rare, indeterminate (known to be endangered, vulnerable or rare), and insufficiently known (suspected of being threatened) (Table 1). They are hereafter referred to as threatened. The 188 species of non-threatened landbirds that occur regularly in Victoria are hereafter referred to as common.

Geographical distributions of threatened species were recorded for every 30' x 30' block in Victoria, using data from the Atlas of Victorian Birds (Emison *et al.* 1987). From this information I calculated the total number of threatened species recorded per block.

Habitat preferences, nest-site requirements and diets of threatened and common species were derived from literature sources (Pizzey 1980; Blakers *et al.* 1984; Emison *et al.* 1987). Physiographic regions were obtained from Emison *et al.* (1987). Habitats were broadly defined according to the categories listed by Frood and Calder (1987). The seven habitats recognized were:

**grasslands** (communities 5.1 and 5.4 in Frood and Calder 1987);

**grassy woodlands**, Red Gum woodlands and Red Gum riparian forest (communities 5.1, 5.2, 5.3, 5.4);

**dry forests and heathy woodlands** (communities 3.1, 3.2, 3.3, 3.4, 6.3, 6.4, 6.5);

**wet forests, montane forests and rain-forests** (communities 1.1, 2.1, 2.2, 2.3, 2.4);

**heathlands** (communities 6.1, 6.2, 7.1);

**mallee** (communities 8.1, 8.2, 8.3);

**saltmarsh, saltbush, samphire** (communities 5.4, 7.2, 7.3).

Nest-site categories were defined as: ground, less than 1 m above the ground, understorey, canopy, tree hollows, and tunnels and sheltered sites.

Diet categories were defined as: ground seeds, ground invertebrates, shrub and understorey invertebrates and/or nectar, canopy invertebrates and/or nectar, understorey and canopy seeds and fruit, aerial insects, and vertebrates and/or large invertebrates.

More than one habitat could be listed as a species' major habitat if that species was recorded from different vegetation communities. Food preferences and nest-site requirements were scored only once for each species. Analyses of threatened species' nest-site requirements and diets were done by Chi-square comparisons between threatened and common species. Analyses of threatened species' distributions in northern (north of 37°S) and southern Victoria, and western (west of Melbourne) and eastern Victoria were done by Student's t-tests.

## Results

More than 50% (23 species) of threatened landbird species in Victoria occur in grassy woodland or mallee habitats (Table 1). Another five threatened species occur in dry forest or woodland habitats (Table 1), particularly in box-ironbark forests and woodlands (Emison *et al.* 1987; Brouwer and Garnett 1990). These habitats all occur widely in western and northern Victoria (Frood and Calder 1987). Consequently it is not surprising that more threatened species have been recorded per 30' x 30' block from western than eastern Victoria, and northern than southern Victoria (Table 2). The most significant regions for threatened species are the Northern Uplands, Lower Murray Valley, Grampians, Mallee, East Gippsland, Mid Murray Valley, Northern Plains, Upper Murray Valley, Little Desert, Northern Goldfields and Wimmera Plains (Fig. 2). Few threatened species occur in the Victorian highlands or on the coastal, volcanic, or Gippsland plains (Fig. 2).

Although woodland and mallee habitats support the largest number of threatened landbirds in Victoria, every major habitat supports one or more threatened species. Eleven species are confined to habitats in southern and eastern Victoria: Grey Goshawk, Sooty Owl, Powerful Owl and Masked Owl to wet forest habitats; King Quail, Ground Parrot, Eastern Bristlebird and Rufous Bristlebird to coastal and near-coastal heaths; Glossy Black-Cockatoo to East Gippsland forests; Orange-bellied Parrot to coastal salt-marshes; and Helmeted Honeyeater to damp forests near Melbourne (Emison *et al.* 1987). The remaining 29 species of threatened landbird are more common in western and northern Victoria.

Threatened species appear to have significantly different nest-site and diet requirements from those of common species. A significantly greater proportion of threatened species than common species nest in tree hollows ( $x = 2.74$ ,  $P < 0.10$ ), and on or near the ground ( $x = 6.51$ ,

$P < 0.05$ ). By contrast, more common species nest in the understorey and canopy layers ( $x = 7.6$ ,  $P < 0.01$ , Table 3).

Thirty-five percent of threatened species feed largely on seeds or fruit, while only 22% of common species do so. A higher percentage of threatened species also feed on vertebrate prey (Table 4). Common species instead tend to feed on invertebrates and/or nectar in the canopy and understorey layers of vegetation. Some common species also feed on aerial insects. No threatened species do so (Table 4).

## Discussion

The two bird species considered to be extinct in Victoria, the Night Parrot *Geopsittacus occidentalis* and Magpie Goose *Anseranas semipalmata* (Baker-Gabb 1990) were confined to, or recorded at highest densities from the western and northern districts of the State (Emison *et al.* 1987; Frood and Calder 1987). Similarly, most landbirds now threatened in Victoria occur in the western and northern regions (Fig. 1), notably in woodland, mallee, box-ironbark and grassland habitats. The distributions and habitat preferences of threatened landbirds in Victoria thus parallel the distributions and habitat preferences of the 21 Victorian mammals considered extinct. Further, it is clear that the distributions of most extinct/threatened species of bird and mammal are restricted to those areas that have endured the greatest habitat loss (Fig. 1).

Major reserves in the Mallee, East Gippsland, Little Desert and Grampians regions (Fig. 3) should provide adequate habitat protection for most threatened species found there. By contrast, the conservation status of other significant regions for threatened birds in Victoria is extremely poor. Large reserves are lacking from the Murray Valley, Northern Plains, Wimmera Plains and Northern Goldfields. More reserves are needed in the Northern Uplands (Fig. 3).

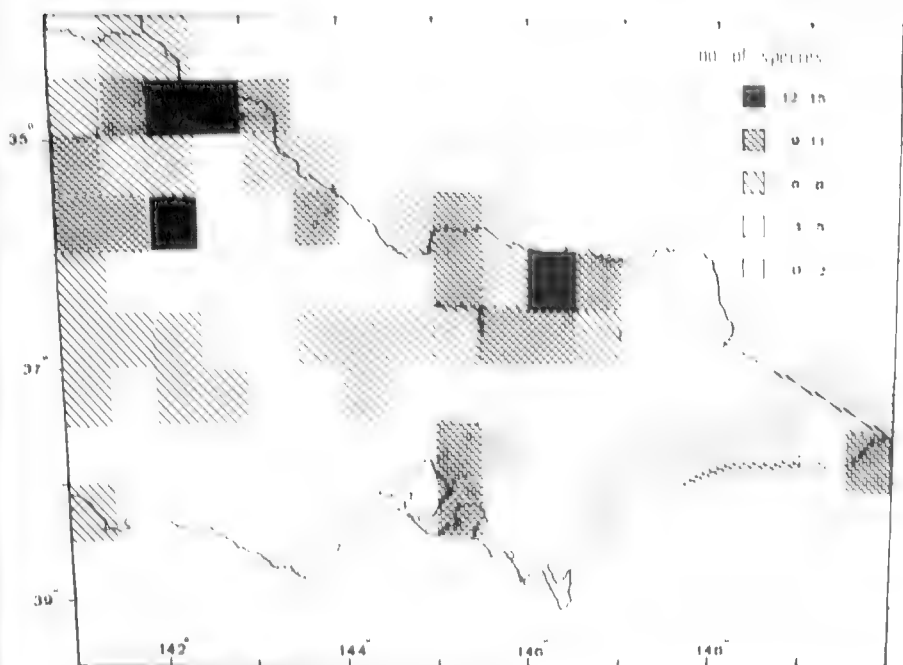


Fig. 2. Density of threatened landbird species in 30 x 30 blocks across Victoria (after Emlson *et al.* 1987).



Fig. 3. The distribution of conservation reserves in Victoria as of March, 1991.

Regent Honeyeater and Swift Parrot similarly has been linked to the disappearance and fragmentation of their major habitat — mature stands of box-

ironbark forest (Brouwer and Garnett 1990).

Even where remnant patches of woodland and grassland do remain, isolation of the patches may restrict the distributions of certain species. For instance, Regent Parrots and Superb Parrots use habitat corridors to move between their feeding and breeding grounds (Burbidge 1988; Webster 1988); they rarely cross open ground. Furthermore, neither species nests more than 10 km away from its major feeding grounds, even if suitable nest trees occur in the nearest breeding habitat. Both species consequently are absent from areas of suitable breeding habitat that are removed or isolated from patches of feeding habitat (Beardsell 1985; Burbidge 1985; Webster 1988). The distribution of Red-tailed Black-

The lack of conservation reserves and extensive habitat corridors in these areas especially threatens the survival of those bird species dependent on grassy woodlands, grasslands, and box-ironbark forests. For example, the distributions of six threatened species of woodland bird in Victoria (Red-tailed Black-Cockatoo, Pink Cockatoo, Superb Parrot, Grey-crowned Babbler, White-browed Treecreeper and Apostlebird) are linked to the distribu-

tions of *Casuarina* and *Callitris* woodlands (Emison *et al.* 1987; LCC 1987). Just as these woodlands have disappeared from much of their original range, (LCC 1983, 1985b, 1987; Frood and Calder 1987; Blakers and Macmillan 1988), so have these birds disappeared or become much less common (Middleton 1974; Emison *et al.* 1987). The Apostlebird has become locally extinct in the Wimmera (Emison *et al.* 1987). The declining status of the

**Table 2.** Mean number of threatened species recorded from different districts in Victoria. Numbers give mean, standard deviation, and sample size (number of 30' x 30' blocks).

District	No. of threatened species	P
Western	5.3 + 3.2 (65)	n.s.
Eastern	5.1 + 3.3 (51)	
Northern	6.2 + 3.5 (58)	< 0.001
Southern	4.2 + 2.5 (58)	

**Table 3.** Nest-site locations of Victorian landbirds. Open figures are percentages. Numbers in brackets give the number of species.

Nest-site category	Threatened species	Common species
Tree hollows	32.5 (13)	19.8 (36)
Tunnels, sheltered sites	0.0 (0)	3.9 (7)
Ground	15.0 (6)	8.2 (15)
< 1 m	20.0 (8)	8.2 (15)
understorey	15.0 (6)	36.3 (66)
canopy	17.5 (7)	23.6 (43)

**Table 4.** Diets and feeding substrates of Victorian landbirds. Open figures are percentages. Numbers in brackets give the number of species.

Diet category	Threatened species	Common species
Ground seeds	22.5 (9)	16.5 (31)
Canopy seeds	12.5 (5)	5.3 (10)
Ground insects	25.0 (10)	27.7 (52)
Shrub insects	7.5 (3)	12.2 (23)
Canopy insects & nectar	15.0 (6)	22.3 (42)
Aerial insects	0.0 (0)	8.0 (15)
Vertebrates	17.5 (7)	8.0 (15)

Cockatoos similarly may be constrained by the availability of habitat corridors between remnant woodland patches, as reported for the White-tailed Black-Cockatoo *Calyptorhynchus baudinii* in Western Australia (Saunders 1977). Where habitat corridors ran out, the cockatoos did not disperse further in search of new feeding areas, subsequently contributing to the extinction of the study population (Saunders *et al.* 1985).

The small size of most remnants of native vegetation in fragmented landscapes further increases the chances of local extinctions. A study of the avifauna of the wheatbelt region in southwestern Western Australia (in which 7% of original vegetation remains) found that 29% of species had declined in status over the past 80 years. A further 17% of species known to once occur there had become extinct, while more species were predicted to do so in the next twenty years (Saunders and Curry 1990). On a smaller scale, three species have disappeared from an 81 ha reserve during the past decade and the demise of a fourth species is expected soon (Saunders 1989). Conservation of remnant patches of native vegetation, and of interlinking habitat corridors, hence require urgent attention to try to arrest the increasing rate of local bird extinctions (Saunders 1989; Recher and Lim 1990).

Comparisons between the diets and nest-site requirements of common and threatened landbird species suggest that threatened species are more likely to feed on vertebrates or seeds, and to nest in tree hollows and on or close to the ground. Given these differences between the nest-site requirements and diets of threatened and common landbirds, birds most at risk of becoming threatened in Victoria are those woodland, box-ironbark and grassland species which feed on seeds or vertebrates, and/or which nest on the ground or in tree hollows. These comprise: Australian Kestrel *Falco cenchroides*; button-quail *Turnix* spp.; Blue Bonnet *Northiella haematogaster*; Sacred

Kingfisher *Halcyon sancta*; Singing Bushlark *Mirafra javanica*; Spotted Quail-thrush *Cinclosoma punctatum*, Brown Songlark *Cinclorhampus cruralis*; Rufous Songlark *Cinclorhampus mathewsi*; Speckled Warbler *Sericornis sagittatus*; Buff-rumped Thornbill *Acanthiza reguloides*; Southern Whiteface *Aphelocephala leucopsis* (listed as vulnerable in South Australia, Robinson and Brouwer 1989); Brown Treecreeper *Climacteris picumnus*; and Diamond Firetail *Emblema guttata* (a species that has declined in abundance in various parts of its range, Blakers *et al.* 1984).

Studies of the changing status of woodland species in other parts of Australia indicate that additional species may become locally rare in Victoria as the remaining habitat is fragmented or modified by various land-use activities. Species reported to have become locally rare in woodlands elsewhere include: Tawny Frogmouth *Podargus strigoides*, Australian Owlet-nightjar *Aegotheles cristatus*, White-winged Triller *Lalage sueurii*, Hooded Robin *Melanodryas cucullata*, Crested Shrike-tit *Falcunculus frontatus*, Varied Sittella *Daphoenositta chrysoptera*, Restless Flycatcher *Myiagra inquieta*, Jacky Winter *Microeca leucophaea*, White-eared Honeyeater *Lichenostomus leucotis*, White-naped Honeyeater *Melithreptus lunatus*, Brown-headed Honeyeater *M. brevirostris*, White-fronted Chat *Ephthianura albifrons*, Grey Currawong *Strepera versicolor* and Grey Butcherbird *Cracticus torquatus* (Heron 1973; Baldwin 1975; Saunders and Curry 1990). In addition, it has been noted that some still-common species in woodlands and forests are vulnerable to continuing habitat loss (Kavanagh *et al.* 1985; Saunders 1989; Saunders and Curry 1990) as their populations decline following the loss of native vegetation (Saunders 1989). Species placed in this category in the wheatbelt district of Western Australia include Grey Shrike-thrush *Colluricincla harmonica*, Golden Whistler

*Pachycephala pectoralis*, Scarlet Robin *Petroica multicolor*, cuckoos, bronze-cuckoos, Chestnut-rumped Thornbill *Acanthiza uropygialis* and White-winged Fairy-wren *Malurus leucopterus* (Saunders and Curry 1990).

Altogether, some 60% of the Western Australian wheatbelt district's avifauna has declined in status or become vulnerable to further vegetation loss over the past 80 years (Saunders 1989; Saunders and Curry 1990). No such data are available for the avifauna of Victorian woodlands. It seems clear, nonetheless, that local patterns of decline and loss among the woodland avifauna here will resemble the patterns described above. This is especially true of the Northern Plains where just 15% of original vegetation remains (Woodgate and Black 1988). Protection of remnant patches of grassy woodlands, grasslands and box-ironbark forests through the Murray Valley, Northern Uplands, Northern Plains, Wimmera Plains and Northern Goldfields consequently is critical to the conservation of the remaining avifauna. Such habitat protection is needed not only on public land but also on private land. Conservation of roadside reserves of native vegetation is especially important to the long-term survival of some threatened species (Saunders 1989; Bennett 1990). Without such protection, habitats will continue to be fragmented and mature trees lost (Saunders *et al.* 1985; Saunders 1989), increasing the chances of local extinctions (Saunders 1977; Saunders 1989; Webster 1988).

Although this paper has focussed on the adverse effects of vegetation loss and fragmentation in woodland, box-ironbark and grassland habitats, it should be emphasized that similar processes endanger species in other habitats (Recher and Lim 1990). Timber-harvesting operations may adversely affect the status of 50% of the local avifauna, by removal of mature eucalypt forest (Lobert *et al.* in prep.). They may threaten the survival of some

forest-dependent species such as the larger owls (Powerful Owl, Masked Owl, Sooty Owl), canopy-feeders and bark-foraging birds. Conservation of such species requires protection of remnants of ecologically mature forest (Recher and Lim 1990). Without protection of mature forest remnants, populations of forest-dependent species will inevitably decline (Recher and Lim 1990). Similarly, without protection of remnant native vegetation in other habitats throughout the State, bird species now listed as common in Victoria may soon become threatened, and species now threatened may become extinct.

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Table 1.

Habitat distributions, diets and nest sites of threatened landbird species in Victoria. Status categories are: endangered (A), vulnerable (B), rare (C), indeterminate, possibly threatened (D) and insufficiently known (E) (Baker-Gabb 1990). The habitat categories include all vegetation communities listed for each habitat in the Methods section.

Species	Status	Habitat	Diet	Nest site
Malleefowl				
<i>Leipoa ocellata</i>	(B)	mallee	ground seeds	ground
Regent parrot	(C)	mallee, grassy woodlands	ground seeds	hollows
<i>Polytelis anthopeplus</i>				
Red-lored Whistler	(B)	mallee	ground insects	understorey
<i>Pachycephala rufogularis</i>				
Western Whipbird	(A)	mallee	ground insects	< 1 m
<i>Psophodes nigrogularis</i>				
Mallee Emu-wren	(B)	mallee shrub insects	< 1 m	
<i>Stipiturus ruficeps</i>				
Striated Grasswren	(B)	mallee	ground seeds	< 1 m
<i>Amnytoris striatus</i>				
Redthroat				
<i>Sericornis brunneus</i>				
Slender-billed Thornbill	(B)	mallee shrub insects	< 1 m	
<i>Acanthiza iredalei</i>				
Black-eared Miner	(C)	mallee shrub insects	< 1 m	
<i>Manorina melanotis</i>				
Grey-fronted Honeyeater	(A)	mallee	canopy insects	canopy
<i>Lichenostomus plumulus</i>				
Bush Thick-knee	(D)	mallee	canopy insects	understorey
<i>Burhinus magnirostris</i>				
Red-tailed Black-Cockatoo	(B)	grassy woodlands	ground insects	ground
<i>Calyptrorhynchus magnificus</i>				
Pink Cockatoo	(A)	grassy woodlands	canopy seeds	hollow
<i>Cacatua leadbeateri</i>				
	(D)	grassy woodlands	canopy seeds	hollow

Species	Status	Habitat	Diet	Nest site
Superb Parrot <i>Polytelis swainsonii</i>	(C)	grassy woodlands	ground seeds	hollow
Turquoise Parrot <i>Neophema pulchella</i>	(C)	grassy woodlands	ground seeds	hollow
Barking Owl <i>Ninox connivens</i>	(C)	grassy woodlands	vertebrates	hollow
Ground Cuckoo-shrike <i>Coracina maxima</i>	(C)	grassy woodlands	ground insects	canopy
Grey-crowned Babbler <i>Pomatostonus temporalis</i>	(B)	grassy woodlands	ground insects	understorey
White-browed Treecreeper <i>Climacteris affinis</i>	(D)	grassy woodlands	canopy insects	hollow
Spotted Bowerbird <i>Chlamydera maculata</i>	(A)	grassy woodlands	canopy fruit	understorey
Apostlebird <i>Struthidea cinerea</i>	(C)	grassy woodlands	ground insects	canopy
Grey Falcon <i>Falco hypoleucos</i>	(B)	grasslands, woodlands	vertebrates	canopy
Red-chested Button-quail <i>Turnix pyrrhorrax</i>	(E)	grasslands	ground seeds	ground
Plains-wanderer <i>Pedionomus torquatus</i>	(B)	grasslands	ground seeds	ground
Australian Bustard <i>Ardeotis australis</i>	(A)	grasslands, woodlands	ground insects	ground
Square-tailed Kite <i>Lopholictinia isura</i>	(B)	dry forests, woodlands	vertebrates	canopy
Glossy Black-Cockatoo <i>Calyptrorhynchus lathami</i>	(D)	dry forests	canopy seeds	hollow
Swift Parrot <i>Lathamus discolor</i>	(D)	dry forests	canopy nectar	hollow

Regent Honeyeater <i>Xanthomyza phrygia</i>	(A)	dry forests, woodlands	canopy nectar	canopy
Painted Honeyeater <i>Grantiella picta</i>	(D)	dry forests, woodlands	canopy fruits	canopy
Grey Goshawk <i>Accipiter novaehollandiae</i>	(C)	wet forests	vertebrates	canopy
Powerful Owl <i>Ninox strenua</i>	(C)	wet forests	vertebrates	hollow
Masked Owl <i>Tyto novaehollandiae</i>	(D)	wet forests	vertebrates	hollow
Sooty Owl <i>Tyto tenebricosa</i>	(C)	wet forests	vertebrates	hollow
Helmeted Honeyeater <i>Lichenostomus melanops</i> <i>cassidix</i>	(A)	wet forests	canopy nectar	understorey
King Quail <i>Coturnix chinensis</i>	(C)	heathlands	ground insects	ground
Ground Parrot <i>Pezoporus wallicus</i>	(C)	heathlands	ground seeds	< 1 m
Eastern Bristlebird <i>Dasyornis brachypterus</i>	(B)	heathlands	ground insects	< 1 m
Rufous Bristlebird <i>Dasyornis broadbenti</i>	(C)	heathlands	ground insects	< 1 m
Orange-bellied Parrot <i>Neophema chrysogaster</i>	(A)	saltmarsh	ground seeds	hollow

## Obituary

### Mrs May Salau (nee Vale)

Late 1990 saw the passing of one of the Club's oldest and longest serving members, Mrs. May Salau, in her 96th year. She was born in Heathcote and lived all her early years on a farm and then to the town to further her education. From there she began a teaching career. It was at one of her postings she met her husband Fred. Fred Salau became a Nurseryman and after several positions was sent to Clarinda to set up and manage a wholesale nursery. Mrs. Salau was elected to the Club at the meeting of the 15th of June, 1931, four months after her husband joined. On that same night Mr. Stan Colliver, a long time Secretary of the Club and then President, was also elected.

Soon after a group was set up, unofficially called the "Gang", or the Colliver Gang. These were a group of enthusiasts, both amateur and professional who got together about every two months to further their interests. The Salau home was the venue for many of these workshops. What an environment to raise a young family! Fred Salau was an authority on plants and forays were made into the nearby bush and heathland looking for rare species including orchids. These tracts have long since gone. The Colliver home was a popular venue because of Stan's large library and fossil collection. This "Gang" was no doubt the forerunner to the formation of the Geology and Botany groups.

The "Gang" broke up during World War II. Stan, a gifted amateur Palaeontologist moved to Queensland where he became long time curator of fossils at the Queensland University. He gained an Honorary Doctorate and later an O.B.E. for his services.

When her husband died, Mrs Salau moved closer to Melbourne, first to Deepdene and then to East Kew. She became a long time member of the Nature Show committee, under the leadership of Mr. Dan McInnis, helping to organize and arrange exhibits. These Annual Shows were a feature of the Club's activities and ran over a long period of time. Many of the main exhibits were of a rather ambitious nature and Mrs. Salau will be remembered by the professional way in which she approached the tasks. She was frequently heard telling fellow helpers that "near enough wasn't good enough", it had to be right.

Mrs. Salau was a prominent member of the Geology Group and the Botany Group over a long period of time. She received her Honorary Certificate in 1971 after 40 years membership.

Although in the last years of her life she was confined to a Nursing Home she kept her interest in Natural History. During this time, one thing she would not miss was the A.B.C. Science Show. She was without doubt a true Naturalist.

Tom Sault

# GUIDELINES FOR CONTRIBUTORS

## Submission of Manuscripts

The following general statements apply to all submitted manuscripts.

Three copies of the manuscript should be provided, each including all tables and copies of figures. Manuscripts should be typed, double spaced with wide margins and pages numbered. The name and address of all authors should appear beneath the paper title. The full postal address, telephone number and fax number (if available) of the author who is to receive correspondence and check the proofs should be provided.

## Abbreviations and Units

SI units (metre, kilogram, etc.) should be used wherever possible. Statistics and measurements should be given in figures (i.e. 10 mm) except where the number begins a sentence. When a number does not refer to a unit of measurement it is spelt out, unless the number is greater than nine. The word 'figure' should be abbreviated to Fig. unless starting a sentence.

## Tables and Figures

All illustrations (including photographs) are considered as figures. All figures should be referred to in the text. Original figures or high quality photographic copies should be provided with the manuscript. Each figure should bear the figure number and authors name on the back in pencil. Line drawings should be in black Indian ink on stout white paper or high quality tracing paper. Lettering should be added bearing in mind legibility after reduction. Bar scales are preferred to numerical scales. Figure captions should be numbered consecutively (Fig. 1, Fig. 2, etc.) and provided on a separate page at the end of the manuscript.

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Ashton, D. H. (1976). Phosphorus in forest ecosystems at Beenak, Victoria, *Aust. J. Ecol.*, **64**: 171-86.

Gill, A. M. (1981). Adaptive responses of Australian vascular plant species. In 'Fire and the Australian Biota'. Eds A. M. Gill, R. H. Groves and T. R. Noble, pp. 243-72. (Australian Academy of Science: Canberra).

Leigh, J., Boden, R. and Briggs, J. (1984). 'Extinct and Endangered Plants of Australia'. (MacMillan: Australia).

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A research report is a succinct, formal, original scientific communication. Preference will be given to reports that make a significant contribution to natural history literature and are of general appeal. The manuscript should consist of an abstract not exceeding 250 words, an introduction, methods, results, discussion, acknowledgements and references.

## Contributions and Naturalist Notes

The general comments on figure and table presentation, referencing and units also apply to these manuscripts. The appropriate style and format will vary with the manuscript but concise simple English should be used at all times. The use of sub-headings is encouraged where they improve comprehension.

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In which is incorporated the Microscopical Society of Victoria

Established 1880

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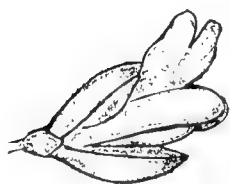
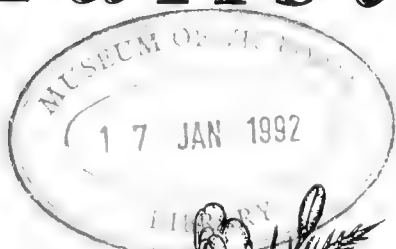
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# The Victorian Naturalist

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### **December**

- Sun. 1      General Excursion - A stroll, not a hike, for all the family, along Gardiner's Creek Valley, from Glen Iris Railway Station to Hughesdale Railway station. Leader Dan McInnes.
- Tues. 3      Fauna Survey Group - Members night and Christmas breakup.
- Wed. 4      Geology Group - Members night.
- Sat 7 - Sun 8      FSG - Frog survey eastern Otway Ranges. Contact Laurie Conole on (H) 481 4926.
- Mon. 9      General Meeting - Members night - members bring along your slides and exhibits.
- Thu. 12      Botany Group - Members night and Annual General Meeting.
- Sat. 14      FSG - Leadbeaters Possum survey. Contact Ray Gibson (H) 874 4408.
- Wed. 18      Microscopy group - no meeting until January, 1992.
- January**
- Wed. 15      Microscopy Group - Members night.
- February**
- Sun. 2      General Excursion
- March**
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Editor: Robyn Watson

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Cover photo: Gorse, a declared noxious weed in Victoria by Jim Watson.  
See the article on another serious weed, Montpellier Broom by Adams and Simmons.

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## The invasive potential of *Genista monspessulana* (Montpellier Broom) in dry sclerophyll forest in Victoria

Robyn Adams and Dianne Simmons\*

### Abstract

*Genista monspessulana*, a woody perennial species native to Mediterranean Europe, is a widespread weed of dry sclerophyll forests in Victoria. It has the potential to become a serious environmental weed because of its spread, and the promotion of germination, by management activities such as road maintenance, roadside slashing and burning. Seeds are initially dispersed by explosive dehiscence, but subsequent dispersal of seeds by ants increases the potential of the species to invade relatively undisturbed vegetation. *Genista monspessulana* is polymorphic in its germination behaviour, with 82% of seeds being 'hardseeded' and 18% of seeds being able to germinate as soon as suitable conditions allow. The dormant seeds remain as a substantial pool of soil-stored seed which is able to germinate prolifically after fire. The dispersal of *Genista monspessulana*, combined with its polymorphic germination behaviour, the size of the soil seed bank and a number of other characteristics, results in a species with great invasive potential, and which poses serious problems of control.

### Introduction

The Brooms are a group of European species, now found widely distributed as weeds throughout Victoria, and all species (Table 1) are declared noxious weeds outside the metropolitan area of Melbourne (Parsons 1971). *Cytisus scoparius* (English Broom) is already a serious weed in New Zealand (Williams 1981) and has invaded large areas of grazing land and public forest in northern New South Wales (Smith and Waterhouse 1988). *Genista*

*monspessulana* (Montpellier Broom) is becoming increasingly noticeable as a weed along roadsides, in many small bushland reserves and remnants, and in some larger areas of public forest in Victoria. Species of *Genista* are sold widely in nurseries and supermarkets as attractive ornamental bushes, but their invasive potential has clearly established them, and their close relatives, as serious bushland weeds. *Genista monspessulana*, which is a woody leguminous shrub, forms dense thickets and excludes other desirable native species. It is a native of Mediterranean Europe, and is recognized as a weed in North America and New Zealand (Parsons 1971). If *Genista monspessulana* follows the pattern indicated by other Broom species overseas, the potential for the rapid spread of *Genista monspessulana* into remnant native forest is very high.

Although *Genista monspessulana* is a widespread weed in dry sclerophyll forest in Victoria, its present distribution is patchy. It appears to be initially spread along roadsides and tracks, often as a result of road maintenance activities. During these activities soil containing seeds is rapidly redistributed, and mechanical damage to the seed coat promotes rapid germination. Roadside slashing activities also spread seed widely, in the pods attached to fragments of the adult plant. However, our observations suggested that the spread of *Genista monspessulana* was more rapid in unburnt/ "undisturbed" sites, than might be expected in a "hard-seeded" species, and a preliminary investigation into seed production, the characteristics of the seed bank in the soil and the germination requirements of *Genista monspessulana*

\*Faculty of Applied Science, Victoria College, Clayton, Victoria, 3168.

Table 1

Current taxonomic status and synonymy of the Broom species (family Fabaceae) occurring in Victoria. Nomenclature follows Forbes and Ross (1988).

Species	Synonyms
<i>Genista monspessulana</i> (L.) L.A.S. Johnson (Montpellier Broom or Cape Broom)	<i>Cytisus canariensis</i> (L.) Steud. <i>Cytisus monspessulanus</i> (L.) <i>Teline monspessulana</i> (L.) K. Koch
<i>Genista linifolia</i> (L.) (Flax-leaf Broom)	
<i>Cytisus scoparius</i> (L.) Link (English Broom)	<i>Sarothamnus scoparius</i> (L.) Wimmer ex W. Koch
<i>Calycotome spinosa</i> Link (Spiny Broom)	

seeds was commenced. Some preliminary observations and findings which have immediate implications for management, are reported here.

### Methods

**Site 1:** Site 1 was a dense infestation of *Genista monspessulana* located in dry sclerophyll vegetation in the Christmas Hills area 40 km north-east of Melbourne. Bulk seed was collected in January 1987, separated from the pods and stored for 2 years in air-tight jars at room temperature. Seeds collected in January 1987 were divided into ten replicates of 80 seeds each. Five replicates were immersed in boiling water for 60 seconds to crack the testa. Treated seeds and controls were germinated on wet filter paper in petri dishes in the light at 20°C constant temperature. Comparisons of final mean % germination of treated and untreated seeds was tested using a t-test on arcsin transformed data (Sokal and Rohlf 1969).

Ten pods were collected from each of ten plants (January 1987) and the mean number of seeds per pod, and the percentage of damaged pods was determined. Samples of litter and soil at 0-2.5 cm depth were collected from five plots of 38 cm x 38 cm in January 1988, immediately before the release of the current seed crop. The seeds were separated by sieving in order to determine

minimum levels of soil-stored seed. Mass germination of seedlings occurred following autumn rains in April 1988, and "maximum" seedling densities were determined from five undisturbed plots 25 cm x 25 cm. Seedling roots were also examined for the presence of nitrogen fixing nodules.

**Site 2:** A second site near site 1, comprising a small colonizing population with juvenile and mature *Genista monspessulana*, was burned in October 1987. All above ground plants were reduced to ash, and there were no apparent post-fire introductions of seed into the site by soil disturbance or from nearby plants. In April 1989 (18 months after burning) seedlings ranging in height from cotyledon stage to the maximum height of 17 cm were counted from five 25 cm x 25 cm plots. In September 1989 (23 months after burning) several of the seedlings were observed to be over 20 cm tall and flowering.

### Results and Discussion

#### *Seed Production and Predation*

*Genista monspessulana* produces numerous small pods covered in fine silky hairs. On average 5 seeds per pod are produced, resulting in large quantities of seeds each season (Table 2). Seed is usually released in January, and as the pods dry

out they split explosively, ejecting the seeds. Seeds were observed to be ejected up to 3 m from the seeding adult plants. For the purposes of weed management, *Genista monspessulana*, as a member of the family Fabaceae, has been assumed to have seeds all of which are "hard-seeded" and to require damage to the testa before germination can occur.

Pre-dispersal seed predation in native legumes from fire prone communities similar to those being invaded by *Genista monspessulana*, is known to be significant (Auld 1983). Pre-dispersal loss due to external seed predators was not measured, but only 5% of pods collected in January 1987 showed damage to individual seeds within the pod (Table 2). This is in marked contrast to native *Acacia* species, where seed loss may vary between 10-60% (Auld and Myerscough 1986), and of the closely related *Cytisus*, where predation may reduce seed yield by 75% in plants in their native habitat (Waloff and Richards 1977). Seasonal variation in predation rates may explain the low proportion of seed loss, but it may also be due to a lack of natural predators in these introduced populations of *Genista monspessulana*.

### Seed Dispersal

The secondary dispersal of seeds of *Genista monspessulana* may also increase the invasion of this species into native bushland. Seed transport and the removal of the elaiosome by ants has been observed in *Genista monspessulana* by the authors. Seed dispersal by ants (myrmecochory) is well documented for native plant species, especially woody sclerophyllous shrubs of heaths and dry forests, and it is particularly common within the families Fabaceae and Mimosaceae (Berg 1975). Woody weed species such as *Genista* spp. and *Cytisus* spp. are unusual in that they do not show the secondary myrmecochorus features, such as an herbaceous habit and loss of normal dehiscence in capsules, usually found in plants from the northern hemisphere (Berg 1975), but have the characteristically Australian dispersal combination of explosive fruits coupled with the subsequent dispersal by ants (Berg 1975). Although the dispersal distance may be only up to 50 cm (Mossop 1989), the similarity of the dispersal mechanism of *Genista monspessulana* to that of native shrubs makes it a species

Table 2

- (a) Final mean % germination (5 replicates) of treated and untreated seeds of *Genista monspessulana* at 20°C constant temperature.  
\*\*\*  $p < (0.001)$ .
- (b) Details of the soil stored seed bank, seed production and seedling counts at two sites (a mature, dense population and a colonizing population). Standard errors are given in brackets.

(a) Mean % germination of 20°C (treated)	96.7 ***	
Mean % germination at 20°C (untreated)	18.5 ***	
(b) Mean Number Seeds Per Pod	4.8 (0.2)	(5 x 10 pods)
Mean Number Pods per Bush	7,400 (1122.5)	(n=5)
Percentage of Pods Damaged by Insects	5%	
Mean Seed Dimensions	2.83 (0.09) mm	(5 x 10 seeds)
Mean Seed Weight	7.3 (0.1) mg	(5 x 100 seeds)
Mean Number Soil Stored Seeds	3774 (978.5) per m <sup>2</sup>	(n=5)
Number Seedlings Emerged		
Site 1 - Dense infestation (without burning)	790 (51.7) per m <sup>2</sup>	(n=5)
Site 2 - colonizing population (after burning)	174 (34.2) per m <sup>2</sup>	(n=5)

particularly well adapted to Australian conditions. The interaction of seed dispersal, seed burial, and the germination stimulus provided by fire, may maximize the invasive potential of this species into dry sclerophyll vegetation.

### Nitrogen Fixation

Seedlings of the closely related genus *Cytisus* are able to fix atmospheric nitrogen (Dancer *et al.* 1977; Wheeler *et al.* 1979; and all seedlings of *Genista monspessulana* examined, even at the first leaf stage, also had well developed root nodules. The ability of *Genista monspessulana* to fix nitrogen may convey a significant advantage to seedlings establishing on the low nutrient soils which support native dry sclerophyll vegetation.

### The Soil Seed Bank

Observations of hard-seeded native and weed species suggest that a long fire free period will result in the loss of the adult plants, and that the regeneration of the species is dependent on stimulation of soil stored seed to initiate germination (Lee *et al.* 1986). The stimulus is frequently the heat from fires, and without such a stimulus there will be no germination of these obligate seed regenerators. Vegetation managers have generally assumed that *Genista monspessulana* also follows this pattern, and have concentrated their efforts on the removal of adult plants by methods such as burning, slashing or herbicide application, but with minimal attention being given to the future potential of the soil seed bank. Large quantities of seed are held in the soil seed bank: an average of 3774 seeds/m<sup>2</sup> were recorded during this study (Table 2) and a similar seed bank estimate of 2563 seeds/m<sup>2</sup> (range 368 to 7056 seeds/m<sup>2</sup>) was obtained from a mature thicket in dry sclerophyll forest near Smythesdale (Adams and Simmons 1988, unpublished data).

### Germination

The seeds which were heat treated to simulate the cracking of the testa by fire confirmed the expected 'hard-seeded' response. They germinated rapidly at 20°C, with over 50% of viable seeds germinating within 12 days, and 90% within 14 days (Fig. 1). However, it is also apparent that *Genista monspessulana* is polymorphic in its germination behaviour. It has a significant proportion of seeds, about 18%, which do not require 'treatment' and which are able to germinate immediately on exposure to suitable temperatures and soil moisture levels (Fig. 1). These seeds usually germinate in the first months of autumn and spring, and under dense mature stands the average seedling counts in study plots were 790 seedlings/m<sup>2</sup> (7.9 million seedlings/ha, Table 2). Thus, even in the absence of fire, the annual germination of non-dormant seed is more than sufficient to enable the continuous advancement of an 'invasion front' of *Genista monspessulana* into bushland. Observations at one site indicate that the invasion front has moved over 3 m in 12 months. Managers need to take this into account when the shrubs are removed by spraying with herbicide or slashing with the assumption that soil stored seeds will not germinate in the absence of a suitable stimulus. Annual inspection of these areas will be necessary in order to remove seedlings resulting from germination of the non-dormant soil stored seed.

### Weed Management

The occurrence of bushfires in invaded vegetation, or in the use of prescribed burning as a fire prevention or weed control measure, presents managers with a massive problem in terms of seedling recruitment and the increased size of the invaded patch. Although post-dispersal seed predation was not measured, the high rate of seed production and low rates of pre-dispersal seed predation will result in the rapid build-up of soil stored seed, and

allow a large potential seedling recruitment following a fire (Auld and Myerscough 1986). The eradication of *Genista monspessulana* from these situations may take several years. The persistence of the species is exemplified by the authors' observations in a small colonizing population resulting from road maintenance earthworks, and burned with the objective of eradicating the population. Following burning, seedling emergence was quite dense (174 per m<sup>2</sup>; Table 2), and seeds were observed to continue germinating without further disturbance for up to 3 years (October 1990) after the fire. The rootstocks of some adult plants were also observed to resprout after burning, and seedlings as young as 24 months were capable of flowering and producing seed.

The removal of only the established plants of *Genista monspessulana* by burning, spraying or slashing will do little more than provide cosmetic control, as the soil stored seed provides a vast reservoir

for the rapid re-establishment of *Genista monspessulana*. Prevention of further seed production at the site is essential, and follow-up seedling removal is necessary for at least 3-5 years after the initial treatment. However, the most serious and costly management problem is the prevention of establishment of new patches of *Genista monspessulana* due to the rapid spread of non-dormant seeds by road maintenance and roadside slashing equipment. In order to prevent the distribution of this source of seeds, changes in the practices involving slashing and grading equipment will have to be considered, and may incorporate regular cleaning of all equipment. Co-operation between management agencies and groups such as rural fire brigades is also vital, as a common cause of the proliferation of patches of *Genista monspessulana*, once the initial seed is present, is burning the roadsides for fuel reduction. Areas burned should be regularly checked, and seedlings removed before they reach reproductive

#### % Germination

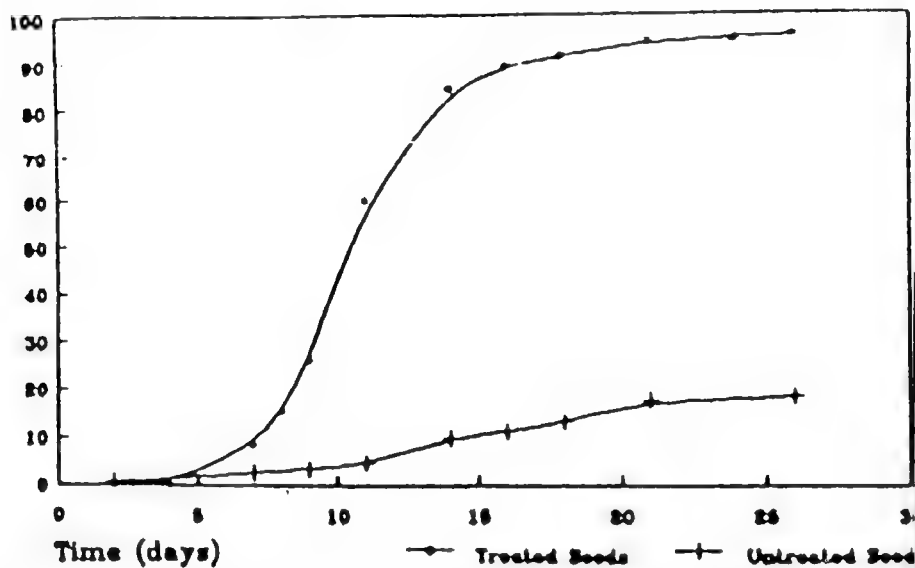


Fig. 1. The germination of *Genista monspessulana* at 20°C constant temperature. + = untreated seeds, ● = heat treated seeds.

maturity. However at present, there is no organization which has the clear responsibility for weed management at this level.

The continued sale of *Genista* in nurseries also poses a serious difficulty in curtailing its spread, and it may be necessary to consider legislative restrictions on the sale of "weeds" such as the Brooms, if new infestations are to be prevented.

The present distribution of *Genista monspessulana* is probably grossly underestimated due to the presence of soil stored seed and isolated individuals likely to proliferate after burning, and may not become obvious until more areas of dry sclerophyll vegetation which are presently 'at risk', are subjected to fire. The information presented here indicates that the potential for the rapid spread of *Genista monspessulana* into remnant native vegetation is very high, due to the dispersal combination of explosive seed dispersal and myrmecochory, combined with a high proportion of non-dormant seeds and the ability of seedlings to 'fix' nitrogen. Once established, the rapid build-up of seeds in the soil seed bank, high rates of seed production, and the germination characteristics of both dormant and non-dormant seed make it extremely difficult and costly to eradicate. If the species is not eradicated *Genista monspessulana* will become a major problem in dry sclerophyll vegetation in the future.

## Acknowledgements

This project was supported by a grant from the Victoria College Research Fund.

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# The genus *Cryptandra* (*Rhamnaceae*) in Victoria and a new species record for the state.

David Albrecht\*

## Introduction

Extensive areas of heathland occur in the extreme south east corner of New South Wales in the Nadgee Nature Reserve, and several heathland species are not known to extend south of this reserve into Victoria (Gilmour, 1983). With this in mind, a small group of walkers hiked into several patches of comparable heathland in the extreme eastern corner of Victoria during September 1988, with the expectation of finding some of these heathland species just within Victoria. One species new to Victoria, *Cryptandra ericoides* Sm. (Heathy *Cryptandra*) was located. This article provides a description of *C. ericoides*, together with information on distribution, habitat and conservation status. In addition, some general notes on *Cryptandra* are provided along with a key to the Victorian representatives.

## Description of *Cryptandra ericoides*

Low decumbent shrub to c.60 cm high. Branchlets covered with appressed simple hairs (which sometimes overlay minute fine stellate trichomes), becoming glabrous with age. Leaves shortly petiolate, clustered or occasionally alternate, subtended by small brown scarious stipules. Leaf-blade terete, 2-10 mm long, 0.5-1 mm wide; apex acute or obtuse; margins tightly revolute, concealing the undersurface or rarely with the undersurface vestiture slightly exposed; outer surface glabrous or minutely scabrid. Inflorescence a few- to many-flowered terminal cluster, often surrounded by leaves. Flowers sessile, subtended by several imbricate bracts. Bracts brown, lanceolate-ovate, acute-acuminate, ciliate

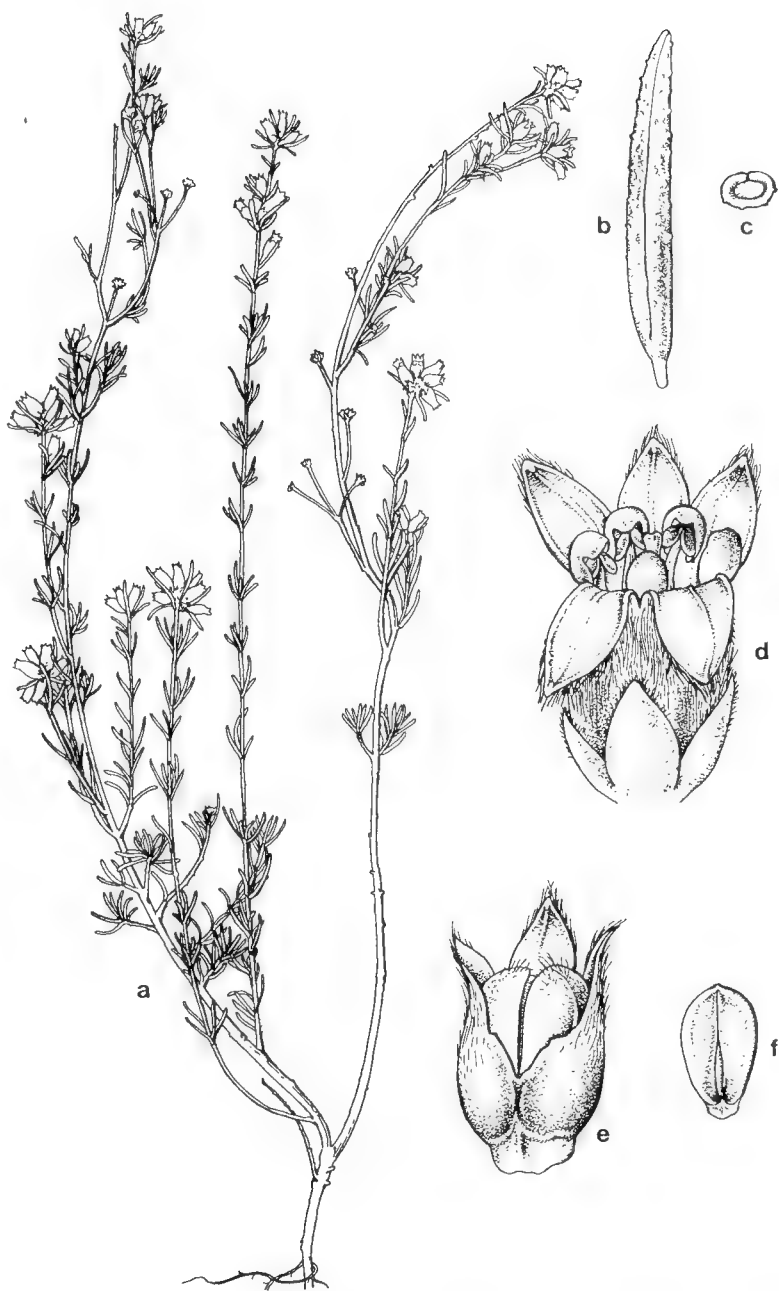
and  $\pm$  with appressed hairs on the outer surface. Perianth narrowly bell-shaped, consisting of a floral tube terminated by sepals and hood-shaped petals, the latter attached at the summit of the tube and enclosing the anthers; sepals usually shorter than the floral tube, together (2.7-) 3-4 mm long, with indumentum of appressed or ascending simple hairs overlaying minute fine stellate trichomes, often dense on sepal tips and becoming glabrous towards base of floral tube. Style equal to or exceeding the level of the petals, densely covered by stellate trichomes in the lower third to two thirds. Ovary semi-inferior, densely covered with stellate trichomes above the point of attachment of the floral tube, the portion below the point of attachment of the floral tube expanded and conspicuous in fruit. Fruit a capsule surmounted by persistent perianth, separating into 3 fruitlets. Fruitlets convex on outer surface, keeled on the inner surface. Seeds ovoid, dorsally compressed with a basal aril. See Fig. 1.

## Distribution

The known distribution of *C. ericoides* is shown in Fig. 2. It is an uncommon species in N.S.W. (D. Keith pers. comm.) where it is known from the Central Coast, Central Tablelands and South Coast botanical divisions (Harden 1990).

*C. exilis* D.I.Morris, a recently described species from Cape Barren Island and coastal eastern Tasmania has close affinities to *C. ericoides* and for some time was filed as *C.sp.aff.ericoides* at the National Herbarium of Victoria (MEL). The morphological similarities and distribution patterns of *C. ericoides* and *C. exilis* suggest that the pair are of biogeographical interest, particularly with

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**Fig. 1.** *Cryptandra ericoides* a. habit x1; b. leaf x9; c. transverse section through leaf x9; d. flower x13; e. fruit x10; f. seed x10.

regard to the role of Bass Strait in plant speciation. However, it is yet to be established whether the pair are sister species.

### Habitat

In N.S.W. *C. ericoides* occurs in wet heathland from almost sea level to an altitude of c. 1000 m. The habitat in which the Victorian population was found is consistent with the known habitat in N.S.W. The Victorian population occurs in an area of low, open, wet heathland on a gentle north facing slope above a drainage line. The soil is sandy with a fairly high organic content. Associated species include *Allocasuarina paludosa*, *Leucopogon esquamatus*, *Epacris paludosa*, *E. obtusifolia*, *Boronia parviflora*, *Mitrasacme polymorpha*, *Tricostularia pauciflora*, *Tetraria capillaris* and *Phylloglossum drummondii*.

### Conservation Status

Unfortunately time restrictions precluded a thorough investigation of the extent of the population. However it is estimated that there is in the order of 1000 plants occurring over an area of c. 0.4 ha. The population occurs within Croajingolong National Park. On the basis of this information, Gullan *et al.* (1990) consider *C. ericoides* to be a vulnerable species in Victoria.

### The genus *Cryptandra* and its Victorian representatives

The genus *Cryptandra* with approximately 40 species is endemic in Australia and occurs in all states except the Northern Territory. The generic name is derived from the Greek words **Kryptos** (hidden) and **andros** (man or male) (Baines, 1981) in reference to the feature of the anthers being hidden within the hood-shaped petals (see Fig. 1d). However, within the family Rhamnaceae this feature

is not restricted to *Cryptandra*. Of the other genera that share this character, *Spyridium* and *Trymalium* are the two most likely to be confused with *Cryptandra*. *Cryptandra* can be readily separated from both genera by the floral tube which extends well beyond the ovary and disc.

Willis (1973) lists four species of *Cryptandra* for Victoria, viz *C. amara*, *C. leucophracta*, *C. propinqua* and *C. tomentosa*. The addition of *C. ericoides* brings the state total to five species. *C. amara* is the only one of these species with recognised infraspecific taxa. The recent account of *Cryptandra* for New South Wales (Harden, 1990) divides *C. amara* into three intergrading varieties, viz. var. *amara*, *longiflora* and *floribunda*. Using the key provided in this treatment, it appears that the Victoria specimens of *Cryptandra* housed at MEL can be divided more or less into the three varieties.

However, some of the key characters in Harden's treatment break down in Victorian material due to the greater level of variation within each variety. For example, var. *floribunda* is either spinescent or non-spinescent in Victorian populations. The key characters distinguishing var. *amara* and var. *longiflora* in particular break down in Victorian material. Most Victorian specimens appear to best fit var. *amara*, though four collections from the Suggan Buggan-Tubbut area appear to conform to var. *longiflora*. It is with some hesitation that the latter variety is recognised for Victoria, as it only differs slightly from var. *amara*. A detailed study of the *C. amara* complex across its entire distribution range is much needed. Such a study would not only need to reassess the infraspecific taxa but also investigate the relationship between the infraspecific taxa and other species (*C. amara* var. *floribunda* and *C. tomentosa* being an obvious example as possible intermediates have been collected).

## Key to the taxa of *Cryptandra* in Victoria.

\*The term perianth used in this key refers collectively to the floral tube and sepals above the point of insertion on the ovary. The known occurrence of each taxon based on specimens at MEL is given for each taxon using the Victorian Plant Distribution Grids 1° × 1.5°, see Churchill & de Corona (1972) or Willis (1973). Indumentum terminology follows Hewson (1988). The key has been designed for the identification of pressed and dried specimens.

1. Leaves flat or with recurved or incurved margins, the lower surface clearly visible .....2

2. Flowers sessile in dense terminal heads surrounded by two or more felted, whitish spatulate floral leaves; leaves densely silky pubescent on the under surface; perianth with a silky indumentum; shrub of the Mallee region.....*C. leucophracta* (Grids ABCFG)

\*2. Flowers sessile or shortly stalked, solitary or in few-to many-flowered spike-like clusters at the end of the branchlets; specialized floral leaves absent; leaves glabrous on the under surface or with a few sparse hairs; perianth with a close hoary indumentum ± overlaying hairs on the sepals.....3

3. Perianth 2-4 (rarely to 5) mm long; sepals usually not spreading, with a close hoary indumentum; widespread ± spinescent shrub (except for the farther west) .....*C. amara* var. *amara* (Grids JMNRSVWZ)

\*3. Perianth 3.5-6 mm long; sepals usually spreading, with longer hairs overlaying hoary indumentum; ± spinescent shrub apparently confined in Victoria to the Deddick River valley and Suggan Buggan area .....*C. amara* var. *longiflora* (Grid VZ)

\*1. Leaves terete or almost so, the margins strongly revolute so that the undersurface is not or scarcely visible .....4

4. Perianth greater than 3 mm long, or if slightly shorter, the lower third to two

thirds of the style covered with trichomes .....5

5. Perianth (2.7-)3-4 mm long; the lower third to two thirds of the style covered with trichomes; bracts acute-acuminate, not covering most of the floral tube; decumbent, tenuous shrub of far East Gippsland .....*C. ericoides* (Grid Z)

\*5. Perianth usually greater than 4 mm long; trichomes present on style only near base; bracts broad, obtuse, ± mucronate, often covering most of the floral tube; rigid, divaricate shrub of the far north-western part of the Mallee region, with an outlying occurrence in the rainshadow area of the Upper Snowy River

.....*C. propinqua* (Grids ABV)

\*4. Perianth less than 3 mm long; trichomes present on the style only about the junction with the ovary.....6

6. Perianth with a vestiture of very short matted trichomes; base of floral tube and inferior part of ovary glabrous or becoming so when in fruit; shrub of scattered distribution but absent from the far north-western part of the Mallee region .....*C. tomentosa* (Grids BCDEHJNPT)

\*6. Perianth with longer hairs overlaying shorter hoary vestiture; base of floral tube and inferior part of ovary with persistent indumentum; commom shrub of the Mallee region, with an outlying occurrence in the rainshadow area of the Upper Snowy River.....*C. amara* var. *floribunda* (Grids ABCGV)

## Acknowledgements

I wish to thank Estelle Canning for confirming the identification of the Victorian material of *C. ericoides*, David Keith for providing distribution and habitat information, Anita Barley for preparing the illustration and Neville Walsh for useful comments on the manuscript.

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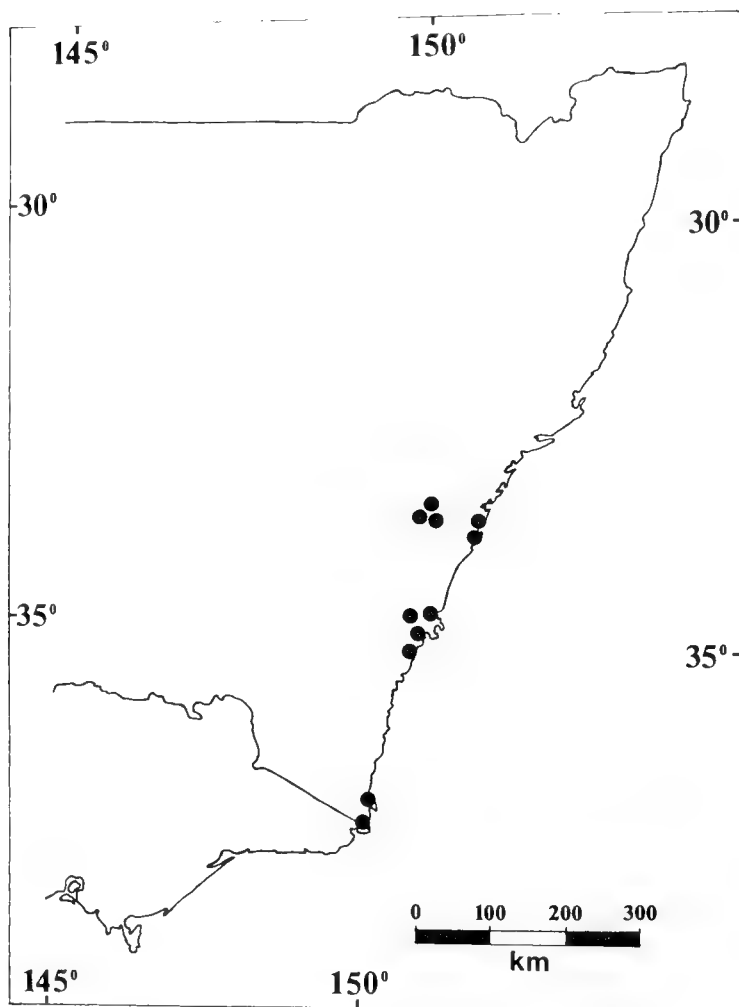


Fig. 2. Distribution of *Cryptandra ericoides* based on herbarium specimens lodged at MEL and NSW.

## Field Naturalists Club of Victoria Annual Report for Year Ended 31st December 1990

The year 1990 proved to be a difficult one for the Club. Declining membership and attendance at meetings and at excursions led to special meeting of Councillors, Office Bearers, Group Leaders and other interested persons to discuss the future of the Club.

This meeting and its major conclusions led the Council to implement several actions which hopefully will improve the situation over the next year or two.

### 1. Council and Officer changes

During the Year the following changes occurred in the composition of Council and Office Bearers:

Resignations:	Michael McBain (Councillor)
	Graeme Gillespie (Councillor)
	Ron Pearson (Appointed President by Council 27.8.91; Resigned 24.9.91)
	Alan Parkin (Assistant Secretary)
Replacements:	Bruce Abbott (Councillor)
	Noel Schleiger (Councillor)
	Arthur Farnworth (President)
	Graeme Love (Vice President)
	Bev Vonarx (Assistant Secretary)
Appointments:	Alan Parkin (Book Sales Officer)
	Noel Schleiger (Activities Coordinator)

### 2. Communications and Coordination

For a variety of reasons, particularly some unavoidable delays in the printing of 'The Victorian Naturalist', there was a severe breakdown in communicating to members information about meetings, excursions, group activities etc.

In order to overcome this problem several steps were taken:

(i) publication of a bi-monthly, up-to-date newsletter to be distributed with 'The Victorian Naturalist' except when that publication is delayed, when the newsletter will be despatched as a stand-alone item. This arrangement is to be reviewed after six months;

(ii) amalgamation of the positions of Programme Secretary, Club Reporter, Diary Coordinator and the new position of Editor of the Newsletter into a position of Activities Coordinator;

(iii) establishment of an Activities Coordination Committee to assist the Activities Coordinator to discharge his/her responsibilities and hopefully achieve coordination between the groups, the Club in general and overall activities. The Committee comprises the Coordinator as Chairman, a representative of each group, the Excursion Secretary and the former Diary Coordinator;

(iv) termination of the arrangements with the current printer of 'The Victorian Naturalist' effective December 31st 1990 and invitation of submissions from other appropriate printers.

### 3. Publications

In addition to 'The Victorian Naturalist', two other publications with which the Club has been actively and financially involved went on sale during the year. These were: (i) *Down Under at the Prom.* (A guide to marine life and dive sites at Wilson's Promontory). Authors: Marg O'Toole and Malcolm Turner. A joint activity with the Bicentennial Authority and the Victorian Department of Conservation and Environment; (ii) *Wildflowers of the Stirling Range.* Authors B. Fuhrer, N. Marchant.

### 4. Accommodation

When the Club was forced to vacate its premises during the reconstruction of the National Herbarium, a firm commitment was given to the Club to make appropriate office, library and meeting accommodation available on completion of the work.

Consistent with this commitment, the former arrangements for general, group and council meetings have been reinstated and late in the year an office was made available and immediately occupied. Appropriate facilities and rostered assistance was established as soon as possible.

Space for the Library is to be made available when a room in a building behind the Astronomer's Residence is renovated by the Botanic Gardens Staff. However there is some doubt about the suitability of these premises for the purpose and further discussions are to be held.

Meanwhile the Club's longer term requirements are being investigated by a Premises Subcommittee which will consider a range of options, including purchase of our own premises, either alone or jointly with a kindred organisation. The Subcommittee's activities have been deferred for a few months at the request of its Convener/Chairman (Dr Jack Douglas).

### 5. Australian Natural History Medallion

The Club is responsible for the administration of the above prestigious medallion which, this year, was awarded to Mrs Ellen McCulloch, a dedicated, enthusiastic and widely acknowledged ornithologist. The medallion was presented to her by the President of the Royal Society of Victoria, Dr W. Briggs, at the December Meeting.

Mrs H. Weatherhead and Messrs P. Kenley and P. Menkhorst, having served the statutory maximum term of four years on the Medallion Award Committee which selects the medallionist from the many nominations received, retired from the Committee. The Club is deeply appreciative of their great contribution to this onerous but rewarding task.

Mrs B. Longanuir, Dr M. Calder and Dr N. Schleiger have kindly accepted the invitation of the Award General Committee to fill the resultant vacancies for the next four years.

Mrs B. Vonarx efficiently and enthusiastically performed the functions of Secretary to the General and Award Committees and presentation function organiser when the long-serving Mrs Houghton resigned to take up an appointment in China for 6-12 months. Grateful thanks for her totally outstanding service were conveyed to Mrs Houghton.

### 6. Special Items

(i) The Specialist Groups have all engaged in activities and meetings appropriate to their interests and membership. However, the Day Group recommended its disbandment during the year and this was agreed to by Council which is grateful to Dan McInnes for his enthusiastic work as Convenor of this group for so long, as well as for his outstanding contribution to many other Club activities.

(ii) The Club participated in the Maranoa Gardens Festival, with all groups contributing exhibits and assisting on the day. Miss Margaret Potter excellently coordinated the whole activity.

(iii) The Minister for Conservation and Environment advised that his Conservation Advisory Committee on which the club was represented, was to be abolished. The Club expressed its disappointment to the Minister and volunteered assistance to an alternative advisory mechanism which the Minister foreshadowed.

(iv) Since 1975 the Victorian Government has made a grant of \$1,500 towards the production of 'The Victorian Naturalist' but this is to be cancelled. At the appropriate time the Club will protest strongly and seek not only its reinstatement, but at a significantly increased level to reflect the greater production costs in 1990 compared with 1975.

### 7. Meetings and Excursions

During the year an interesting series of addresses were presented at the monthly general meetings. The thanks of the Club are extended to the speakers.

- |          |   |
|----------|---|
| Feb. 12  | - Mr David Clindworth: The New VCE Geology Course for Years 11 and 12.                              |
| March 3  | - Mr Peter Kelly: The Diversity and Life History of Beetles.  |
| April 9  | - Mr Clarrie Handrek: The Work of the Marine Research Group of the National Museum.                 |
| May 14   | - Mr G. Love: President's Address.  |
| June 18  | - Dr J. Bowler: Museum Development on the South Bank.   |
| July 9   | - Dr T. Gooney: The Impossible Dream - The Reconciliation of Resource Development and Conservation. |
| Aug. 13  | - Mrs Marshall: Marine Life of Heron Reef.  |
| Sept. 10 | - Mr Gary Backhouse: A Year of Orchids on French Island.  |
| Oct. 8   | - Miss M. Doery: Gannets of the Oceans.   |
| Nov. 12  | - Bro. M O'Loughlin: Breeding Fissiparity in the Shallow Water Echinoderms of Southern Australia.   |
| Dec. 10  | - Mrs E. McCulloch: Birdwatching By-ways (A.N.H.M. Medallionist's address).                         |

Excursions were arranged each month to a variety of interesting areas related either to the subject of the preceding general meeting and/or a particular growing season. Responsibility for arranging the excursions was taken over by Mrs Dorothy Mahler from Miss Marie Allender who willingly, efficiently and enthusiastically had carried out this onerous task for more than 30 years—truly a remarkable contribution.

### 8. Acknowledgements

The club could not operate without the dedicated service of its Councillors, Office-bearers, Group Leaders and numerous individuals who give most generously of their time and skills. Their efforts are gratefully acknowledged by me and their fellow members.

A.J. Farnworth  
(President)

## FNCV Geology Group Annual Report for 1990

Well, what a year!

First, it was back to meeting in the Herbarium (with new addition plus alterations) for the first time since 1988.

Second, the year saw a record average attendance, actually the highest average since the 1960s. For this we must thank the former members of the AEA Geology Group who chose to join us. From our group we must thank Noel Wigmore for the part he played in inducting these new, and most welcome members.

Third, our new club room (office) became available, which gave us a chance to have a central contact and collection point.

Our group, for the second year running, eagerly participated in, which included an exhibition, the Maranoa Gardens day on the 14th October.

Subjects for the year were just as exciting and varied, just to mention a few: African rift valley system; the greenhouse effect; cliff instability on the Victorian coast (this followed two unfortunate cliff deaths in Victoria); metamorphism; along with reports covering the Newcastle earthquake of December 1989; VCE geology paper and not to forget the 'Argyle' diamonds. A disappointment during the early part of the year was the comet 'Austin'.

Our speakers varied between members and visitors, such as: Mr Tyler (Ashton Diamonds), Dr Eric Bird (Melb. Uni.), Mr Barrie Hunt (CSIRO), Mr Powel (Melb. Uni.) and locals like Mrs Gabi Love (as a speaker and reporter).

And finally on a sad note we wish to record the passing (on the 10th of October 1990) of Mrs Salau (Emma May). Mrs Salau was 96 years old and to us older members a much loved and valued member of our group.

To the faithful I must say, thank you, I will be trying in 1991 to lead us back onto the path of excursions.

Graeme C. Love  
Chairman

## OBITUARY

### Laura White

20 August 1895 - 13 October 1990

There is probably no-one in recent experience as Laura White who so fully deserves the accolade given in the parable recorded in the gospel according to St Matthew 25.21: 'Well done, thou good and faithful servant'.

Laura was born on 20 August 1895 at Dunbulbalane near Numurkah, Victoria, eldest of two daughters to Mathew and Margaret White. Mathew was a farmer and Laura's love of the land and nature was undoubtedly a brush-off from him. Laura attended a small primary school with the intriguing Aboriginal name of Naringaningalook where, as an outstanding pupil, she won a scholarship as a boarder to Methodist Ladies' College, Hawthorn, from 1910 to 1913 when her parents moved to Canterbury. Laura remained as a day pupil until she commenced her Science course at the Melbourne University in 1914. She graduated in Science in 1917 and obtained the Diploma of Education in 1920.

December 1914:	Chemistry Part I Zoology Part I, First Class Honours and Exhibition Botany Part I, First Class Honours and 2nd Brunning Prize
December 1915:	Zoology Part II, First Class Honours and divided Exhibition Botany Part II, First Class Honours and Exhibition Physiology Part I, Second Class Honours and Exhibition
December 1916:	Botany Part III, Honours Psychology, Logic and Ethics
March 1917:	Chemistry Part II

She was admitted to the degree of Bachelor of Science on the 21st April, 1917.

Her standard was 'excellence' and her students understood what she expected of them and strived to respond adequately. Three such students came to Presbyterian Ladies' College one year before entering the Melbourne University Medical Course, two having not attempted Botany or Zoology previously. They obtained the Exhibition, second and third placings in the final State examinations in both subjects after only twelve months of Laura's tutelage. There are many such success stories in Laura's teaching history.

Laura White's philosophy was always one of optimism and a continual search for truth. She inspired her pupils and always had faith in them.

She had an acute sense of humour. One day during an outdoor biology lesson near the music school at PLC, East Melbourne, one of the singing pupils nearby let out

a piercing wail "A-a-a-ngels —ever bright and fair!", and Laura White looked up at the members of the biology class and innocently asked, "Was that a cat in pain?".

After her retirement she undertook a temporary appointment—which lasted for 14 years—at Canterbury Girls' High School, until her 70th birthday, and it is known that at least one of her previous PLC students sent her children to Canterbury Girls' High School because 'Miss White' was a teacher there; such was their faith and her fame as a teacher.

In 1955 she joined the Field Naturalists Club of Victoria and exhibited her skills as an occasional lecturer, but mainly she was a superb field guide and was kept busy on excursions identifying specimens of native flora. She was always enthusiastic about such plants and reliable in her identifications and will be sadly missed on field days.

At the age of 94 years, she was discovered 'looking out her waders' for an excursion on aquatic plants, and the week before her sudden, quiet and dignified death, alone in her own home on 13 October 1990, she greatly enjoyed a week at Gypsy Point Lodge with the Field Naturalists Club members and her nephew, Dr Brian Faragher and his wife. Her family were most important in her life.

She retained her membership of the National Parks Association, The Native Plants Preservation Society, the Society for Growing Australian Plants and the Royal Horticultural Society, and she endeavoured always to attend the Royal Agricultural Society's show each year. She worshipped each Sunday at the Canterbury Uniting Church and was a member of the Uniting Church Fellowship. Three days before her death she listened and made minor corrections to her biography being written for publication in the MLC paper, 'The Star', by Val Kerr.

For a few years before her death she had been studying Molecular Biology and valiantly tried to keep up with the rapid changes in botanical nomenclature.

Truly we have lost a very great and gallant figure but so many of us have been blessed by having her as a friend.

Elizabeth Turner, M.D.

## THE WAR YEARS

At the commencement of 1939, Cato welcomed Miss Laura White as its new head, and at the start of second term, Rev. A.H. Wood became the new Principal – resident at M.L.C. in Kew, but visiting each Friday.



*Miss L. White, Vice-Principal M.L.C. 1939-1945*



*Laura White talking to Emeritus Professor Sir Douglas Wright  
at the Science Congress 1987*

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In which is incorporated the Microscopical Society of Victoria

Established 1880

Registered Office: FNCV, c/- National Herbarium, Birdwood Avenue, South Yarra, 3141, 650 8661.

**OBJECTS:** To stimulate interest in natural history and to preserve and protect Australian fauna and flora.

Members include beginners as well as experienced naturalists.

*Patron*

His Excellency, The Rev Dr John Davis McCaughey, The Governor of Victoria.

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## MEMBERSHIP

Membership of the F.N.C.V. is open to any person interested in natural history. *The Victorian Naturalist* is distributed free to all members, the club's reference and lending library is available and other activities are indicated in reports set out in the several preceding pages of this magazine.

### Membership rates 1992

Metropolitan	.....	\$30
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Joint Country/Interstate	.....	\$32
Concessional rate (Students/pensioners)	.....	\$22
Joint Concessional	.....	\$27
Junior (under 18; no Victorian Naturalist)	.....	\$5

### Subscription rates 1992

Club subscription	.....	\$30
Libraries within Australia	.....	\$40
Overseas	.....	AUD \$50

# The Victorian Naturalist

Vol. 108 (5) 1991



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the Field Naturalists Club of Victoria  
since 1884

## FNCV Calendar of activities

For any enquiries about the following activities, contact the group secretaries. Addresses and contact numbers can be found on the back cover.

### December

- Sun 1 General Excursion – A stroll, not a hike, for all the family, along Gardiner's Creek Valley, from Glen Iris Railway Station to Hughesdale Railway Station. Leader Dan McInnes.
- Tues 3 Fauna Survey Group – Members night and Christmas breakup.
- Wed 4 Geology Group – Members night.
- Sat 7 – Sun 8 FSG – Frog survey Eastern Otway Ranges. Contact Laurie Conole on (H) 481 4926.
- Mon 9 General Meeting – Members night – members bring along your slides and exhibits.
- Thu 12 Botany Group – Members night and Annual General Meeting.
- Sat 14 FSG – Leadbeater's Possum survey. Contact Ray Gibson (H) 874 4408.
- Wed 18 Microscopy Group – no meeting until January, 1992.

### January

- Wed 15 Microscopy Group – Members night.

### February

- Sun 2 General Excursion.

### March

- 6-9 Assoc. of Field Naturalists Clubs of Victoria Annual Camp, The Basin.

## Great Ocean Road Appeal

The appeal, authorized by the Victorian Conservation Trust, is aimed at securing maximum protection for coastal heathland, the habitat of rare and endangered flora and fauna, between Anglesea and Aireys Inlet.

The very best protection is public ownership. Appeal funds will be used to purchase privately held coastal heathland between Anglesea and Aireys Inlet as it becomes available. It is our intention that each acquisition will become an extension to the Angahook-Lorne State Park.

If you can help please contact  
THE VICTORIAN CONSERVATION TRUST,  
8th Floor, 49 Spring Street,  
Melbourne, 3000. Phone – 03 651 4040

ANGAIR – 052 63 1975  
SECRETARY GREAT OCEAN  
ROAD COMMITTEE  
– 03 722 1776

# The Victorian Naturalist

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Cover illustration: *Eucalyptus camaldulensis* by Jeremy Wallace.

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## Notes from the National Herbarium of Victoria

### The names of plants — Introduction

Ian Clarke\*

*The following notes mark the beginning of a small introductory series, continuing under the general title of 'Notes from the National Herbarium of Victoria,' dealing with aspects of botanical nomenclature — the naming of plants. Subjects to be covered include the construction of plant names, 'correct names' and why name changes occur, authorities, the concept of nomenclatural types, and possibly a few other related topics. Although each article will be complete in itself, later ones will build on the information presented previously.*

The 'scientific' or 'botanical' name of a plant, called a binomial, always consists of two words (minimum), and there can only be one **correct** name. In contrast, common or vernacular names are not so restricted — there may be more than one for a particular kind of plant, they may contain one or a number of words, and the same common name may be used for more than one kind of plant. The rules that govern the construction and application of plant names are set out in the International Code of Botanical Nomenclature (ICBN).

In botanical names, the first word denotes the genus (plural genera) to which the plant belongs. This is equivalent to our surname. The second word is the specific epithet (equivalent to a first name), and together the generic name and the specific epithet constitute the name of a species.

*Eucalyptus globulus*

generic	specific
name	epithet

species name

In this example, the genus is *Eucalyptus*. The generic name always begins with a capital. The specific epithet begins with a small letter.

In many cases the endings of the generic name and the specific epithet will be the same ('-us' in the above example). This is because botanical names are treated as Latin, and thus have gender (i.e. they are

masculine, feminine or neuter) and follow the rules of Latin grammar.

In scientific literature a botanical name is often followed by the name(s), usually abbreviated, of the original author(s) of the plant name. This abbreviation is called 'the authority'. For the name *Eucalyptus globulus* the authority is Labill., an abbreviation for J. J. H. de Labillardière, the name of a French botanist of the late 18th and early 19th centuries. In popular books authorities are usually omitted.

The same specific epithet can be used in more than one genus. Thus *Eucalyptus alpina* and *Grevillea alpina* are two totally different species that share the same epithet. If a botanist decides that a particular species is better placed in a different genus, the original epithet must be retained unless this would contravene the rules — e.g., in the case where the epithet is already in use in the new genus.

The 'genus' and the 'species' are two of the lower ranks in the sequence that constitutes botanical classification. The **main** ranks are shown in the accompanying list (there are many more!), using *Eucalyptus globulus* as an example. The most commonly encountered ranks are **FAMILY**, **GENUS** and **SPECIES**.

Species that are botanically similar are grouped into genera, similar genera into families, and so on. The family Myrtaceae includes many other genera besides *Eucalyptus*, for example *Callistemon* (bottlebrushes), *Melaleuca* (paperbarks,

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Birdwood Avenue, South Yarra, 3141

## Contributions

Kingdom	Plantae (plants)
Division	Anthophyta (flowering plants, angiosperms)
Class	Dicotyledones (dicotyledons, dicots)
Order	Myrtales
FAMILY	Myrtaceae (myrtle family)
Subfamily	Leptospermoideae
Tribe	—
GENUS	<i>Eucalyptus</i> (eucalypts)
SPECIES	<i>E. globulus</i> (blue gum)
Subspecies	<i>E. globulus</i> ssp. <i>globulus</i>
Variety	—

honeymyrtles), and *Leptospermum* (teatrees). Not all ranks have to be used for a particular species; thus 'tribe' and 'variety' are not formally used in this case.

The names used in the list for the groups of higher rank are taken from a recent text (Raven, 1981) and represent one current view. There is considerable debate about the limits of these groups and the names that should be applied to them. For example, the fungi are no longer considered to be part of the plant kingdom but are placed in a kingdom of their own. In the new *Flora of Australia* series, following the American botanist Arthur Cronquist's classification, the flowering plants are called 'Magnoliophyta', the dicots 'Magnoliopsida', and the monocots 'Liliopsida'. The traditional names for some of these groups, for example the gymnosperms, angiosperms (flowering plants), monocots, and dicots, remain very useful for practical purposes.

The endings of the names of the higher ranks are standardized. The names of orders end in '-ales'. The names of families end in '-aceae', although for eight of these there are alternative names that are sanctioned by long use:

Traditional name	Recommended name
Compositae (daisies)	Asteraceae
Cruciferae (cabbages)	Brassicaceae
Gramineae (grasses)	Poaceae
Guttiferae	Clusiaceae
Leguminosae (legumes)	Fabaceae
Labiatae (mints)	Lamiaceae
Palmae (palms)	Arecaceae
Umbelliferae (carrots)	Apiaceae

Sometimes the Leguminosae are split into three smaller families (a procedure followed at the National Herbarium of Victoria). In this case the name Fabaceae is used for one of these smaller families, and in this sense it is a recommended alternative for the older name Papilionaceae (peas). The other two segregate legume families are the Mimosaceae (wattles) and the Caesalpiniaceae (sennas and cassias).

### References and further reading:

The recent booklet by Lumley and Spencer provides a useful and inexpensive introduction to plant nomenclature, including that for garden plants.

### Acknowledgements

Thanks to David Albrecht and Jim Ross for their comments on the manuscript.

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## A subfossil site on New Year Island

N.P. Brothers\*, D. Pemberton\* and N. Smith\*\*

### Introduction

Acolian calcarenite sub-fossil sites are common on the islands of Bass Strait, being usually located in wind eroded sand dune formations (blowouts). They contain mammalian and avian remains (Hope 1973, Sutherland and Kershaw 1970). The faunal components of many of these deposits and the biogeography of the mammals present in relation to the formation of a land bridge between Tasmania and Victoria are described by Hope (1973). This paper describes the mammalian component of a hitherto unreported sub-fossil site on New Year Island located off the north-west tip of King Island, at 143°49' east and 39°41' south. Christmas Island is located off the southern tip of New Year Island (Fig. 1) and collectively the two are referred to as the New Year Island Group or the New Year Islands by various authors (e.g. Plomley and Henley 1990, Micco 1971).

### The subfossil deposit

The island has an area of 1.2 square kilometres and the fossil site is in a typical unconsolidated sand dune blowout on the north western end of the island. The site covers an area of approximately one hectare and is strewn with bird and mammal bones. No attempt was made to quantify the number of species present in the deposit, but it was apparent that the bird bones were far more numerous than the mammal bones and short-tailed shearwaters, *Puffinus tenuirostris*, are by far the most common in the deposit. A representative sample of mammalian bones were collected. This material was lodged at the Queen Victoria Museum Launceston, where it was identified by Dr.

B. Green. Table 1 shows the species list of mammals collected on the site. A more extensive investigation of the site is likely to reveal the presence of additional species.

**Table 1.** The mammalian components of the subfossil site on New Year Island. The catalogue numbers of the specimens are shown.

Species	Catalogue Number
<i>Arctocephalus pusillus</i>	1988/1/18/A-F
<i>Thylogale billardieri</i>	1988/1/19/A-L
<i>Vombatus ursinus</i>	1988/1/20/A-D
<i>Macropus rufogriseus</i>	1988/1/21/A-E
<i>Dasyurus maculatus</i>	1988/1/22/A-H
<i>Sus scrofa</i>	1988/1/23

### Discussion

The presence of Australian fur seal, *Arctocephalus pusillus doriferus*, and pig, *Sus scrofa*, bones in the deposit is uncharacteristic of such subfossil sites. Seals have not been recorded from similar subfossil deposits. Sealers were living on the island collecting seal skins here in 1802 when Peron visited (Micco 1971) and sealers from the brig the Harrington are reported to have collected both Elephant seal and 'other' species of seals from the New Year Island Group (Hooper 1973, Plomley and Henley 1990). Seals were therefore using the island at least as a haulout site and possibly Elephant seals were breeding as they were on nearby King Island (Micco 1971). Pigs are recent introductions by European settlers to the

\* Department of Parks, Wildlife and Heritage,  
134 Macquarie Street, Hobart, Tasmania, 7000.

\*\* P.O. Box Stanley, Tasmania, 7331.

## Contributions

Bass Strait islands with documents of this for Flinders and Swan Islands (Pullar 1953, Hope 1973). The remains of a pig in the New Year Island deposit indicate that they were also present in western Bass Strait. The date of the introduction is unknown but could have either been by the sealers who occupied the island in the early 1800's, or by the Chinese market gardeners who farmed the island in 1861 (Hooper 1973). Cabbages, probably remnants of this enterprise, are found growing on the island today.

The dune systems of King Island are of Holocene age and the subfossils in them of comparatively recent age (Hope, 1973). All the marsupial species found in the New Year Island deposit are also present in the subfossil deposits of King Island (Hope 1973) suggesting that elements of the deposit are of a similar age. The pig material, and perhaps the fur seal may be far more recent accumulations than the rest of the fossils as the erosion of the dunes results in mixing of strata of different ages. Certainly the pig material would be more recent than the marsupial remains. As the sea level rose New Year Island would have become separated from King Island and the area of suitable habitat supporting the herbivores would have decreased. Hope (1973) calculated that a Bass Strait island had to be at least 6.1 km square in area to support two or more species of herbivores. New Year Island is 1.2 km<sup>2</sup> and three herbivores, *Thylogale billardieri*, *Macropus rufogriseus* and *Vombatus ursinus* are found in the subfossil deposit. It is probable therefore that the terrestrial mammals here became extinct as the sea levels rose creating what is now New Year Island, an area insufficient in size to support the herbivores once present. The lack of fresh water on the island would probably have prevented the survival of the Tiger cat, *Dasyurus maculatus* as many species of Dasyurid require access to standing water to survive (Green and Eberhard 1979, 1983; Green and Newgrain

1989). The terrestrial mammals were therefore most likely to have been absent from the island by the 19th century so sealers did not contribute to their extinction which probably would have been the case had these terrestrial animals still been present, as happened on the larger King Island (Hope 1973).

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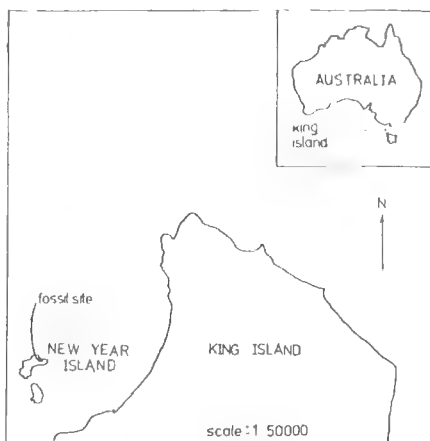


Fig. 1. Location of subfossil site on New Year Island.

## Buttressed Booyongs at Binna Burra, Mt Lamington plateau

Noel W. Schleiger\*

### The setting

On a recent FNCV visit to Binna Burra, on the Mt Lamington plateau, SE Queensland, most of us spent some time on excellent walks on well graded tracks through the sub-tropical rain forest in the dry, sunny conditions of late August. The forest trees have special adaptations of their roots to cope with the steep slopes and the thin veneer of soils developed on the lavas extruded from the huge Miocene 'Tweed Volcano'. The Tweed Volcano was a shield volcano similar to that of Hawaii today, being over 120 km in diameter. Twenty three million years ago the volcano extruded first basalt, then a rhyolite phase, finishing with basalt again. The volcanic phases extended well into Miocene time and there were parasitic vents (e.g. Egg Rock) as well as the central one now occupied by Mt Warning (Willmott 1986).

The verticality of the tallowwoods, white ironbarks, booyongs, *Ficus* spp., etc. is quite remarkable. Likewise are the number of species with buttressed tree roots to ensure stability by using the jointing in the lavas below the soil (Churchett 1982). Such trees usually have a prominent buttress downslope with another longer one transverse with the slope. Yet another buttress is directed in the upslope direction. The downslope buttress is usually short, having a deep anchor root. The transverse buttress can be quite long, with its ends even curving up slope.

### The problem

The question arose as to how buttressed trees would develop on flat ground. One would expect a radial development of buttressed roots from the trunk.

The summit of Mt Roberts, on which the Binna Burra Lodge stands, is a narrow spur of flat land trending meridionally. This spur extends southerly to Koolanbilba and Tullawallal Lookouts.

### Methodology

To test the behaviour of buttressed trees on flat ground, two trees were chosen in the forest. No. 1 close to the Koolanbilba Lookout, the other, No. 2, on the flat part of the Tullawallal circuit. (Fig. 1).

A mini compass-tape traverse was conducted around the base of each tree, from buttressed root to buttressed root until the traverse closed on the starting point. Every 25 cm, an offset was taken from the transverse line to the tree trunk. Where roots intersected the transverse line, the thickness and direction was recorded.

### Results

Figures 2 and 3 show the tree bole plots for two booyong trees, 1 and 2. Tree No. 1 close to Koolanbilba LO showed sub-parallel roots in the SE direction with transverse roots westerly and northeasterly. The expected radial pattern was not there. Figure 3 of Tree 2 on the Tullawallal circuit had a decided trunk lean from the SE with a general small slope from W to E. Again the buttressed roots were dominantly NW to SE aligned or transverse to this and certainly not radial.

### Interpretation

The striking morphometric feature of both tree boles is the SE-NW orientation of the buttresses which is independent of slope. This suggests that the tree roots orient themselves to combat the sway of the canopy, set up by the SE trade winds. In another study, the author has shown (Schleiger 1983, 1991 in press) that trunk lean is a significant indication of the

\* 1 Astley Street, Montmorency, 3094 Vic.

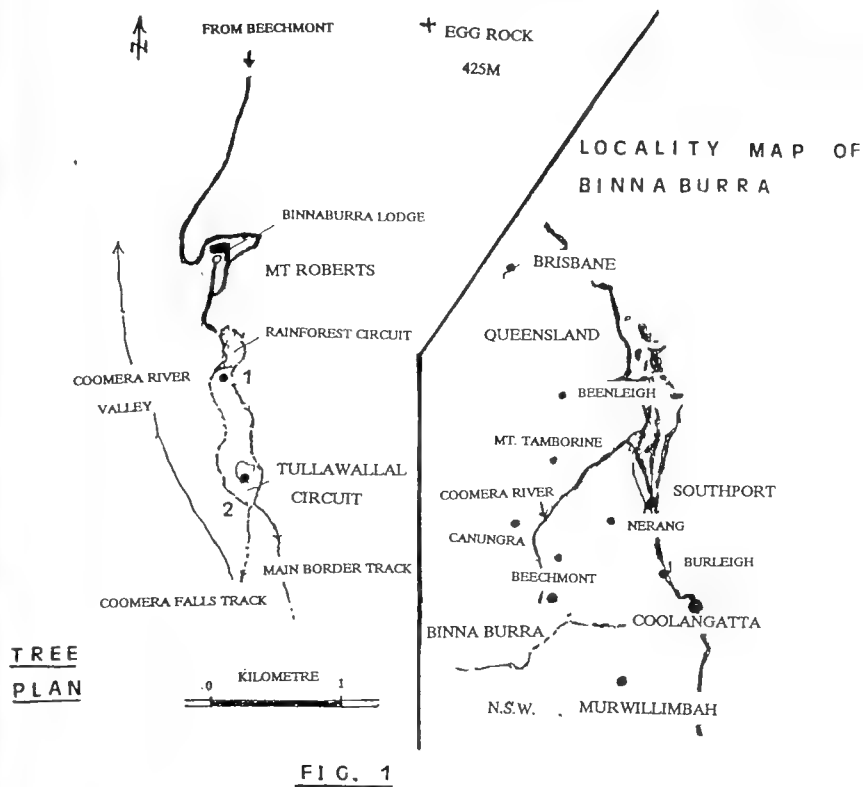


Fig. 1. Locality map of Binna Burra to show Booyong samples and trunk lean populations.

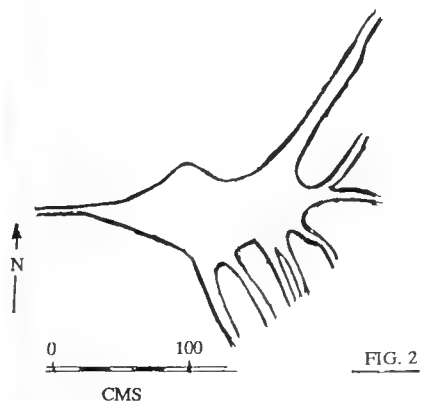


Fig. 2. Tree bole plot of Booyong (*Argyrodendron trifoliolatum*) close to Koolanbilba Lookout.

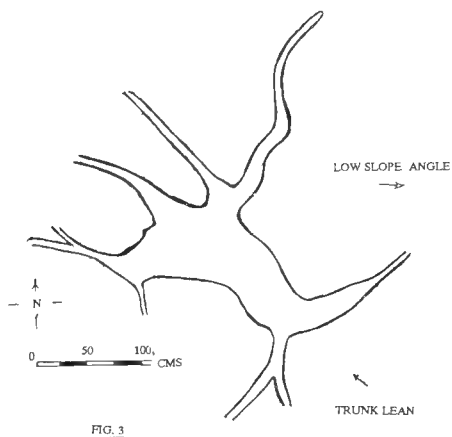


Fig. 3. Tree bole plot of Booyong (*Argyrodendron trifoliolatum*) on the Tullawallal Circuit.

## Contributions

prevailing wind direction. A minimum sized sample (1 to 2 dozen) of leaning trunks usually is enough to give a significant wind direction.

A search of leaning trees on flat ground on the Tullawallal circuit is shown on Fig. 4 whilst those on Mt Roberts (Fig. 5) demonstrated that SE trades were the dominant winds at Binna Burra. The minor westerly mode at Tullawallal would mean that westerlies can blow across the Coomera Valley. Binna Burra is more open to the SE and NE and is protected from the west.

## Conclusions

1. Buttressed trees on sloping ground have a strong buttress deeply rooted downslope and very long buttresses transverse to slope.

2. The root system tends to be symmetrically oriented with the major slope direction, with strong along slope cross slope elements.

3. On flat ground the root geometry tends to be parallel and perpendicular to the prevailing wind direction.

4. This orientation is supported by the major direction of trunk lean where this exists.

5. Depending on the position of trees on the ridges, east and south east winds as well as westerly winds are dominant in influencing tree growth in this part of SE Queensland.

## Acknowledgements

The author thanks Dorothy Mahler and Andrew Wilson for help with the field work and Dorothy for typing the manuscript.

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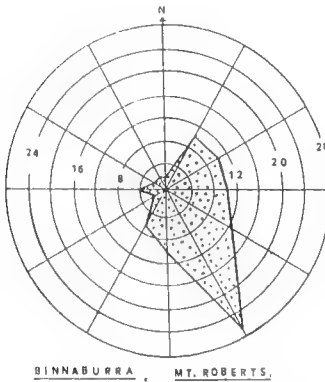


Fig. 4. Rosette showing direction of leaning trunks of trees with lean angles of 70 or less in the Binna Burra Lodge area (Mt Roberts). Circles in 8% frequencies,  $n = 50$ .

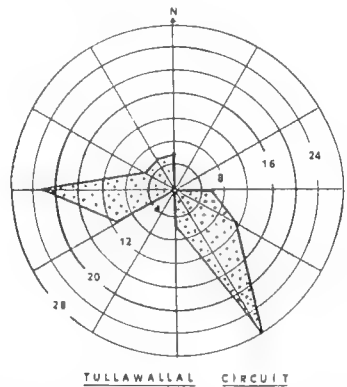


Fig. 5. Rosette showing direction of trunk lean of 70 or less in the Tullawallal Circuit area. 8% frequency circles for  $n = 50$ .

## A Retrospective look at the discovery of the Western Whipbird in the Mallee of Victoria and South Australia

Leo Joseph \*

The Western Whipbird *Psophodes nigrogularis* was discovered by John Gilbert, who collected birds in Australia for John Gould, at Wongan Hills, Western Australia on 14 September 1842. The subsequent history of the bird's discovery in Western Australia has already been reviewed by McNee (1986) and Serventy and Whittell (1976).

It was not until after 1910 that the long discovery of the eastern Australian populations of this species began. Although much of the story was told by Howe and Ross (1933), there are a few points in their account that have been overlooked by later writers and these, and other points, can now be placed in better perspective. Some of these concern the late Hugh Collins, an egg-collector from Edenhope, who collected widely in southern Australia and whose extensive collection is still in the care of his family at Edenhope. Therefore, I hope that a retrospective look at the story will both be of some interest and use to today's naturalists.

### Western Whipbirds in the Murray Mallee — a brief history

In September 1913, three egg-collectors, F.E. Howe, J.A. Ross and E.W. Bunn, began more or less annual collecting trips to the Manya and Panitya districts in the mallee of north-western Victoria. Six years elapsed before, on 22 September 1919, they heard at Manya a strange and unfamiliar call, which, by a process of elimination, they suspected to be of the Singing Honeyeater *Lichenostomus virescens*.

We can suppose here that they probably would not have dreamt of considering the Western Whipbird relevant to this

problem. The species was after all at that time known only on the other side of the continent; also it was about then that fears surfaced of the Western Whipbird having become extinct (e.g. Mathews 1917).

In September 1920 the trio again were in the area and collected a nest and eggs, which they ascribed to the species today known as the Chirruping Wedgebill *Ps. cristatus*. But again they heard the strange call.

On comparing known wedgebill eggs in Melbourne collections with these and other, similar eggs they collected in the following days, they noted that the new eggs were appreciably larger and of a lighter blue.

In 1921 and 1922 they again heard the calls and found more nests and eggs. On 16 September 1926 they flushed a bird with an olive-green back (wedgebills have grey backs) from another of the strange nests with its pair of bluish-tinted eggs. And again they heard the strange song.

'By this time we were completely mystified', Howe and Ross (1933) later wrote. 'We had jumped to conclusions on two occasions: when the call notes were first heard in 1919, we attributed them to those of the Singing Honeyeater, and in 1920, when we found the first set of eggs, we called them Wedgebill's. What else could they be? We had now found that our so-called Wedgebill had an olive green back.'

September 1927 found them searching again. The trio located another nest and Ross even observed the sitting bird, noting the black V-shaped throat markings, green back and brownish tail. That Ross had seen the sitting bird and still not realized that the Western Whipbird was involved should remind us that in 1927 one did not have the ready

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## Contributions

access to descriptions or illustrations of birds that exist today.

Despite patient waiting and the location of other birds nearby, no specimen was secured.

About this time, Howe and Ross wrote to a Western Australian colleague and asked for a description of the call of the wedgebill. The description they obtained 'in no way resembled that of our mysterious stranger', they later wrote. In fact, we now know that the wedgebill consists of two very similar-looking taxa that have very different calls: the Chirruping Wedgebill *Ps. cristatus* of eastern Australia and the Chiming Wedgebill *Ps. occidentalis* in other, more western parts of southern Australia (Ford and Parker 1973).

September 1929 again saw the trio at Manya. Again the birds were heard and again they were not even seen.

Also in 1929 another ardent Victorian egg-collector, Hugh Collins of Edenhope, visited Ongerup, Western Australia where he had earlier seen the birds in 1903 and effectively rediscovered Western Whipbirds there. The few details of Collins' 1903 and 1929 sightings that are available are in a letter written by Collins and quoted in Howe and Ross's (1933) paper. Both sightings have been overlooked by later writers (i.e. McNee 1986, Serventy and Whittell 1976 and Chisholm 1946).

In 1930, Hugh Collins, by then back in Victoria, brought Western Whipbird tail feathers and relevant notes he had made, all from Western Australia, to George Mack of the National Museum. Mack contacted Howe and Ross who then corresponded with Collins. Finally, Howe and Ross began to ask whether the Western Whipbird, then known only from Western Australia and until recently thought extinct, might be the bird they were pursuing in the Victorian mallee. This possibility must have taken on a certain enormity in 1930. In retrospect, Mack's role in thinking to acquaint Howe

and Ross with Collins was also a critical step.

Two more years passed before, finally, on 19 September 1932, nineteen years after first visiting the area and thirteen years after first encountering the bird, Ross secured a specimen of the Western Whipbird in the Murray Mallee. This specimen, the first of the Murray Mallee population, revealed minor differences in size and colouration from the Western Australian birds. Subsequent work revealed the consistency of these differences.

The population was later also reported from nearby South Australia (though it had in fact been recorded there earlier — see below). After the 1929 Ongerup record, Western Australian birds have been reported more or less steadily though with some local declines evident.

### Some comments on the discovery of Western Whipbirds in Victoria

Howe and Ross (1933) commented that it was in 1926, 13 years after their first trip, when they thought they were meeting with a new species of *Sphenostoma*, the genus in which wedgebills were then placed. This suggestion was in fact probably first made by J. Neil McGilp 1923 after he examined the so-called Wedgebill eggs (see McGilp and Parsons 1939: 19).

Howe (1928 — presumably written early in or before 1928), noted without comment that he and his colleagues had collected six sets of wedgebill eggs in the Manya area. Yet it was in 1926, according to Howe and Ross (1933), that doubts of the birds being wedgebills arose. And it was about 1927 that they obtained notes on the calls of Western Australian wedgebills so strengthening their doubts.

### Discovery of other populations

News of a third population came unexpectedly from the foot of Yorke Peninsula, near Pondalowie Bay, in South Australia. B. Glover first noted strange calls there in January 1965 and later

## Contributions

searches, in particular by F. Chapman, M. Waterman and M. Daley in October 1965, confirmed the species' presence there (Condon 1966).

Two more populations remained to be discovered. On Kangaroo Island, South Australia, the birds were first recorded in January 1967 by H. Crouch (Condon 1967) and are now known to be common and widespread on the island in mallee. The presence of a population on Eyre Peninsula became widely appreciated in 1966 (McNamara 1966) though here again the Edenhope egg-collector Hugh Collins appears in the story. It has generally been overlooked that Hugh Collins had sometime prior to 1930 recorded not only the Murray Mallee population at Lamerloo, South Australia but also the Eyre Peninsula population between Cowell and Kimba. Again, the only reference to these reports is in a letter written by Collins to, and quoted by, Howe and Ross (1933: 142).

Finally, fears of extinction also surfaced in the 1960s, this time relating to the Murray Mallee population. But it, too, was rediscovered in South Australia in 1967 and in 1968 in Victoria (Hunt and Kenyon 1970). It has been observed regularly ever since and a significant north-westward range extension of this population to Malinong, South Australia became apparent as late as 1981 (Woinarski *et al.* 1988).

## Acknowledgements

I thank Alan Danks for his comments on a draft of this article.

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## Antique Microscopes

Microscopy Group

Geoff O'Loughlin

In commendation of ye Microscope.

Of all the Inventions none there is Surpasses  
the Noble Florentine's Dioptrick Glasses

For what a better, fitter guift Could bee  
in this World's Aged Luciosity

To help our Blindnesse so as to devise  
a paire of new and Artificial eyes

By whose augmenting power wee now see  
more  
than all the world Has ever down Before.

*Henry Powers 1664*

On Wednesday, October 16th, we had a display of 50 antique microscopes selected from the collections of John Dawes and Dr Geoff O'Loughlin. Referring to examples from this comprehensive display, John Dawes, with his profound knowledge of microscopy, demonstrated the important events in the development of microscopy from the time when, it is said, Galileo turned his telescope the wrong way round, until the early twentieth century.

One of these landmark inventions was the Leeuwenhoek Microscope. John has a replica of the tiny single lens Leeuwenhoek microscope with which this Dutchman in 1674, single handedly founded the science of microbiology. The single glass bead lens is housed in a beaten brass plate, while the specimen is fixed to a screw operated pointer in front of the lens. It is held close to the eye and according to John Leeuwenhoek had the advantage of being short sighted.

Another is the 'Compass' Microscope of the middle 1700s, of brass and steel with an ivory handle, shaped like a compass, with the specimen on one point and on the other, a single lens. Interchangeable lenses in turned wood, ivory, or brass cells were provided. At this time, lenses were often surrounded by a parabolic silvered mirror of 'Lieberkuhn' which concentrated reflected light onto an opaque specimen, giving excellent illumination.

The early Compound Microscopes in the display included three replicas (Figs. 1-3) made by Dr. O'Loughlin. Fig. 1 is a replica of a John Yarwell side-pillar microscope typical of the period 1670-90. It is 20 inches high and made of walnut, paste-board, gold tooled leather and brass. It has three simple bi-convex lenses — an eye lens, a large diameter field lens within the body, which provides a much wider field of view, and a small objective lens. Coarse focussing is by sliding on the side pillar, fine focussing by rotating the body on the brass threaded nose piece. This style is the prototype of the modern microscope and is similar to that used by Robert Hooke, a pioneer of microscopical investigation.

Italian makers produced models such as the 'screw barrel' type of 1670 in Fig. 2, focussing by means of a coarse wooden thread. It is made from beech and tooled leather.

A later replica (Fig. 3) is possible Italian and has decorative turning in mahogany.

Pond life was a favourite source of material for the popular hobby of microscopy throughout the 18th and 19th centuries. An 'aquatic' microscope of 1820 by Bancks & Son Instrument Makers to His Majesty was shown. This is almost identical to the Bancks microscope taken by Darwin on the *Beagle* voyage in 1831, and to Robert Brown's microscope with which he discovered 'Brownian' movement. The microscope screws to the box lid and the single lens may be moved in two dimensions horizontally to observe the movements of tiny water creatures in a watch glass on the stage.

The Culpeper Tripod Microscopes were all brass with elegantly curved tripod legs to support the stage, and a second tripod on the stage to support the body tube. Culpeper introduced the substage mirror (Fig. 4).

## Contributions

The improved Compound Microscope (Fig. 5) shown was an English 'Newman' typical of the early 19th century when a great variety of accessories were available. The flat mahogany box (Fig. 6) has a lid padded with purple velvet, an instruction booklet describing the accessories and listing the specimens which are held between discs of mica in ivory mounts. Accessories include a hand magnifier, compressor for holding live specimens between glass, brass box for mica discs and split rings, stage forceps, glass trough with brass ring for pond water, diffusing glass to place under stage, bulls-eye lens with candle? holder, tweezers, needles and brush for lens cleaning, Lieberkuhn reflector for 'opaque' objects, and seven objective lenses.

Several examples of the 'Wenham Binocular' were on show. Wenham's ingenious contribution was the invention in 1861 of a new beam splitting prism of peculiar design which was interposed directly above the objective lens and covering only half of it. This diverted half the rays to a second tube which emerged at an angle to the vertical tube. A great advantage was the true stereoscopic view obtained. 'No one', says a writer in 1906, 'can fail to be struck with the beautiful

appearance of objects viewed under the Binocular microscope, when the wonderful relief and solidity of the bodies astonish and delight even the adept. Foraminifera always beautiful, have their beauties increased 10 fold'.

This characteristic inclination of the tubes set the pattern for British binocular microscopes for the remainder of the 19th century. Their popularity was enhanced by the ease with which monocular vision could be restored — by pulling out the prism, as was necessary at high power.

In a book on *Collecting Microscopes*, L'E Turner says, 'The collector of old microscopes is in a particularly fortunate position. Not only does he enjoy the satisfaction of tracking down an antique, and the pleasure of owning a piece of fine craftsmanship from an earlier age, he can actually use the instrument as its earlier owners used it, to broaden his knowledge of the natural world.'

If any reader has interest in old microscopes, or knows of someone who does, a phone call to John Dawes on 592 4230, or to Geoff O'Loughlin on 589 3103, would be greatly appreciated.



**Fig. 1.** A replica of a John Yarwell side-pillar microscope typical of the period 1670-1690.

**Figs. 2 and 3.** Screw barrel models typical of those produced by Italian makers.

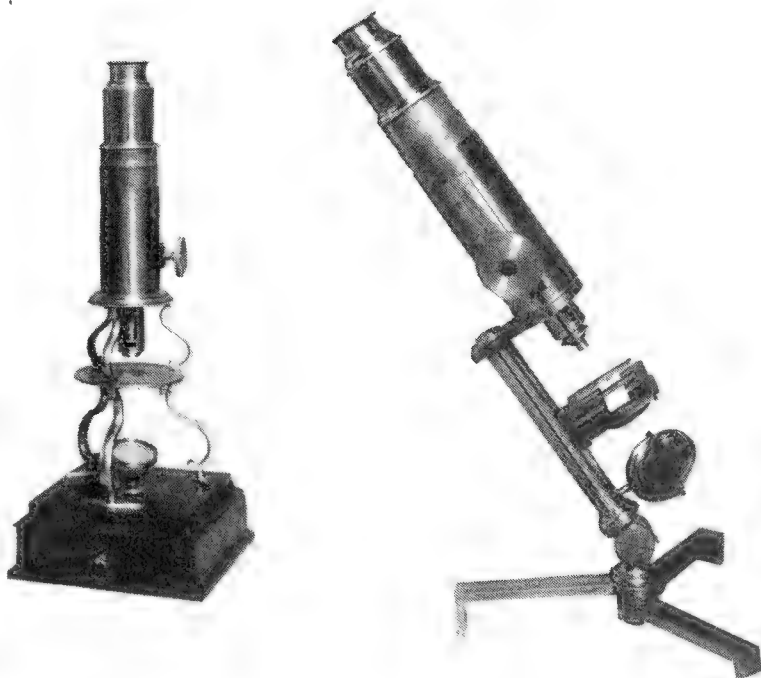


Fig. 4. A Culpepper Tripod Microscope.

Figs. 5 and 6. An English 'Newman' improved Compound Microscope together with the mahogany box.

# The M. A. Ingram Trust

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The objects of this trust, stated more precisely, are:

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The trust was established by the late Janet, John, Mary and Will Ingram, who each left their residuary estates upon identical trusts, which they directed to be known as the 'The M. A. Ingram Trust', in memory of their mother.

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*The Victorian Naturalist* is the bi-monthly publication of the Field Naturalists Club of Victoria.

### Scope

*The Victorian Naturalist* publishes articles on all facets of natural history. Its primary aims are to stimulate interest in natural history and to encourage the publication of articles in both formal and informal styles on a wide range of natural history topics.

### Research Report

A succinct and original scientific communication. Preference is given to reports on topics of general interest.

### Contributions

Contributions may consist of reports, comments, observations, survey results, bibliographies or other material relating to natural history. The scope is broad and little defined to encourage material on a wide range of topics and in a range of styles. This allows inclusion of material that makes a contribution to our knowledge of natural history but for which the traditional format of scientific papers is not appropriate.

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Short and informal natural history communications. These may include reports on excursions and talks.

### Commentary

Informative articles that provide an up-to-date overview of contemporary issues relating to natural history. Whilst commentary articles are invited, the editors welcome discussion of topics to be considered for future issues.

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Priority is given to major Australian publications on all facets of natural history. Whilst reviews are commissioned, the editors welcome suggestions of books to be considered for review.

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Any items of news concerning the FNCV.

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Notice of coming events including activities of FNCV groups and any other activities of interest to *Vic. Nat.* readers.

### Review Procedures

Research reports and Contributions are submitted to the editors and are forwarded to the appropriate member of the editorial board for comment. All research reports are assessed by two independent qualified referees prior to publication. Contributions are assessed by the appropriate member of the editorial board and may be refereed at the editors discretion. All other articles are subject to editorial review.

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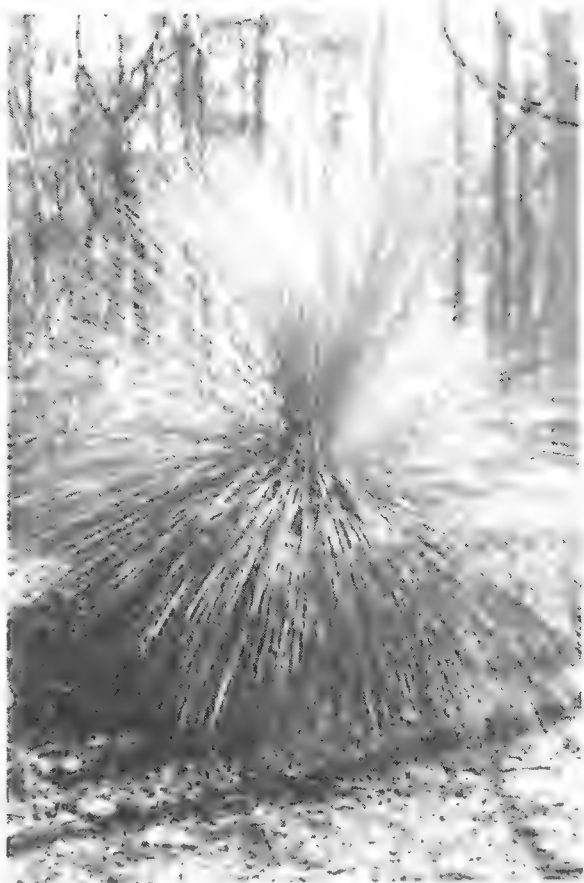
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# The Victorian Naturalist

Volume 108 (6) 1991



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## FNCV Calendar of Activities

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- Wed. 15      Microscopy Group. Members night.  
Sat. 18      Fauna Survey Group. Leadbeaters Possum Watch. Contact Ray Gibson (874 4408).

### February

- Sun. 2      General Excursion. Contact 850 9379 or 435 8408 for details.  
Tues. 4      Fauna Survey Group. Owls, Ed McNab.  
Wed. 5      Geology Group. Santorini Volcano and Archaeological Dig Site. Slide show. Joyce Leveson.  
Mon. 10      General Meeting. Natural History of Wattle Park. Ian Faithfull.  
Thurs. 13      Botany Group. Orchids. Dr. G. Carr.  
Wed. 19      Microscopy Group. Art Under the Microscope.  
Sat. 22      Botany Group Excursion. Tooradin Salt Marshes.

### March

- Sun. 1      General Excursion. Wattle Park.  
Tues. 3      Fauna Survey Group. Forestry and Wild Life. Richard Loyn.  
Wed. 4      Geology Group.  
Fri. 6 – Mon. 9      Assoc. of Field Naturalists Clubs of Victoria. Annual Camp. The Basin.  
Thurs. 12      Botany Group. Speaker – Malcolm Calder.  
Mon. 16      General Meeting. Natural History of South-West Queensland. Helen Aston.  
Wed. 18      Microscopy Group. Plant Section. An explanation of what we see.  
Sat. 28      Botany Group Excursion. Native Berries. Upper Thomson River.

---

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## Photographic Competition

To all budding photographers. Send your slides to the office. Three to be chosen for front covers in 1992.

*Deadline for February issue, volume 109, is Feb 12th 1992.*

# The Victorian Naturalist

Volume 108 (6) 1991

ISSN 0042-5184

Editor: Robyn Watson  
Assistant Editors: Ed and Pat Grey

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Cover photo: *Xanthorrhoea australis*, by Alistair Phillips.

## A note on the occupancy of nest trees by Leadbeater's Possum at Cambarville in the montane ash forests of the Central Highlands of Victoria.

D.B. Lindenmayer\*

Leadbeater's Possum, *Gymnobelideus leadbeateri* McCoy is an endangered species of petaurid arboreal marsupial that is virtually confined to the montane ash-type eucalypt forests in the Central Highlands of Victoria (Lindenmayer *et al.* 1991). Groups of up to nine animals of this species share a communal nest constructed of strips of bark inside a large tree with hollows (Smith 1980).

The first detailed study of the biology of *G. leadbeateri* was conducted at Cambarville (37°33'S, 145°53'E) between 1978 and 1980 (Smith 1980). During this study, wooden ladders were attached to seven large dead trees with hollows or stags to allow access to nest sites used by *G. leadbeateri*. One of the marked trees collapsed whilst the study was in progress. The remaining trees were located in July 1983 and stag-watched as part of an investigation of the habitat requirements of *G. leadbeateri* (Smith and Lindenmayer 1988). Stag-watching involves observing animals in silhouette as they emerge at dusk from large trees with hollows (Lindenmayer *et al.* 1990a). The six trees which supported ladders were stag-watched at an interval of every 6-8 weeks between August 1990 and March 1991. Trapping also took place on, and close to, two of these trees. Radio transmitters were fitted to those animals that were caught.

Of these six trees, four were used by *G. leadbeateri* in July 1983, but only two trees were inhabited by the species between August 1990 and March 1991. Over the seven years, four of the nest trees had apparently been deserted by the species.

The two trees most recently occupied by *G. leadbeateri* were approximately 100 m apart and radio tracking showed that the animals swapped regularly between nest trees. *G. leadbeateri* shared one of these trees with an adult female Mountain Brushtail Possum, *Trichosurus caninus*. The Brown Antechinus, *Antechinus stuartii*, was found to co-occur with *G. leadbeateri* in both trees. These species used a different entrance to the nest tree from *G. leadbeateri*.

The four trees with ladders not used by *G. leadbeateri* between August 1990 and March 1991 were amongst a suite of den sites used by several *T. caninus* that have been fitted with radio collars.

These findings demonstrate the long term use of particular trees with hollows by *G. leadbeateri*, although it was not possible to determine if habitation was continuous during this time. The results also suggest that over time, some trees become unsuitable as nest sites for the species. This conclusion is supported by studies by Lindenmayer *et al.* (1990b) that found six of 36 trees with hollows occupied by *G. leadbeateri* in 1983 had collapsed by 1988 and did not contain the species. Four trees with ladders at Cambarville were measured for decay in 1983, 1988 and 1991. All showed substantial decay over the eight year period.

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*Xanthorrhoea*: Consequences of 'Horticultural Fashion'

Alistair Phillips and Robyn Watson\*

In recent times a popularity has developed for the use in horticulture of an arborescent member of the Xanthorrhoeaceae family *Xanthorrhoea australis* (Austral Grass-tree). The Grass-trees are harvested as mature plants from natural vegetation, legally, via the mechanisms of the Flora and Fauna Guarantee Act 1988 (referred to herein as FFG), from private land and illegally from public land. *Xanthorrhoea australis* may occur in heathlands, open eucalypt forest, and in *Banksia* woodland in Victoria and up the eastern seaboard to southern Queensland.

Although the use of *Xanthorrhoea* as an urban garden plant was promoted in the late 1970's it was the following decade saw the fashion set and the availability of the plant from commercial sources broadened (Anon., 1981). The popularity of this plant continues in the 1990's, specifically as a feature plant in the landscape.

A survey of nurseries carrying native plant stocks has shown that some nurseries conduct a consistent trade in Grass-trees. All stocks are mature plants that have been removed from the natural environment, with the exception of one nursery, which sells both propagated 'grass-like' tube stock of the Small Grass-tree, *Xanthorrhoea minor*, as well as advanced plants of *X. australis* removed from the bush. The reason mature plants of *X. australis* are removed from the natural environment is due to their slow growth rate, so commercial propagation of *X. australis* to an arborescent size is not a workable option when catering for the immediate demands of a present day horticultural fashion.

Although the myth that Grass-trees grow 1 foot per hundred years is over

stated, at 1 cm per year *Xanthorrhoea* are a slow growing plant. How slow an *Xanthorrhoea* grows has been a point of interest for years. Different methods of ageing *Xanthorrhoea* have been proposed over time. It is often said that *Xanthorrhoea* grow 1 ft. (30 cm) every 100 to 120 years. This idea originates from Lewis (1955). His method estimated the age of living plants by observing, over time, the number and dimensions of the annually produced leaves. Lewis, whilst being on the right track appears to have overestimated the slowness of growth, probably due to the difficulty in assessing the dimensions of leaf bases on growing specimens due to the production of resin, which obscures the leaf base waves. These waves of annual growth can only be identified if dead sections of the trunk, particularly the leaf bases, were longitudinally cut. It appears that Lewis underestimated growth rates approximately three fold.

LaMont and Downes (1979) report that *Xanthorrhoea* growth rates approximate a mean of 1.0 — 1.5 cm per year. Their work on *X. preissii* in Western Australia, showed that *Xanthorrhoea* spp. produce an annual ring of leaves, typical in monocots, and glands at the base of the leaves secrete a resin that bind the leaf bases together in a bundle or fascicle. This annual leaf initiation forms an annual ring of leaves around the trunk. If a longitudinal section is taken through the leaf bases each year's production of leaves can be clearly counted, a little like counting tree growth rings. Although the work was carried out on the West Australian species *X. preissii* Lamont and Downes (1979) suggest this ageing technique is applicable across the *Xanthorrhoea* genus. A study presently being conducted by the author has analysed samples of leaf base material from *X. australis* from sites at Port

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Welshpool, the Brisbane Ranges, Anglesea and Greens Bush using the Downes/LaMont ageing method. Sample material collected (which was not from living plants), was cut longitudinally and revealed a mean growth rate of 0.9 cm/year with a 0.7 cm to 1.4 cm range.

Once growth rates had been established the conversion of height to age can be undertaken. For example, a mean annual growth rate of 1.2 cm will indicate a two metre high plant approximates a one hundred and sixty six year old plant. It is not intended to suggest that precise ageing *Xanthorrhoea* species is a simplistic task; one must be wary of variables such as how one ages multi stemmed plants, and take into account that *X. australis* have a subterranean trunk for their first years of growth, 20 years in the case of *X. preissii* (La Mont pers. comm. 1991). Gill and Ingwersen (1976) found *X. australis* develops a subterranean trunk 15 cm deep before the arborescent trunk appears.

The smallest plants offered for sale have a 30 cm trunk. Thus, in order for the plants to be of a marketable size they have to be at least 50 years old. Many *X. australis* for sale in Melbourne are 200 years old or older. A range of trunk sizes, 20 cm to 300 cm are offered at nurseries around Melbourne.

Flowering and the recruitment of new plants in the natural environment is closely linked with fire. After fire the plant's produce a flowering spike, which will grow at rates of up to 7 cm per week (Staff and Waterhouse 1982). Costermans (1989) has noted the spikes of a fire affected population will develop simultaneously. Seed set rates can be high, with 10 000 seeds per inflorescence in *X. australis* (Gill and Ingwersen 1976). *X. resinosa* have the potential, given the appropriate conditions, to produce 180 000 seeds per metre of inflorescence (Staff 1976). Seed germination follows around 6 to 12 months after fire (La Mont and Downes 1979). The genus *Xanthorrhoea* has contractile roots and in the species *X.*

*australis* these roots may draw apices to depths of 15 cm (Gill and Ingwersen 1976), or even further (Gill 1981). In particular the contractile roots pull the shoot apices underground during the passage of fire. The protected apices of *Xanthorrhoea* result in the first spots of 'green' after a bushfire.

Although fire seems to be intrinsically linked to flowering in *Xanthorrhoea* species (Specht et al 1958) the stimulus is not well understood. There is mounting evidence indicating ethylene stimulates the production of inflorescences in *Xanthorrhoea*. Smoke contains small amounts of ethylene, and plant tissue injury causes ethylene release. Gill and Ingwersen (1976) observed that either cutting of leaves or fire contribute to inflorescence production, with fire in particular having an 86.7% success rate in triggering the shoot apex to develop an inflorescence. Any recruitment by the population in the absence of fire will have to take place as a result of the occasional inflorescence produced in the interfire period (Gill 1981). The structure of *Xanthorrhoea* populations also indicates that recruitment is strongly linked to fire because plants can be readily placed into discrete age groupings at a site, indicating episodic recruitment events (Phillips and Watson, unpub.).

All harvested plants from Victoria should be collected under the Department of Conservation and Environment permit system, which is administered under the Flora and Fauna Guarantee (FFG) legislation. The harvesting of *Xanthorrhoea australis* for nursery stocks, under FFG criteria, from private bushland must be practised on a sustainable basis (Flora and Fauna Guarantee Act 1988). Each harvested plant must bear an FFG certificate at the point of sale. It is specified on the permit precisely how many plants can be harvested. Additionally, under FFG legislation, stock imported from interstate must also display the tag approving their sale. Under

FFG legislation it is illegal to remove *Xanthorrhoea* from public land.

A survey of Melbourne nurseries advertising Australian plants for sale revealed that at least 14 sell *Xanthorrhoea* and 2 would procure the plant if ordered. Two nurseries reported they formerly sold *Xanthorrhoea* but have since ceased because they could not keep the plants alive. Two of Melbourne's major native plant nurseries claim a small but steady stream of sales of the plant. Both these businesses say that their main sources of sales are the general public, rather than landscaping projects.

Costs ranged between \$45.00 for a 14 cm trunk to \$400.00 for a 3.3 m trunk. Prices seem to vary according to the number of trunks — a 300 year old triple trunked *X. australis* may sell for over \$400.00. Plants that were showing signs of mortality, leaf ends at different stages of chlorosis, were lower in price, whilst nurseries that had kept stock for a year generally asked high prices. Should one decide to purchase untagged illegally harvested stock (for instance from the back of a truck on the Mulgrave freeway) then only \$20.00 may be required. Living vegetative history is going cheap in Melbourne.

Interestingly some nurseries offer *X. australis* from Queensland, whilst others sell plants from South Gippsland, the South Australian border and Victoria's western district. Although sold under the name *X. australis* the Queensland species *X. johnsonii* is often the plant sold in Melbourne.

The current popularity of *Xanthorrhoea* has led to the illegal practice of harvesting the plant from public land. Evidence of such activities unmistakably apparent on public land in areas as far ranging as the Brisbane Ranges, Greens Bush, Port Welshpool and the Grampians.

The opportunism associated with such practices was well illustrated on the occasion of a field trip to Port Welshpool. Whilst examining a remnant stand of

*Banksia serata* and *X. australis* close to housing, a local resident offered to sell the remaining *X. australis* on this publicly owned block of land.

A visit to nine nurseries in Melbourne selling *Xanthorrhoea* revealed that only one nursery complied with FFG regulations. Some nurseries had no permits, others had only one permit for a collection of plants and some displayed permits issued for tree ferns, not *Xanthorrhoea*. Two proprietors offered south Gippsland plants for sale, one collection was FFG permitted. These plants had *Banksia serrata* leaves lodged in the leaf bases — *B. serrata* and *Xanthorrhoea australis* can grow as co-dominants at limited coastal Gippsland locations. Yet there are no permits issued for commercial harvest in this area.

One might suggest on the above evidence the FFG protection of *Xanthorrhoea australis* is a failure, particularly when major nurseries in Melbourne are quite openly selling illegal plants. Not many people interested in matters ecological would condemn the formulation of the FFG policy. However the disconcerting thing about the FFG policy is that there appears to be few resources for its implementation. The FFG appears to have limited departmental backing to either prosecute or educate.

In addition to pressure placed on *Xanthorrhoea* populations by the horticultural industry, florists and associated industries are also influencing the future of this plant. Foliage of *Xanthorrhoea* has been established in the 1980's as popular green filler for floral displays. Along with this is the use of the spike inflorescence in florist shop products. There are many plants in the Brisbane Ranges that have had foliage shaved off- they appear to have been given a 'hair cut'.

The rise in this horticultural fashion is driving the rise of illegal harvesting of the plant both in Victoria and Queensland. Given the recruitment ecology of the

plant, the sanctioning of *X. australis* harvesting under the FFG permit system begs the question; is the practice sustainable? One might hypothesise that the legal or illegal removal of *X. australis* is unsustainable and if the current removal practices are not ceased, *Xanthorrhoea australis* in areas of Victoria (and other states) will eventually reach the state of being locally extinct.

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## Legislation

- Acts 1988 No.47.  
Flora and Fauna Guarantee Act 1988.

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## Report on 'The marine life of Heron Reef'

*This talk was given by Julie Marshall to the August General Meeting, FNCV, at the Herbarium, August 13th, 1990.*

### Location

The Great Barrier Reef stretches for almost 2000 km parallel to the North East Australian coastline. Heron Island is situated in the Capricorn-Bunker Group which is at the southern end of the Great Barrier Reef about 70 km from the Queensland coastal town of Gladstone.

### Background

Heron Reef is approximately 11 km long and 4-5 km wide. Originally discovered during the surveying trip of the H.M.S. Fly in 1843, the island was first used by turtle canners. Eventually the island was taken over in 1932 by Christian Poulson who established a small resort. In 1973 the P & O Shipping Line took this over and greatly expanded it so that it now caters for over 200 guests. They have also recently dredged out a large harbour to accommodate a 'wave piercing catamaran'. Heron Island is a coral cay, and, apart from Green Island, this is the only resort situated on a cay. The University of Queensland also has a research station on the island. The marine life of the reef has been protected since the 1960s.

### The Beach Zone

#### *Bird Life*

The dominant bird life consists of terns, herons and shearwaters. The White-Capped Noddy Tern (*Anous minutus*) provides guano for the *Pisonia* trees in which it nests, and also disperses the seeds of the tree which stick to its feathers. The nests are made from the leaves and twigs of the *Pisonia* trees.

Reef Herons are common. They have two colour varieties within the same species, and both white and grey phases are found at Heron Island.

The Wedge-tailed Shearwater nests on the island from November to March. From April to May the large fluffy chicks have trial flights.

### Turtles

Green and Logger-head Turtles come ashore on the rising tide at night during the summer months. They lay their eggs in a chamber (hollow dug in the sand) above the high tide mark. They lay a clutch of 100 to 150 eggs, which are soft and rather like ping pong balls. They hatch in 50 to 80 days. The temperature of the sand controls the sex of the hatchlings. The biggest day time predator of the hatchlings are sea gulls, whilst the ghost crab and the red-eye crab lie in wait on the beach and rocks at night for emerging turtle hatchlings.

### Marine Life in the Intertidal Zone

At low tide a large amount of the reef rim and reef flat is exposed. This area can be divided into a number of zones. There is the beach rock which houses chiton populations which graze on algae at night. Then a shallow gutter off shore which always contains about 1 metre depth of water. Here, underneath dead coral boulders are terebellid worms which live in a tube made of fine sediment and which have long feeding tentacles. The swimming bivalve, *Lima fragilis*, is also found. It moves by clapping the valves of its shell together and expressing the water – a form of jet propulsion.

In the inner or sandy zone are broad expanses of sand with sparse clumps of living coral. The main animals here are holothurians (commonly known as sea cucumbers because of their shape). These have mouths ringed by tentacles which sweep the sand into the gut, extract the food, and expel the remains through the anus. Many species when molested throw out part of their internal organs (called Cuvierian tubules) through the cloaca. These tubules elongate and become very

sticky. They also contain toxic substances which can poison a predator. Minute calcium carbonate spicules are embedded in their skin. Some species are still a popular food for the Chinese.

Many species of nudibranchs are found in the shallows including one of the largest – the Spanish Dancer, *Hexabranchus sanguineus*. Nudibranchs are molluscs although they all lack shells as adults. Their name means 'naked gills' and many species carry their gills clearly visible on their back (mantle). Most species of nudibranch are brightly coloured and this seems to warn other animals that they are unpalatable and they in fact have few predators. Nudibranchs are carnivorous, feeding on a variety of organisms such as sponges, bryozoans, ascidians and coelenterates, especially hydroids. The Spanish Dancer is one of the few nudibranchs which can swim. It does this by unfurling and undulating its mantle. It is about 25 cm in size but most nudibranchs are much smaller, some only being a few mm.

Gastropod molluscs can be divided into three main subclasses – the pulmonates (e.g. the common land snail), the opisthobranchs (which include the nudibranchs) and the prosobranchs which include most of the small shells which can be found in the reef shallows such as the baler shell, volutes such as *Amoria maculata*, spider shells (*Lambis lambis*) and mitre shells. Large numbers of the clam *Tridacna maxima* are found in the coral clumps.

Corals include the massive coral, *Goniopera*, brain corals, soft corals such as *Sarcophyton*, and the staghorn coral (*Acropora*). The main predator of corals are starfish but some nudibranchs also feed on corals (e.g. *Phostilla lugubris* on *Goniopera*).

Starfish can regenerate an arm if it is broken off. Many extrude their stomach externally to digest their prey. They use digestive enzymes to dissolve the tissue before ingesting. Heron Reef is largely free of the Crown-of-thorns Starfish which

devastate coral reefs further north.

Sea urchins are also common e.g. *Diadema* which is light sensitive. Little black fish live symbiotically with it.

In the living coral zone, coral is well developed forming an even topped platform encrusted with pink calcareous algae. Cowries are found in this area and also the abalone *Haliotis asinina*. It has holes in the distal part of its shell through which it expels water after the oxygen has been removed by the gills. Hermit crabs which inhabit dead univalve shells are common. There are many beautiful shrimps.

A sacoglossan which resembles a nudibranch, *Cyerce nigricans* lives in this area. It is herbivorous and feeds on the turtle grass, *Chlorodesmis*. It has numerous flattened leaf like cerata on its back. These contain branches of the gut and also glands which secrete noxious substances when the animal is attacked.

The reef crest or rim is the highest part of the intertidal zone. It is littered with large coral boulders. The underside of these shelter a large variety of life such as bryozoans, ascidians, sponges, flatworms, cowries and nudibranchs. Some nudibranchs such as *Pectinodoris trilineata* are very small and up to 50 can be found in one patch of sponge. 'Sponge crabs' carry a protective covering of sponge held in place by two of their legs. Sponges are unpalatable to most marine life and thus form a protection for the crabs.

Many sea hares (*Aplysia*) are found in this area. They produce a violet-purple ink like fluid when irritated. Brittle stars and shrimps are also common.

### Marine Life in the Subtidal Zone

The reef slope falls sharply down to about 20 m. The brilliant yellow *Tubastrea* coral can be found in caves and under overhanging ledges. Sometimes the polyps are eaten out by the mollusc, *Epitonium*. Gorgonian corals are large and branching and portray beautiful colours. Crinoids have numerous long, brightly coloured feather arms which catch plankton in the

currents. They use small jointed appendages known as cirri to cling to the substrate.

Fish are various including the Blue Angel fish, the Butterfly fish and the Trumpet fish. Moray eels are large and can be aggressive and bite. It is a common sight to see larger fish with smaller 'cleaner fish' eating parasites in the larger fishes' gills and mouth. Manta Rays are some-

times seen.

There are many beautiful flatworms and colourful nudibranchs, especially Chromodorids.

A feature of all these descriptions was the clear, colourful and typical environmental photography, which made the talk a valuable introduction to the life of the Heron Reef.

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## Naturalist Notes

### Flowering of the Lizard Orchid, *Burnettia cuneata*, on slashed firebreaks.

Clive and Fay Gordes\*

The Lizard Orchid has become a feature of Spring on French Island. With the burning involved in the Pine eradication programme and the annual burning of firebreaks, *Burnettia cuneata* can usually be found in burnt wet heath. The orchid is noted for flowering after fire. It flowers profusely under *Melaleuca squarrosa* for the first year after a fire with the odd flower coming through in the second year.

An unusual feature of this plant's flowering regime is recurring in the Park. In October 1988 we found sixteen plants flowering on a slashed firebreak. The closest burnt vegetation was twenty metres away. More plants were found flowering on an unburnt firebreak in September 1991. This time over fifty flowering plants were counted. The firebreak was ten metres wide and the plants were evenly

distributed over twenty metres of the slash. The area adjacent to the firebreak had been burnt six months prior to flowering. The unburnt and unslashed vegetation beside these areas contained no flowers.

*Burnettia cuneata* is a common orchid in French Island State Park provided the ground has not been disturbed. Thus plant has actually become a very good indicator of disturbance to the soil. In many areas of the Park the vegetation has appeared intact with all the appropriate small herbs and shrubs. However, after burning very few orchids are found, and in particular, few or no *Burnettia*. After reference to old records and local knowledge of clearing associated with settlement and crops farmed, these sites have generally been traced back to having a history of soil disturbance, sometimes dating back a hundred years or more.

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## Marsupial critics

Rod Barker\*

We live in the hills near Healesville, where my wife operates a ceramic studio, specialising in Australian wildlife. You'd think, in this day and age of ecological disaster and extinction that they would be grateful for all the publicity they can get. Ha!

Our problems began with a small sculpture of a Brown Snake rearing to strike. This was drying in the spare room, preparatory to bisque firing, so it was still only clay. One morning, disaster! A bite size chunk had been neatly removed from just behind the eyes, nearly severing the entire head. Inspecting the scene of the crime, we located a series of muddy footprints. From the backdoor, into the room, onto the chair, then the table. Chomp. Possum footprints! We could find no trace of the missing mouthful.

We suppose the animal in question jumped onto the table and was startled to find itself facing a 'snake'. That single bite was so placed to have killed the real thing instantly. It got us to wondering how often this happens 'in real life', and whether small snakes are included in the average Possum diet. Their paths would certainly cross on warm summer evenings.

Then there was the Dinosaur. This Camarasaurus had been a particularly difficult piece, taking well over a week to complete. Finally finished, much to everyone's relief! Next morning... The still wet clay sculpture was covered in tiny little footprints! Not content with this graffiti, the culprit/s had chewed an earhole, the snout and the tip of its tail! This time it was those dear little native mice (Brown Antechinus), of which there was somewhat of a plague at the time. These 'dear little mice' are one of the most

voracious predators imaginable, and eat anything that moves – or even stands still long enough, apparently! They even chewed up our boxes and packing material.

This leads us to a new theory of Dinosaur extinction. You can forget all that stuff about comets, volcanoes or little mammals eating their eggs. They were all chewed to pieces by a plague of Antechinus!

Most recently, we were firing a Water Dragon for an Exhibition that opened in the very near future. This was the bisque fire, a very long and tedious process necessitating an early start and very late finish (usually around twenty hours), with much to-ing and fro-ing to adjust the gas. Around dusk, a problem presented itself. A very large and grumpy problem in the form of an outsize wombat that obviously thought just outside the studio door was the place to be. It resisted all attempts at shooing, and just sat there, grunting loudly if approached. Adult wombats are not noted for their good manners. Not working to any deadline, it was nearly two hours before it decided the grass was greener elsewhere. We got to bed around three!

In all honesty, the problems are not confined to marsupials. Our elderly feline placental loves to help too. By sitting on the heater, meowing hideously to get in (or out) of the studio, walking all over the studio table and drinking the water in the work bowl (rather than its own fresh water!). It's no wonder that my wife has given up on furry animals completely, and now specializes in Reptiles and Amphibians. And if you are thinking of taking up wildlife art, I suggest you rent a city penthouse, and stick to pen and ink. It's a lot easier on the nerves!

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## Skink as prey of Hooded Robin

Ian Faithfull\*

During a circumambulation of Lake Powell, 16 km SSE of Robinvale, Victoria, on September 1991, Hooded Robins, *Melanodryas cucullata*, were observed on the western side in Black Box, *Eucalyptus largiflorens*, woodland that fringes the Lake. One or more of these birds continually returned to a long-dead Red Gum, *Eucalyptus camaldulensis*, a few metres from the water's edge, and perched at the end of one remaining large branch which jutted out to the north with its end nearly upright. The obviously hollow end of this limb and the behaviour of the birds led me to suspect that a nest was concealed there. Such a nest location is commonly chosen by this species (Beruldsen 1980).

While I watched, one bird, a female, landed on the outer edge of the limb above the suspected nest with the body of a skink, 10 cm long, in its bill. It seemed like a very large prey item for a bird of this size. The corpse was pale and silvery underneath, dark grey above with indications of dark lateral striping, prominent fairly smooth scalation and a thick body. The tail seemed to be missing and the head could not be discerned. Later

reference to Cogger (1983) suggested it might have been a tree skink, *Egernia striolata*.

In the same manner as a kookaburra, *Dacelo novaeguineae*, with a snake, the robin macerated the skink by moving it lengthways through the bill, and knocked it several times against the branch, evidently softening it up before consumption or feeding to nestlings. However the great disturbance resulting from my presence caused the bird to fly into the woodland where it was lost to sight, and me to move on, the fate of the skink being unrecorded.

Upon checking the records of the food of birds (Barker and Vestjens 1990), which show that Hooded Robins mostly eat insects, I found that no vertebrate material had previously been identified in its diet.

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## Book Review

### The Platypus, A Unique Mammal

by T. Grant *University of New South Wales Press,  
Kensington, NSW, Australia. 73pp. 1989.  
Price (Soft-bound) \$A14.95.*

The Platypus, written by Dr Tom Grant and illustrated by Dominic Fanning, was first published in 1984. It presented a most readable, knowledgeable and concise work, with a fresh approach to the subject, linking together old and new research findings. The earlier jacket belied the nature of the work; it was a simple platypus drawing, which to some indicated that the book was aimed solely at a children's market. This was not so, but the book may not have attracted as many readers as the second edition is likely to do.

The jacket of the new edition shows a colour photograph of a Platypus, and has a new sub-title, *A Unique Mammal*, which immediately evokes a response in potential buyers. Layout and contents of the work have been revamped, and the figures by Fanning re-drawn, without losing their original character. There is a clear reference to both contents and figures throughout the work.

The division of each chapter into succinct sections is a great improvement. New information is incorporated throughout, often in the caption to the figures, as in Fig. 1.1, which discusses modern Platypus systematics, utilising recent research information. Although the figures are well referenced, this is not the case with the few coloured plates, which are however, well-captioned and informative.

Information on distribution has been revised and expanded, which results in a good overview of the range of the species throughout Australia.

Grant has again maintained the

division of his work into the four seasons; winter, spring, summer and autumn. These divisions allow him to comment in depth on dietary components of the Platypus over the year, and to give an ongoing account of the unique breeding cycle. Not only does he discuss general biology of the Platypus, but he includes descriptions of his own work on various aspects of their behaviour. He covers tagging of individuals, recapture data, population studies and ageing, all of interest, and mostly dealt with only in specialist literature.

In recent years, there has been extensive study of the sensory mechanisms of platypuses, and the methods by which they locate their prey. In this edition Grant expands the information presented in his earlier text, but does not refer to it in his index.

The biological profile of the Platypus at the completion of the text is very useful. It includes many facts often required for general information, such as status, longevity and mortality. These facts are grouped for easy reference.

The excellent bibliography has 21 more references than the 1984 version, reflecting the interest and research on the species in recent years.

I recommend this book to a broad audience, to include school children, the lay person and the academic. It should appeal to a wide market, in Australia and overseas.

Joan M. Dixon, *Curator of Mammals,  
Museum of Victoria, 328 Swanston Street,  
Melbourne, Victoria 3000 Australia.*

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# **The Victorian Naturalist**

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