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From the Editors

The Victorian Naturalist would not be successful without the enormous amount of time and effort voluntarily given by a large number of people who work behind the scenes.

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The Victorian Naturalist endeavours to publish articles which are written for a wide and varied audience. We have a team of dedicated proof-readers who help with the readability and expression of our articles. Thanks to:

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Cover: Peter Menkhorst receiving the 1998 Australian Natural History Medallion (see article p. 4). Photo by Wendy Clark, Empathy Photographics.

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Australian Natural History Medallion 1998

Peter Menkhorst

'Destruction of habitat' is a phrase heard frequently these days, and it is the reality behind this that makes the work of this year's Medallionist so important and valuable. For more than twenty-five years, Peter Menkhorst has been involved with endangered species of birds and mammals, either by field survey, research or coordinating recovery efforts. As a Wildlife Scientist in the former Fisheries and Wildlife Department, and since 1996 a Senior Wildlife Policy Officer with the Department of Natural Resources and Environment, he has played a major role in improving knowledge of Victoria's wildlife and developing recovery strategies.

The Orange-bellied Parrot Recovery Project, one of the first intensive recovery efforts undertaken in Australia, required the collaboration of the wildlife agencies of the Victorian, Tasmanian, South Australian and Federal Governments, Birds Australia, and other non-government agencies. Peter Menkhorst has been the Victorian representative on this recovery team since its inception in 1983. He developed and led the Helmeted Honeyeater Recovery Effort, involving the coordination of scientists from a variety of disciplines, and in 1993 he was put in charge of the recovery of the Regent Honeyeater, an ecologically complex project, also requiring the coordination of organisations in three States. He has collaborated in the preparation of recovery plans and Action Statements under the Flora and Fauna Guarantee Act for the Orange-bellied Parrot, Helmeted Honeyeater, Regent Honeyeater, New Holland Mouse, Squirrel Glider and the Koala in New South Wales.

Peter has been involved in many field surveys, often as team leader. These included investigation of the requirements of the Squirrel Glider in northern and central Victoria, the Smokey Mouse in the Eastern Highlands, and the feeding ecology of Australasian Gannets breeding in Port Phillip Bay, Victoria.

The status of the Koala is a vexed question. Overpopulation is a problem in parts of Victoria, and since 1995 Peter has coordinated Koala management across the State, including investigation of options for fertility control. He represents Victoria on the National Koala Network, which has prepared a National Strategy for Koala Conservation.

In 1995 Peter represented Australian wildlife agencies at a workshop on Population and Habitat Viability Assessment for the Komodo Dragon, in Bogor, Java, and later encouraged and facilitated the Conservation Breeding Specialist Group of IUCN to conduct the first such workshop in Australia, for the Spotted Tree Frog.

The *Atlas of Victorian Mammals* project was set up under Peter's leadership in 1980, and he was responsible for the formation of a detailed computer database for mammal records for Victoria. This now includes records of all Victorian vertebrates and is the most comprehensive of its kind in Australia. It formed the basis for *Mammals of Victoria: distribution, ecology and conservation* (1995), for which Peter was the major contributor and editor. In 1996 it received a Whitley Book Award from the Royal Zoological Society of New South Wales. Other publications include contributions to books on the ecology of the Mallee, the status of Australia's seabirds, possums and gliders, *Fauna of Australia, Volume 2 - Aves* and the *Handbook of Australian, New Zealand and Antarctic Birds*, and over 100 articles to journals both scientific and popular.

Over 130 of Peter's photographs have been accepted for the Australian Museum's *National Photographic Index of Australian Wildlife*. Some have been used in the series of books published by the *Index*; others in *Mammals of Victoria*, and in R. Strahan's *Complete Book of Australian Mammals*.

Programs for the recovery and management of endangered wildlife rely very heavily on research, and Peter has designed and co-supervised projects at PhD and BSc Honours level on aspects of the ecology of the Orange-bellied Parrot and the Helmeted Honeyeater. Input from amateur groups is also of great value, and Peter has been very active in cooperating with them to achieve common goals.

Peter is a member of Birds Australia, the Bird Observers Club of Australia, the Australian Mammal Society, the Australian Bird Study Association, the Victorian Ornithological Research Group (V.O.R.G.), who nominated him for the Australian Natural History Medallion, as well as various 'Friends' organisations. He was a committee member of V.O.R.G. for twenty years, and a member of the Healesville Sanctuary Advisory Committee between 1991 and 1995. He has presented over 50 talks to naturalist clubs, and has done much to raise public awareness of the plight of endangered species, and to involve the wider community in the protection and preservation of their habitat.

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Errata

In Volume 115 (5), Mount Buffalo Centenary Issue, the captions on pictures A and B on Plate 5 were reversed. They should read: **A**. *Oreixenica latialis theddora*, a subspecies of the Browns endemic to Mount Buffalo. Photo by David Crosby; **B**. Common Silver Xenica *Oreixenica lathoniella herceus* which flies at the same time as *O. latialis*. Photo by David Crosby. These photographs accompany the paper by David Crosby entitled 'The Butterflies of Mount Buffalo National Park', pages 222-225.

The editor apologises for any misunderstanding this has caused.

Special Issues

The Victorian Naturalist

Mount Buffalo Centenary Issue Volume **115** (5) 1998
Wilsons Promontory Centenary Issue Volume **115** (6) 1998

Copies are available for purchase from Parks Victoria offices at the Mount Buffalo and Wilsons Promontory National Parks or the FNCV Office, Locked Bag 3, Blackburn 3130, Victoria.

Send $8.50 per copy (includes postage).

Farewell Message

Ed and Pat Grey wish to thank all the people who have helped make our job as editors of *The Victorian Naturalist* over the past years rewarding, enjoyable and possible. There are far too many to list, but suffice it to say, we shall miss the contact with such a range of interesting and stimulating people. We are, however, happy to leave in the knowledge that the new editor – Merilyn Grey – will do a wonderful job.

Ed and Pat Grey

Plant Ecophysiology: the Quest to Understand How Plants Cope in a Changing Environment

Jann Williams[1] and Derek Eamus[2]

Abstract
Plant ecophysiology applies physiological principles and methodologies to organisms living in their natural environment. It is a relatively new field in Australia, but is helping unravel the linkages between pattern and process in a range of environments and vegetation types, and is providing basic information that can be used for managing natural resources. This paper reviews recent progress in the discipline and identifies future directions for research. (*The Victorian Naturalist* **116** (1), 1999, 6-10).

Introduction

Until recently, much ecological research into plants has been concerned with the description and classification of vegetation types, as well as the long tradition of assessing differences within and between populations of a plant species using morphological and demographic characters (Pryor 1956; Williams and Ladiges 1985). With the development of new approaches and methodologies, however, we are now gaining a greater understanding of the processes that underly the distribution and abundance of plants.

A more quantitative approach based on knowledge of mechanisms underlying the distribution and performance of plants can further improve understanding, and hence management of systems. Ecophysiology, a hybrid of physiology and ecology provides this approach. For the purposes of this paper, ecophysiology is considered to be the application of physiological principles and methodologies to organisms living in their natural environment, or the study of the influence of the environment on plant growth and development. It gives us the tools to advance our understanding of how plants cope with a changing environment on a daily, seasonal and annual basis.

Ecophysiology is a relatively new field in Australia (albeit a well established field in Europe and America), and is beginning to help unravel the linkages between pattern and process in range of environments and vegetation types (Williams and Eamus 1997). Pattern generally refers to the way plants are distributed in space and time across the landscape. For example, a species may only be found in locations where there is a reliable water supply, such as along river-banks. By examining the processes associated with these patterns, the aim is to identify the key mechanisms that help explain the distribution of individual plants or vegetation types. Using the previous example, the plants in question either may not be able to physiologically tolerate drier areas or could grow there but are outcompeted by other species. By using ecophysiological techniques, there is a greater chance of identifying which is the most likely explanation.

Recent published examples where ecophysiological principles are used to link pattern and process are studies on the dynamics of Mulga woodlands (Anderson and Hodgkinson 1997) and some of the pioneering work on northern Australian savannas (Prior *et al.* 1997; Myers *et al.* 1997). These studies provide considerable insight into the functioning of these ecosystems and provide basic information that can be used for the management of these landscapes. In addition, modelling physiological processes, as illustrated by studies on tree growth and nutrient cycling (Kirschbaum *et al.* 1994) can help predict potential changes in vegetation dynamics as environments change, for example in response to climate change (McMurtrie *et al.* 1992). Models can also inform our understanding of successional changes in vegetation after disturbances such as fire.

With the increasing realization of the importance of natural ecosystems to global environmental health (Mooney *et al.* 1996) and the increased focus on sustainable management (Commonwealth of Australia

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1996), the demand for information on the structure and functioning of ecosystems is likely to expand. The challenge is to provide informed opinions of the linkages between pattern and process and how ecosystems respond to the actions of humans (Williams and Eamus 1997). This paper indicates how the field of ecophysiology can help achieve an increased understanding of the links between pattern and process.

Plant ecophysiology – the links between pattern and process

The production of much of the vegetation covering the Australian continent is limited by low availability of water, nutrients, or both (Pate and McComb 1981). Superimposed on this axiomatic feature is the impact of fire upon vegetation structure and functioning. Availability of water, especially after fire, is a critical factor for plant distribution and performance. The challenge for ecophysiologists is to demonstrate how the different strategies used by plants for acquiring, controlling and using water and tolerating drought can explain observed patterns of vegetation structure and function.

In the recent special issue on plant ecophysiology in the *Australian Journal of Botany* (Volume 45(2)), competition for water was a constant theme across a range of ecosystems. For example, competition for water was central to the study by Anderson and Hodgkinson (1997), who showed, counter-intuitively, that grazing of perennial grasses around island-bands of Mulga *Acacia aneura* reduces the water supply to mulga shrubs, which then die during periods of low rainfall, leading to a dysfunctional landscape. In south-western Australia, competition for water was also important for the survival of *Hakea* species, especially at the seedling stage (Richards *et al.* 1997).

Pre-dawn water potential represents a measure of plant water status and soil water availability – the lower that water potentials are, the more stressed a plant is. In savanna woodlands in the Northern Territory (Myers *et al.* 1997; Duff *et al.* 1997), seasonal patterns in pre-dawn water potential have been related to phenology of a species, and to the micro-climate of the environment, especially vapour pressure deficit (VPD). Survival of species with different patterns of leaf-fall was apparently reliant upon differing 'strategies' and no single strategy appeared to confer a large competitive advantage.

Some of the variability and complexity of physiological responses in these savannas include identification of the different responses of saplings and trees of the same species in the one location (Prior *et al.* 1997; Myers *et al.* 1997) and different physiological responses between different populations of the same species (Fordyce *et al.* 1997). Complementary studies using stable isotopes to investigate water-use-efficiency of different provenances of River Red Gum *Eucalyptus camaldulensis* (e.g. Hubick and Gibson 1993) have shown that such approaches may be successful. Even so, the record of identifying physiological characters that may reflect underlying local adaptation remains modest, even though it has long been advocated (Williams *et al.* 1995).

While both too much and too little water can limit plant performance (Bell and Williams 1997), under certain conditions the amount of light received by a plant can also be a major source of stress. Environmental factors which disrupt leaf functioning, such as low temperatures, can induce a light-dependent loss in photosynthetic capacity known as photoinhibition (Osmond 1981). Cold-induced photoinhibition has been a major topic of biochemical and physiological research for the past fifteen years, but its significance for plant communities, both natural and agricultural, is still poorly known. Our understanding of the role of photoinhibition is slowly improving with an increasing number of field-based studies, as discussed in the next section of this paper.

Considerable benefits can also be gained by using ecophysiological techniques to examine the below-ground dynamics of plants, as illustrated by recent studies overseas (Vogt *et al.* 1996). In Australia our understanding of this area is still in the 19th century (Williams and Eamus 1997) with Keith (1997) identifying the following two areas as critical for future investigation: a) the factors controlling the amount of carbon and nutrients allocated within plants to below-ground parts (mostly roots) compared to above-ground (shoots); and b) the transfer of nutrients from roots to the soil by living roots exuding substances or by the death of roots.

Field-based techniques

Recent technological advances have stimulated rapid progress in the discipline of ecophysiology and hence an increasingly process-based understanding is developing. In particular, recent developments in instrumentation (Pearcy *et al.* 1991) have caused a dramatic expansion of the number of projects involving physiological measurements in the field, allowing studies at more than one site and at greater frequencies. Thus, portable infra-red gas analysers and leaf diffusion porometers, coupled with data loggers for micro-climate studies, have allowed detailed investigations of the relationships between carbon assimilation, stomatal conductance and environmental factors. These instruments allow measurements of, for example, the amount of photosynthesis occurring in plants in the field, how much water a plant is using and measurements of the environment around a plant such as how much light it is receiving.

Methods and interpretation of gas exchange of terrestrial plants in the field have been advanced with the availability of equipment permitting automated control of light flux density, temperature and CO_2 concentration. Whole tree and canopy transpiration rates have become routinely measurable using a range of techniques (sap flow sensors; eddy correlation techniques). Indeed, in reviewing the field of ecophysiology, it is apparent that measurements at the individual tree scale, for above-ground parts, is adequately serviced by technology (Williams and Eamus 1997). Furthermore, the even newer sub-discipline of biochemical, or molecular ecology, is gaining ground – for example the developments in the use of genetically transformed plants to investigate whole plant nitrogen allocation and carbon gain (Stitt and Schulze 1994).

Technological developments in the measurement of photoinhibition *in situ* have also aided our understanding of the mechanisms underlying plant performance (Ball 1994; King and Ball 1998). Physiological studies indicate that species should be most vulnerable to photoinhibition near their distributional limits and that seedlings rather than established plants should be more vulnerable to reductions in growth associated with chronic photoinhibition. Thus, cold-induced photoinhibition may play a role in limiting regeneration, and hence also the distribution, of species along climatic gradients. Indeed, recent research has established that cold-induced photoinhibition is correlated with patterns of seedling regeneration by Snow Gum *Eucalyptus pauciflora* at tree line (Ball *et al.* 1991) and with poor growth of eucalypt seedlings planted in pasture revegetation programs (Holly *et al.* 1994; Ball *et al.* 1997). As the understanding of photoprotection and photodamage increases, the concept of light being a potentially over-abundant resource may receive greater attention amongst ecologists.

Physiological techniques may be used to extrapolate to larger scale ecological questions. For example, Battaglia and Williams (1996) showed that the relative abundance of two eucalypt species at a given site in south-eastern Tasmania could be predicted by a knowledge of the depth and texture of soil at that site. These authors, in a similar manner to that of Eamus and Cole (1997), took observations at the large scale, and then initiated small-scale experiments to provide a mechanistic understanding of the processes generating large-scale patterns.

New technologies such as those described for terrestrial plants in Williams *et al.* (1997) and for aquatic organisms in Westphalen and Cheshire (1997) add to the growing number of tools that can be used to increase our understanding of pattern and process. The techniques used to measure hydraulic conductance and positive stem pressures in seedlings and resprouts in the Californian chapparal species *Adenostoma fasciculatum* could be usefully applied in ecophysiological studies in Australia.

Future Directions

Williams and Eamus (1997) identified two major challenges in the discipline of ecophysiology that are clearly deserving of attention. The first was the ecophysiology of below-ground parts (mostly, but not exclusively roots), while the second was to provide the catchment/regional scale answers and predictions that are required by managers and policy makers. Both challenges require an understanding of how plants respond to changing environments at a range of temporal and spatial scales. Furthermore, being able to meet the challenges will depend on the successful integration of two fields – modelling and remote sensing (see Moore *et al.* 1993) – because experiments at this scale (i.e. thousands of hectares) are not possible, and measurements of individual plants or animals would require vast amounts of replication (Williams and Eamus 1997).

Ecophysiological approaches can, however, currently be used to inform management practices. The diversity of ecophysiological responses in the Australian flora, which can be put to a wide range of applied uses, is a good case in hand. The selection of the best species to plant at a particular site can be greatly improved with good ecophysiological information, as identified by Bell and Williams (1997). For example, Walker *et al.* (1993) highlighted the need for details of water-use characteristics of species to be used for reclamation of degraded catchments. Efforts have been made in this direction (e.g. Bell *et al.* 1994), but progress is slow and the rehabilitation need is great. The lack of knowledge on the type of planting material, location of plantings and planting density have been identified as factors limiting major catchment revegetation programs in Australia (Schofield 1992). The need for more ecophysiological information is even more pressing in order to maximise the success of the major revegetation programs currently being promoted in Australia (Commonwealth of Australia 1997). A recent review of the ecophysiology of eucalypts (Bell and Williams 1997) also concluded that greater attention to ecophysiological interactions was needed to increase our understanding of the genus in both managed and natural systems.

An additional thrust for the future of ecophysiology lies in its penetration into and development with a range of other, more traditional, i.e. older, disciplines (Williams and Eamus 1997). For example, micrometeorologists are concerned with heat and momentum exchange between the planetary boundary layer and canopies and hydrologists need to know how vegetation influences catchment hydrology. Medium-scale (canopy, sub-catchment) and large-scale (regional, continental) processes will only become accessible when modellers and users of remote sensing and Geographic Information Systems (GIS) interact with ecologists and ecophysiologists on research projects at the landscape scale.

Conclusions

In highlighting ecophysiological research in Australia, the recent Symposia held in conjunction with meetings of the Ecological Society of Australia (see volumes 40(2) and 45(2) of the *Australian Journal of Botany*) have demonstrated that plant ecophysiology has a strong base in Australia. It is hoped that the discipline will continue to grow as the benefits of taking this approach become increasingly apparent and as new ways are developed to integrate the impact of physiological responses on the performance of a plant over its life. As the integration of small (leaf, tree), medium (canopy, sub-catchment) and large (regional, continental) scale studies increase, the contribution of knowledge of processes to explaining, predicting and managing patterns in the landscape will also increase.

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Flora of Australia
Volume 12 Mimosaceae (excluding *Acacia*), Caesalpiniaceae

Publisher: *CSIRO Publishing, P.O. Box 1139, Collingwood, Melbourne. RRP $69.95.*

This is the fourteenth angiosperm (flowering plant) volume to be published in the Flora of Australia series. Of the 59 volumes to be published in this major undertaking, 46 will deal with angiosperms and the remainder with the gymnosperm, fern, bryophyte, lichen and oceanic island floras.

A number of botanists, illustrators and photographers have contributed to this volume in which 169 native and naturalised species from 38 genera are described. All of the Australian genera in the Mimosaceae, with the exception of the largest, *Acacia*, and all 22 genera in the Caesalpiniaceae are described. The majority of species in these genera have a tropical to sub-tropical distribution although *Senna*, in particular, is a notable exception.

The Mimosaceae and Caesalpiniaceae are two of three legume families, the third being the very large Fabaceae (pea family). Some authorities treat these three families as sub-families of the Leguminosae.

This volume, like all volumes in this series, has been written by botanists for botanists and the style is formal. A good knowledge of plant descriptive terminology and nomenclatural terms and abbreviations is necessary if one is to fully appreciate this book, although the 64 excellent colour photographs add greatly to its attractiveness to the amateur. Descriptions and keys to genera and species are very concise but are supplemented with detailed and clear illustrations. Brief notes on distribution, rarity, taxonomic difficulties, horticultural value, weed status etc. are provided after each species description. For someone wishing to learn about any of the species in great detail, the treatments in this flora will serve as a useful starting point.

Distribution maps are placed together near the end of the book in the same order as the taxa appear in the descriptions. This, I think, works better than having the maps scattered throughout the text as has occurred in earlier volumes. This volume does not provide a key to angiosperm families or a glossary. These are provided in Volume 1.

Although very few of the species described in this volume occur naturally in Victoria, several are cultivated or occur as weeds. Some members of the Mimosaceae (tribe Mimoseae) are serious weeds, e.g. Mesquites (genus *Prosopis)*, introduced from America for their perceived benefits as soil stabilisers, food sources and stock shelter, and Sensitive plants of the genus *Mimosa*. A few species of *Albizia* (tribe Ingeae) are native to northern Australia and are related to the cultivated species of this genus that are grown in Victorian gardens. Cape Wattle *Paraserianthes lophantha* is native to southern Western Australia and is widely naturalised and cultivated in Victoria. One of the larger genera in the Mimosaceae treated in this volume is *Archidendron* which is distributed widely in Asia as well as in north-eastern Australia.

Familiar introduced species in the Caesalpiniaceae include Honey Locust *Gleditsia triacanthos*, a fodder plant introduced from North America and widely planted and naturalised, and Carob *Ceratonia siliqua*, which is also a useful food plant. The common garden plant, *Caesalpinia gilliesii*, has ten relatives that are native to northern Australia.

A genus in the tribe Cassieae of the Caesalpiniaceae that has been given special treatment in this volume is *Senna* (mostly formerly known as *Cassia*). It appears that taxonomic resolution of sections of this genus has been thwarted by such reproductive strategies as polyploidy, hybridisation and apomixis and this is discussed. In light of the lack of certainty about the current classification, the authors considered it best to identify some of the more problematic elements in the complex as 'form taxa' rather than as species or sub-species. The desert cassias of northern Victoria previously known as *Cassia nemophila* have been recognised as *Senna* form taxa '*coriacea*', '*zygophylla*', '*filifolia*' and '*petiolaris*'.

This book will be an excellent resource for professionals and may be useful for amateur botanists with a special interest in the Mimosaceae and Caesalpiniaceae.

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Leafhoppers in Ant Nests: Some Aspects of the Behaviour of Pogonoscopini (Hemiptera: Eurymelidae)

M.F. Day[1] and K.R. Pullen[1]

Abstract

Field and laboratory observations on a species of the leafhopper tribe Pogonoscopini have shown that it lives in nests of ants of the genus *Camponotus* during the day. At dusk it emerges, attended by the ants, to feed on mallee during the night. (*The Victorian Naturalist* **116** (1), 1999, 12-15).

Introduction

In the 1920s the north-western Mallee district was still a remote part of Victoria when Charles Oke, at that time an amateur entomologist with a particular interest in beetles, visited the railway siding of Gypsum and Hattah Lakes with J.E. Dixon. He described their excursion in a delightful essay published in *The Victorian Naturalist* (Oke 1926). About this time, a fascinating Australian fauna of insects and other invertebrates living as inquilines (guests) in ant and termite nests was being brought to light, and Oke had become an avid collector of the often bizarre inquiline beetles, discovering a diversity of new species. On this trip Oke found many beetles, but at Hattah Lakes he was also intrigued by 'a kind of froghopper (Cercopidae)' which he encountered in ant nests under the ground. The ant host was apparently the 'sugar ant', *Camponotus nigriceps* (Smith). Oke states the froghoppers 'were found in all stages, except the eggs. Little larvae from slightly more than 1 mm up to fully matured imagines (adults) were seen in the same nest....On rolling over the covering log from one of the nests sometimes a dozen or 20 of these guests will be revealed'. Several froghoppers were found at a depth of 'over 3 feet' (915 mm) in a large *Camponotus* nest 'covered by a log and a sheet of bark' that Oke excavated. Speculating on the habits of these inquilines, Oke said 'it would appear that they spent their lives in these nests - unless they are taken out at night to feed on the trees'. However, his brief observations at night did not reveal any froghoppers outside the nests. Oke did not identify his inquiline froghoppers, but we recognised them as one of the Pogonoscopini, a remarkable tribe of eurymelid leafhoppers.

The Pogonoscopini are poorly studied, distinctive and unusual insects confined, as far as is known, to the southern and interior parts of Australia. The history of the discovery and description of the species and their association with ants is worth recording. In 1909 Jacobi described two leafhoppers from the nests of sugar ants of the genus *Camponotus* from Western Australia; he accommodated the two in the existing eurymelid genus *Eurymeloides*, as *E. acmaeops* and *E. levis* (Jacobi 1909). In 1924 China described the new genus *Pogonoscopus* for a new species *P. myrmex*, and suggested that Jacobi's two species probably belonged to the same genus. China (1926) subsequently revised the group, describing several new genera and species to comprise a new subfamily, the Pogonoscopinae. Evans (1966) later referred to the group as the Tribe Pogonoscopini. Representatives of this unusual group were subsequently collected mainly by myrmecologists and almost always in the nests of *Camponotus*.

Yet the most basic aspects of pogonoscopine biology remained a mystery. They must have sucked sap like all leafhoppers, but where did they feed, and where were the eggs laid? Oke's observations shed no light on these questions. Evans (1931), apparently unaware of Oke's observations, was of the opinion that the pogonoscopines 'sucked up sap from below ground level', basing his comments on the advice of D.C. Swan, then in South Australia. Later, he stated unequivocally that the Pogonoscopini 'feed on the roots of eucalypts' (Evans 1946). In a subsequent revision of the Australian leafhopper fauna,

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Fig. 1. Mallee at Calperum. Characteristic of the habitat of *Pogonoscopus*.

Evans (1966) recognised five species of Pogonoscopini in four genera, placing several of China's species into synonymy. On the behaviour of these leafhopers, he quoted Mr Peter McMillan of Perth, who had frequently collected them with ants in Western Australia. McMillan wrote that the ants 'build their nests under logs and stones and have tunnels with large entrance holes which are smooth and vertical'. The leafhoppers 'walk around with a peculiar rolling motion and when escaping just fold their legs and tumble down the shaft'.

Field observations on *Pogonoscopus myrmex*

An opportunity to study a pogonoscopine species under field conditions arose when three leafhoppers identified as *Pogonoscopus myrmex* China were caught in traps set in mallee as part of a survey of the invertebrates of the Calperum sector of Bookmark Biosphere Reserve, South Australia (Pullen 1997). The collection site (Fig. 1), situated in the old Amalia paddock of the former Calperum sheep station, is dominated by Red Mallee, *Eucalyptus socialis* F.Muell. ex Miq. Calperum is located north of Renmark and has a semiarid climate. The manner of collection of the specimens - two nymphs in pitfall traps and an adult female in a combination pitfall/flight intercept trap - dispelled the view that they passed their lives confined to ant nests.

We returned to the Amalia site on 12 October 1995 with the aim of observing *Pogonoscopus* and collecting additional material. Since previous ant collectors had found pogonoscopines most commonly in the nests of *Camponotus* at the base of eucalypts, the Amalia search was begun by excavating nests of *C. gouldianus* Forel located at the base of mallees. The nest tunnels invariably penetrated between the mallee roots, allowing only partial excavation, but after several hours five adults and one nymph of *P. myrmex* had been found, confirming *C. gouldianus* as a host ant. This work was carried out during daylight hours and no leafhoppers were seen outside the *Camponotus* nests.

Appreciating that *Camponotus* are night foragers, we returned to the site at dusk. We found many ants milling around the entrances to their nests and soon one or two pogonoscopines were observed. As darkness fell, more appeared, and eventually both nymphs and adults were seen to be climbing the mallee stems. The temperature was approximately 12-15°C. The pogonoscopines were noticeably more

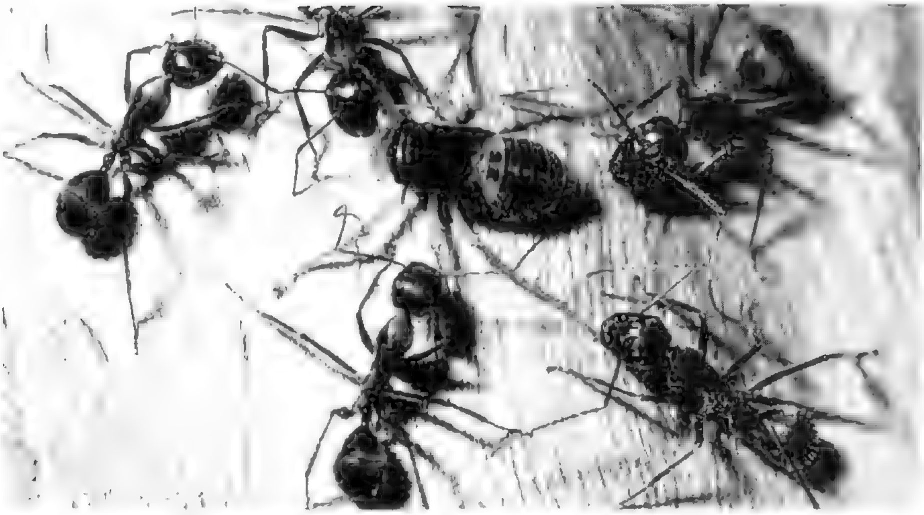

Fig. 2. A nymph of *Pogonoscopus myrmex* feeding at night on *Eucalyptus socialis* and attended by *Camponotus gouldianus.*

affected by the torch beams and moved faster than the ants, either to the far side of the trunk or more frequently under adhering bark. They were not 'herded', but moved independently of the ants, although ants attempted to follow any leafhoppers they encountered. Finally, at about 1930 hrs, some leafhoppers were seen to begin to feed, and then they were always attended by several ants (Fig. 2). During feeding, it was observed that the hind legs were often elevated and waved; the significance of this behaviour is not known. Most of the trees were above 3 m in height, so that, without ladders, it was not possible to see whether the leafhoppers ascended to the smaller branchlets. All nymphal stages and adults were present. Although they were more readily collected at night than during the day, they were not easy to capture because of their rapid movements and their aversion to light. The same behaviour was observed on the following night when the insects were photographed.

Laboratory observations on *Pogonoscopus myrmex*

Some nymphs and adult *P. myrmex* and their attendant ants were brought alive to Canberra where they survived for a week without food. Others were offered *Eucalyptus leucoxylon* F.Muell., on which they appeared to feed, even when the branchlets were considerably desiccated. To test the reaction of a local non-host *Camponotus* to their presence, several *P. myrmex* were placed in a previously prepared colony of *C.consobrinus* Erichson. The leafhoppers were vigorously attacked, with no evidence of any symbiotic relationship, inherent or otherwise.

Observations on *Australoscopus* sp.

During our stay at Calperum, a colleague Mr Michael Moore of Adelaide, returned from a day trip to Waikerie, South Australia, with live specimens of a second pogonoscopine, identified as a species of *Australoscopus*. The species is smaller than *Pogonoscopus myrmex* and was attended by *Camponotus terebrans* (Lowne) in a nest under cover on the ground. In culture, the ants on being disturbed were observed to pick up and carry the leafhoppers, behaviour noted by Oke (1926). On uncovering an ant nest, Oke observed that his froghoppers 'seem to be greatly agitated', and that 'any ant meeting one of the guests will immediately seize it by the thorax and carry it down one of the holes.... The ants invariably carry the leafhoppers off head foremost, and generally turn them over with their feet uppermost as soon as they take hold of them...' . To Oke it was evident 'that these froghoppers are used to being carried by the ants'.

It seems likely that the insect Oke was describing was a species of *Australoscopus*. We never observed *Camponotus gouldianus* carry *P. myrmex*.

Discussion

Our observations demonstrated that *Pogonoscopus myrmex* is not confined to ant nests and that, while feeding, its behavioural interaction with its ant host is comparable to that of other eurymelids (Evans 1931; Buckley 1987), except that *P. myrmex* feeds at night. Diurnal ant inquilinism and nocturnal foraging may be a strategy that allows *Pogonoscopus* to avoid both predation and the hot, desiccating diurnal conditions where it lives.

In most characters, such as their mouthparts, antennae, leg structure and fully developed wings, the Pogonoscopini are typically eurymeline. However, neither the nymphs nor adults are capable of jumping, so that 'leafhopper' is an inappropriate name for these insects. The unusually long legs of all stages, even 1st instar nymphs, have been mentioned in all previous reports, several authors referring to their 'spider-like' appearance. The long legs could be an adaptation to allow an easier daily trip from the host ants' nest up to the mallee branches and return. It would be of interest to learn whether the young nymphs travel long distances walking, both after hatching from the egg and to feed; such travel would represent a substantial feat.

Pogonoscopus myrmex does not appear to exhibit special myrmecophile adaptations for permanent life in ant nests. Myrmecophiles typically have the eyes reduced or absent, and the epidermis is often unpigmented. To avoid injury by their ant hosts they are often rapid runners (e.g. Thysanura, Staphylinidae) or are able to retract the antennae and legs into grooves in the body integument (e.g. many inquiline beetles).

The fat body of both adults and immature stages of pogonoscopines is very well developed, possibly an adaptation necessary to hold them over on occasions when, perhaps due to weather conditions, the insects are unable to leave the host ant nest to feed.

The observations noted above show that significant differences exist between pogonoscopine genera in their behavioural relationships with their host ants. Much of the life history of these inquiline leafhoppers remains completely unknown. We do not know where or at what time of the year the eggs are laid, or where the early instars live. If the eggs are inserted into the twigs or stems of the host plant, as in other eurymelids, how do the nymphs reach the nest of a host ant? We know nothing of the behaviour of the other three described pogonoscopine species. An interesting study awaits a future student.

Acknowledgements

We thank Mr Bruce Lambie, now of the Australian Heritage Commission, Canberra, for facilitating access to Calperum and the Bookmark Biosphere Reserve; Dr Steve Shattuck, CSIRO, and Mr Archie McArthur, SA Museum, for ant identifications; Dr Michael Braby, CSIRO, for photography; and Mr Mike Moore, Adelaide, for specimens of *Australoscopus*.

The survey of insects at Calperum/Bookmark Biosphere Reserve was conducted with support from the Australian National Parks and Wildlife Service (ANPWS), 1994.

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The Orange Palm Dart Skipper *Cephrenes augiades sperthias* (Felder) in Melbourne

John Eichler[1]

Abstract

This article provides additional locality records of the Orange Palm Dart Skipper *Cephrenes augiades sperthias* (Felder); Lepidoptera: Hesperiidae, in suburban Melbourne, lists larval food plants and includes observations of its life cycle. (*The Victorian Naturalist* **116** (1), 1999, 16-18).

Distribution and Range Extension

The Orange Palm Dart is a relatively large skipper, whose larvae feed exclusively on palms.Its natural range is eastern coastal Australia, from Cape York to the Illawarra region of New South Wales (Common and Waterhouse 1981). By the early 1980s it had become naturalised in the Perth region of Western Australia (Hutchison 1983). In 1990, Crosby recorded specimens from Camberwell, Victoria. He concluded that they had probably developed from eggs transported from Queensland on palms and that the Orange Palm Dart was unlikely to become established in Victoria. However, subsequent records from the inner eastern suburbs led Crosby (1994) to conclude that it had become established in Melbourne.

Larvae were first noted on a small Bangalow Palm *Archontophoenix cunninghamiana* in my garden in the Melbourne bayside suburb of Black Rock on 5 February, 1994 and successive generations of Palm Darts have continued to use that palm. The identity of the insect was established by raising butterflies from the pupal stage and comparing male and female adults with the illustrations and descriptions in Common and Waterhouse (1981) and McCubbin (1971).

Later in February 1994, larvae and pupae were found in a nearby garden on numerous species of palm. Larvae had been known from that site since about 1992 (David Radford *pers. comm.*). Subsequent searches revealed that the Orange Palm Dart was present elsewhere at Black Rock, at the nearby suburbs of Beaumaris and Sandringham and at Mitcham. David Britton (*pers. comm.*) recorded the Palm Dart at Kew in 1992 and 1993 and has noted larval shelters in West Melbourne.

Crosby (1994) reported a number of observations of the Orange Palm Dart from Melbourne suburbs, including East Melbourne and South Yarra, during 1990 to 1993.

Description

Cream coloured eggs are laid singly on various parts of palm plants. The larval and pupal stages can be found in cylindrical shelters, which the insect forms by joining together the margins of palm leaflets with silk. Larvae observed at Black Rock are up to 50 mm long, are light green in colour and often have two yellow spots on their back. They have a broad, cream coloured head with brown stripes. Male and female butterflies are quite different in their appearance, the following descriptions being based on Black Rock specimens. Males have a wingspan of approximately 35 mm and are brightly coloured with orange and dark brown patches. Females are an almost uniform dark brown colour and are larger, having a wingspan of approximately 40 mm. The source of those insects may be from Queensland, where females tend to be darker than those from New South Wales (Common and Waterhouse 1981).

Larval Food Plants

In Melbourne, Orange Palm Dart larvae feed on a number of Australian and exotic palms which are listed in Table 1.

Dunn (1995) records 75 palms that are larval hosts of the Orange Palm Dart in Queensland. Crosby (1994) records 5 species of palm that are used in Melbourne, of which the introduced Queen Palm *Arecastrum romanzoffianum* and Senegal Date Palm *Phoenix reclinata*, are additional to the species listed in Table 1.

[1] 18 Bayview Crescent, Black Rock, Victoria 3193

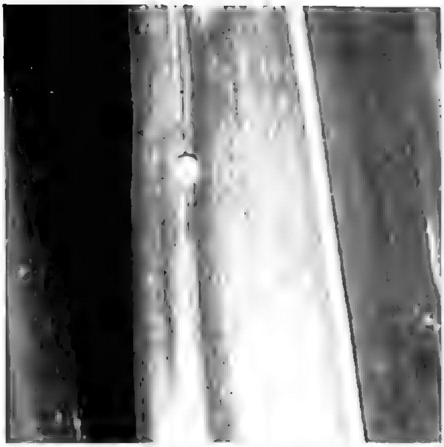

Fig. 1. Egg on upper side of Bangalow Palm leaflet.

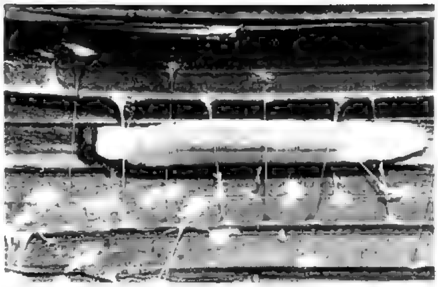

Fig. 2. Larva in opened Bangalow Palm leaflet shelter.

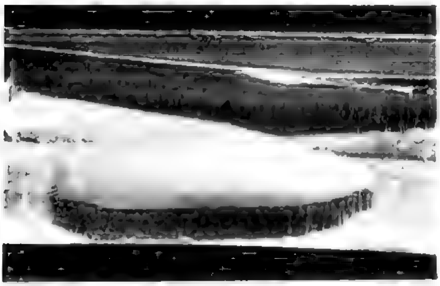

Fig. 3. Pupa in opened Bangalow Palm leaflet shelter.

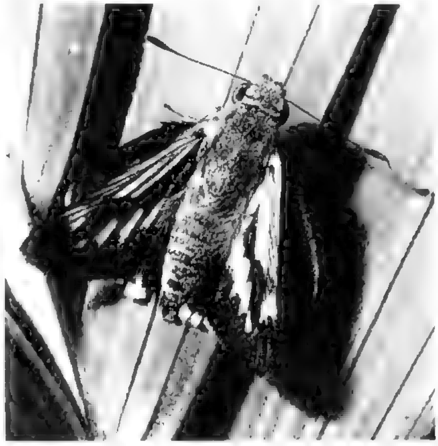

Fig. 4. Adult male on Kentia Palm frond.

Life Cycle Observations and Comments

The following observations were made of the Palm Dart's life cycle in Melbourne.

- Larvae were noted during February, March, April and July.
- Pupation was observed in February and March. The pupation period recorded for pupae kept indoors ranged from 19 to 24 days (four observations).
- Female butterflies were seen in January and March. A male butterfly was found sheltering in a wood pile in May. David Britton (*pers. comm.*) recorded a female in May and a male in April.
- Freshly laid eggs were found on the leaflets, crown shaft (frond base) and trunk of a Bangalow Palm in December, January and March.

The Orange Palm Dart is able to survive Melbourne's winters and is still active during cooler months. At first this seems surprising given its tropical to sub tropical origin. It appears that the lack of suitable larval food plants has been more of a limiting factor than climatic conditions, at least in southern Victoria. Other Australian butterflies, e.g. the Dingy Swallowtail *Papilio anactus* and Orchard Butterfly *Papilio aegeus aegeus*, have also been able to extend their range southwards into Victoria because trees have been planted that are eaten by their larvae (McCubbin 1971). A possible explanation for the Palm Dart's activity during cooler months is that it has not yet adapted to climatic conditions in Melbourne.

Conclusions

The Orange Palm Dart is an adaptable insect whose spread to Melbourne coincides with, and presumably is a result of, the increased use of palms in landscaping since the 1980s.

Because the larvae feed exclusively on palms, it is assumed that this new insect

Table 1. Records of larval food plants, Melbourne.

Australian Palms	Exotic Palms
Alexandra Palm *Archontophoenix alexandrae*	European Fan Palm *Chamaerops humilis* (Mediterranean)
Cabbage Fan Palm *Livistona australis*	Canary Island Date Palm *Phoenix canariensis* (Africa)
Bangalow Palm *Archontophoenix cunninghamiana*	Canary Island and Senegal Date Palm hybrid *Phoenix canariensis x reclinata* (Africa)
Umbrella Palm *Hedyscepe canterburyana* (Lord Howe Island)	Dwarf Date Palm *Phoenix roebelenii* (South East Asia)
Kentia Palm *Howea forsteriana* (Lord Howe Island)	Nikua Palm *Rhopalostylis sapida* (New Zealand)
	Chinese Windmill Palm *Trachycarpus fortunei* (Himalayas)
	Washington Palm *Washingtonia robusta* (USA)

arrival will have little or no adverse impact on indigenous insects or plants in most of Victoria, although it would be interesting to know whether it is present in the stands of Cabbage Fan Palms *Livistona australis* near Orbost.

Acknowledgments
Thanks to Pat and Mike Coupar, who tentatively identified the larvae, later confirmed the identity of adults and referred me to the 1990 Crosby article, David Radford, who identified many of the larval food plants and was able to recall when larvae first appeared in his garden and David Britton, who provided some additional records and helpful comments on an earlier draft.

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Vale
Joan Harry

Joan Harry died on Saturday, October 17, 1998. She suffered from a brain tumour over a nine year period.

When Marie Allender retired as General Excursion Secretary in February, 1990, Joan took over the job and served for about six months, when she had to stop for her first brain tumour operation. Dorothy Mahler then acted temporarily as Acting Excursion Secretary for Joan. However, as Joan convalesced over an extended period, she was unable to resume the position.

In late 1991, Joan was feeling well enough to serve as Chairperson of the Botany Group, after Margaret Potter who had stepped down after many years in that position. Joan held that position for three years until Tom May (present FNCV President) was elected Botany Group Chairperson in December 1994.

Joan was always supportive of working bees, often acting as tea/coffee lady in the kitchen, especially when we were folding the newsletter or after meetings in the evenings at the Hall. She was always a dedicated and helpful club member until she had to drop out over a year ago because of illness. Over the years she also attended most of the excursions and tours organized by the club.

Noel Schleiger represented the FNCV at her funeral on Wednesday, October 21, 1998. The Club extends its sympathy to husband Graeme, and family.

Noel Schleiger and Dorothy Mahler

A Fauna Survey of Riparian and Other Revegetation Sites in Eltham, Victoria

Peter Homan[1]

Abstract

A fauna survey of revegetation sites was carried out over a six-month period in 1996 in Eltham, a north-east suburb of Melbourne with eleven mammals, fifty-six birds, eight reptiles and five amphibians being recorded. Results of the study showed an absence of small terrestrial native mammals and invasion of revegetated areas by introduced species. (*The Victorian Naturalist*, **116** (1), 1999, 19-25)

Introduction

Lenister Farm is located in Homestead Road, Eltham, approximately 28 kms north-east of Melbourne Central, within the Melbourne metropolitan area, on the southern edge of Eltham Lower Park, near the junction of the Yarra River and Diamond Creek. The property was originally a dairy farm, but is now owned by the Shire of Nillumbik and is leased to PEEC Services Inc., a private training provider.

For some years PEEC Services (formally Skill Seekers) has conducted horticultural training at the farm and, since April 1993, has been involved in a long term riparian revegetation project along Diamond Creek and the Yarra River in conjunction with the Shire of Nillumbik. Revegetation work has also been carried out by Friends of Diamond Creek, a local volunteer group, while other habitat enhancement work has also been completed including the removal of woody weeds from Hohnes Hill, a small nature reserve of about 5 ha on the western edge of the study area. An indigenous plant nursery is also located at the farm and helps to provide stock for the revegetation program.

This survey was carried out to determine which species of mammals, birds, reptiles and amphibians now inhabit the general area around Lenister Farm and, in particular, the revegetation sites along Diamond Creek and the Yarra River and at Hohnes Hill (Fig. 1).

Vegetation and topography

The study area covers approximately 23 ha and is bounded by Main Road, Eltham to the north, Diamond Creek to the east, Yarra River and Homestead Road to the south and Jayson Avenue to the west.

Much of the study area is on a flood plain at the junction of the two streams and also includes several small gully systems and three small artificial wetlands, while the highest point is on Hohnes Hill, 60 m above sea level. A large artificial wetland has since been constructed on the flood plain beside the Yarra River.

Eltham Lower Park includes two sports ovals, the Diamond Valley Miniature Railway and a pony club. A public walking track leads along the two streams, which attracts large numbers of walkers, joggers and local residents walking dogs.

Vegetation in the park includes remnant mature Candlebark *Eucalyptus rubida*, Yellow Box *E. melliodora*, Long-leaved Box *E. goniocalyx* and Narrow-leaved Peppermint *E. radiata*. Hollows are numerous amongst these mature trees.

The riparian vegetation along Diamond Creek and the Yarra River includes Manna Gum *Eucalyptus viminalis*, Silver Wattle *Acacia dealbata*, with remnant stands of River Bottlebrush *Callistemon sieberi*,

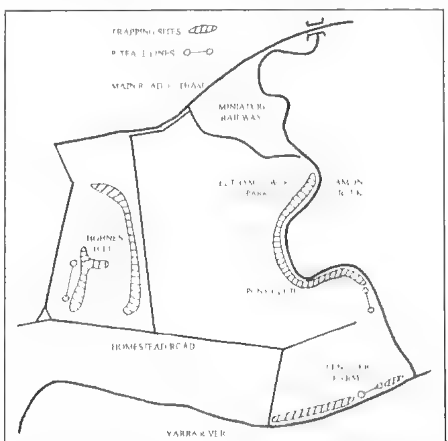

Fig. 1. Location of survey area and trapping sites. Melway Map 21, J11.

[1] 8 Bayfield Drive, Eltham, Victoria 3095

Fig. 2. Grassy eucalypt woodland, Holmes Hill.

Tree Violet *Hymenanthera dentata*, Burgan *Kunzea ericoides*, Kangaroo Apple *Solanum laciniatum*, Dogwood *Cassinia aculeata*, Hop Goodenia *Goodenia ovata*, Spiny-headed Matrush *Lomandra longifolia* and *Poa ensiformis*. All of these species have been used extensively in the revegetation program along both streams. Unfortunately various introduced species have infested the riparian zone including Spider Wort *Tradescantia fluminensis*, Angled Onion *Allium triquetrum*, Blackberry *Rubus procerus*, Hawthorn *Crataegus monogyna*, Crack Willow *Salix fragilis* and *Watsonia bulbillifera*.

Holmes Hill Flora Reserve is an area of grassy woodland (Fig. 2) with Yellow Box *E. melliodora*, Long-leaved Box *E. goniocalyx*, Candlebark *E. rubida*, Red Stringybark *E. macrorhyncha*, Manna Gum *E. viminalis*, Burgan *K. ericoides*, Sweet Bursaria *Bursaria spinosa*, Golden Wattle *Acacia pycnantha*, Hedge Wattle *A. paradoxa*, Tree Violet, Cherry Ballart *Exocarpus cupressiformis* and *Clematis microphylla*. Grasses include Tussock Grass *Poa sieberiana*, Wallaby Grass *Danthonia* spp. and a range of introduced grasses that have invaded large areas of the reserve. Various native orchids including Greenhoods and Spider Orchids persist in reasonable numbers in the southern end of Holmes Hill. Many of the Eucalypts are mature with numerous hollows.

Survey methods

The survey was conducted between May and November 1996, from Monday to Friday of each week.

Survey methods included: cage trapping (Wiretainers standard bandicoot trap) placed on the ground and in trees; Elliott trapping (Type A); pitfall trapping (plastic buckets, 380 mm in depth and 285 mm in diameter); an artificial nest box program and general observation and collection. Baits consisted of oats, peanut butter, honey and vanilla essence. Artificial shelters were also used to survey amphibians. These were made from 23 mm treated pine and measured 600 mm × 400 mm and were raised off the ground by slats of pine of the same thickness along three edges, therefore allowing frogs to move under the shelter from one side. These shelters were placed around several wetlands with the entrance facing the water and were turned over for inspection daily.

Only a minimal amount of spotlighting was carried out (a total of six spotlight hours) and general observation and collection took place on a daily basis.

Trapping took place on Monday, Tuesday and Wednesday nights only. On various occasions trapping was not undertaken due to inclement weather and the water level in both streams. Trapping along the Yarra River and Diamond Creek took place in a narrow riparian corridor between each stream and the public walking track (Fig. 1). Because much of the area is used extensively by the public, traps were set randomly and in a somewhat clandestine fashion, so as to avoid possible theft or interference with equipment. Consequently on some nights only small numbers of traps were set.

Overall 707 trap-nights and 293 pit-nights were completed. Table 1 shows the trapping methods used and effort for each section of the study area.

Artificial nest boxes were designed to survey the presence of Sugar Gliders in the area and to provide breeding records for small parrots. Four Sugar Glider boxes were placed in Holmes Hill and seven were placed along Diamond Creek. Five small-parrot boxes were placed in the southern section of Eltham Lower Park and along Diamond Creek.

All nest boxes were constructed of 19 mm exterior grade ply with an internal diameter of 240 mm and a depth of 420 mm. Entrance holes, which were 50 mm for Sugar Gliders and 70 mm for small parrots, were 300 mm above the floor.

Table 1.

	Trap-nights			Pit-nights	Total
	Cage traps on ground	Cage traps in trees	Elliott traps on ground		
Hohnes Hill	nil	23	59	178	260
Diamond Creek	182	nil	54	80	316
Yarra River	320	nil	69	35	424
All Sections	**502**	**23**	**182**	**293**	**1000**

Results

Since intensive surveys such as this are unusual, particularly within the metropolitan areas of large cities, the results of this survey therefore give a fair indication of those species that may exist in other urban areas with suitable habitat, especially those areas that have undergone revegetation projects.

A total of eighty vertebrate species were recorded during the survey. These were made up of eleven mammals (five eutherian, five marsupial, one monotreme; seven native, four introduced) fifty-six birds (fifty-one native, five introduced), eight reptiles and five amphibians. Fourteen species of birds were also recorded as breeding in the study area. Because the bulk of the survey took place during the winter months no harp-trapping for insectivorous bats took place and a number of birds that would be expected to visit areas such as this during the warmer months were also not recorded.

Cogger (1996), Menkhorst (1995) and Simpson and Day (1996) were used for species names.

Survey codes are the same as used by the Atlas of Victorian Wildlife:

- **B** Breeding confirmed (birds: nest with eggs; or dependent young out of nest)
- **S** Seen
- **H** Heard
- **T** Trapped and released
- **I** Indirect evidence eg. Tracks or traces, including scats, burrows, diggings.

Mammals

1. Bat, White-striped Freetail **Tadarida australis,** ***H.*** One individual was heard flying above trees along Diamond Creek whilst spotlighting on 8/10/96.

2. Fox, Red **Canis vulpes,** ***S.*** One sick/injured individual was seen near Hohnes Hill on 4/6/96 and subsequently one, presumably it, was found dead on 5/6/96.

3. Glider, Sugar **Petaurus breviceps,** ***S.*** Three individuals were disturbed from a stag at Hohnes Hill on 15/5/96. No animals were captured during trapping in trees at Hohnes Hill and none were seen during spotlighting on 8/10/96. Nest boxes were not used by this species during the survey.

4. Mouse, House, **Mus musculus,** ***T.*** Twenty-one house mice were captured in Elliott traps, seventeen in the oldest revegetation site (1993) along the Yarra River, one in revegetating *Poa ensiformis* along Diamond Creek and three in grassy woodland at Hohnes Hill. Two house mice were also caught in pitfall traps along the Yarra (capture rate 5.7%) The capture rate for Elliott traps along the Yarra River was 24.6%, along Diamond Creek was 1.8% and for Hohnes Hill was 5%.

5. Platypus **Ornithorhynchus anatinus,** ***S.*** Platypus were seen in the Yarra River at the same location near its junction with Diamond Creek on three occasions, at 2.55pm on 4/9/96, at 10.30am on 5/9/96 and at 11.00am on 23/10/96.

6. Possum, Common Brushtail **Trichosurus vulpecula,** ***T.*** This was the most common native mammal encountered during the survey. Fourteen individuals were caught in cage traps set on the ground along the Yarra River. Cage trap capture rate overall was 3.8% and along the Yarra River was 4.4%. At Hohnes Hill the capture rate in cage traps set in trees was 8.7%. However, other substantial indirect evidence occurred including scats and scratch marks on trees. Several animals were also seen during the day in hollows throughout the study area. Seven adults and two juveniles were seen during six spotlight hours on 8/10/96.

7. Possum, Common Ringtail, **Pseudocheirus peregrinus,** ***S.*** Many individuals of this species were seen in dreys during the day along both streams,

Fig. 3. Water Rat *Hydromys chrysogaster* capture site on the Yarra River.

however, none were captured in cage traps during the survey. Eight Ringtails were seen during six spotlight hours on 8/10/96.

8. Rabbit **Oryctolagus cuniculus,** ***S.*** Many individuals were seen in all parts of the study area, with a marked reduction in sightings during the second half of the study. A number of dead animals were found during September and October.

9. Rat, Black **Rattus rattus,** ***T.*** This was the most common terrestrial mammal caught amongst the riparian vegetation along both streams. Twenty individuals were caught along the Yarra River, and thirteen along Diamond Creek. Overall capture rate for these sites was 5.9%, with 6.3% for the Yarra River and 7% for Diamond Creek. Individuals were caught in both degraded areas and revegetated sites. No captures occurred at Hohnes Hill.

10. Rat, Water **Hydromys chrysogaster,** ***T.*** This was the only native rodent recorded during the survey. Thirteen individuals, six males and seven females, were caught in cage traps set along the Yarra River (Fig. 3) and Diamond Creek. Eleven animals were caught along the Yarra River adjacent to the oldest revegetation site, and two animals were caught along Diamond Creek near remnant *Poa ensiformis* and *Callistemon sieberi*. The majority of captures along the Yarra (nine) occurred in late June and early July, with the remaining two in late September. The two captures along Diamond Creek took place in late August. Overall capture rate was 2.8%, with 3.4% for the Yarra River, and 1% for Diamond Creek. Weight for males varied from 630 g to 1060 g (average 786 g) and for females, from 650 g to a pregnant animal (caught 25/9/96) weighing 1000 g (average 747 g).

11. Wombat, Common **Vombatus ursinus,** ***I.*** No Wombats were seen during the study, however, substantial indirect evidence was found regularly in the form of active burrows, scratchings and scats.

Birds

Table 2 lists the birds that were recorded in the study area.

Reptiles

1. Lizard, Blotched Blue-Tongued **Tiliqua nigrolutea,** ***S.*** One individual was found at Hohnes Hill on 1/8/96.

2. Lizard, Eastern Blue-Tongued **Tiliqua scincoides,** ***S.*** One individual was found near Diamond Creek on 28/8/96.

3. Skink, Garden **Lampropholis guichenoti,** ***T.*** This was the most common and widespread reptile encountered during the study. Individuals were sighted during each month of the survey, in particular on sunny days. Twelve Garden Skinks were captured in pitfall traps, five at Hohnes Hill (capture rate, 2.8%), five along Diamond Creek (capture rate, 6%) and two along the Yarra River (capture rate, 6%).

4. Skink, Water **Eulamprus** ***sp.,*** ***S.*** One individual was seen by the Yarra River on 16/9/96 and two along Diamond Creek on 8/10/96.

5. Skink, Weasel **Saproscincus mustelinus,** ***S.*** Three found under heavy leaf litter amongst Spider Wort along Diamond Creek, one on 15/5/96 and two on 2/7/96. No individuals of this species were captured in pitfall traps.

6. Snake, Eastern Brown **Pseudonaja textilis,** ***S.*** One individual seen at Hohnes Hill on 11/10/96.

7. Snake, Eastern Tiger **Notechis scutatus,** ***S.*** One individual seen near farm on 16/10/96.

8. Turtle, Eastern Snake-necked **Chelodina longicollis,** ***S.*** One seen in Diamond Creek on 7/11/96 and three more in Diamond Creek on 8/11/96.

Table 2. Bird species recorded at the study area.

Blackbird, Common *Turdus merula*, **S, B**
Bronzewing, Common *Phaps chalcoptera*, S
Butcherbird, Grey *Cracticus torquatus*. **S, B**
Cockatoo, Yellow-tailed Black *Calyptorhynchus funereus*, S
Cockatoo, Gang-gang *Callocephalon fimbriatum*, S
Cockatoo, Sulphur-crested *Cacatua galerita*, S
Corella, Long-billed *Cacatua tenuirostris*, S
Cormorant, Little Pied *Phalacrocorax melanoleucos*, S
Cormorant, Great (Black) *Phalacrocorax carbo*, S
Cormorant, Little Black *Phalacrocorax sulcirostris*, S
Cuckoo, Fan-tailed *Cuculus flabelliformis*, S
Cuckoo-shrike, Black-faced *Coracina novaehollandiae*, S
Currawong, Pied *Strepera graculina*, S
Currawong, Grey *Strepera versicolor*, S
Darter *Anhinga melanogaster*, S
Duck, Pacific Black *Anas superciliosa*, S
Duck, Australian Wood (Maned) *Chenonetta jubata*. **S, B**
Fairy-wren, Superb *Malurus cyaneus*, S
Fantail, Grey *Rhipidura fuliginosa*, S
Frogmouth, Tawny *Podargus strigoides*, S
Galah *Eolophus (Cacatua) roseicapilla*, S
Goshawk, Brown *Accipiter fasciatus*, S
Heron, White-faced *Egretta (Ardea) novaehollandiae*, **S, B**
Heron, Rufous Night *Nycticorax caledonicus*, S
Ibis, Australian White (Sacred Ibis) *Threskiornis molucca (T. aethiopica)*, S
Ibis, Straw-necked *Threskiornis spinicollis*, S
Kingfisher, Azure *Alcedo azurea*, S
Kingfisher, Sacred *Todiramphus sanctus*, S
Kite, Black-shouldered *Elanus axillaris*, S
Kookaburra, Laughing *Dacelo novaeguineae*, S
Lapwing, Masked *Vanellus miles*, S
Lorikeet, Rainbow *Trichoglossus haematodus*, **S, B**
Magpie, Australian *Gymnorhina tibicen*, **S, B**
Magpie-lark *Grallina cyanoleuca*, **S, B**
Miner, Bell *Manorina melanophrys*, **H**
Miner, Noisy *Manorina melanocephala*, **S, B**
Moorhen, Dusky *Gallinula tenebrosa*, S
Myna, Common *Acridotheres tristis*, **S, B**
Oriole, Olive-backed *Oriolus sagittatus*, S
Pardalote, Spotted *Pardalotus punctatus*, S
Parrot, Australian King *Alisterus scapularis*, S
Parrot, Red-rumped *Psephotus haematonotus*, S
Raven, Australian *Corvus coronoides*, S
Rosella, Crimson *Platycercus elegans*, S
Rosella, Eastern *Platycercus eximius*, **S, B**
Scrubwren, White-browed *Sericornis frontalis*, **S, B**
Shrike-thrush, Grey *Colluricincla harmonica*, **H**
Starling, Common *Sturnus vulgaris*, **S, B**
Swallow, Welcome *Hirundo neoxena*, S
Teal, Chestnut *Anas castanea*, S
Thornbill, Brown *Acanthiza pusilla*, **S, B**
Thrush, Song *Turdus philomelos*, S
Turtle-Dove, Spotted *Streptopelia chinensis*, **S, B**
Wagtail, Willie *Rhipidura leucophrys*, S
Wattlebird, Red *Anthochaera carunculata*, S
Whistler, Golden *Pachycephala pectoralis*, S

Amphibians

1. Frog, Brown Tree **Litoria ewingi, *S*.** Several individuals were found amongst plant pots at nursery adjacent to the farm. One also found at new wetland at Miniature Railway on 17/9/96.

2. Frog, Eastern Banjo **Limnodynastes dumerilii, *T*.** Several individuals found near farm and others heard calling on numerous occasions in several man-made and natural wetland areas. Six Eastern Banjo Frogs were captured in pitfall traps at Hohnes Hill (capture rate, 3.3%). One was also found under an artificial amphibian shelter on 2/10/1996.

3. Frog, Spotted Grass **Limnodynastes tasmaniensis, *T*.** Two individuals were found in new wetland near Diamond Creek on 6/6/96. and one was caught in a pitfall trap at Hohnes Hill on 4/9/96 (capture rate, 0.5%).

4. Frog, Verreaux's Tree **Litoria verreauxii, *S*.** One individual found near the farm on 28/8/96.

5. Froglet, Common Eastern **Crinia signifera, *S*.** This species was the most common amphibian encountered during the study, and readily occupied the artificial amphibian shelters placed around wetlands. Common Eastern Froglets were heard calling on many occasions in all wetland areas and individuals were found covering the various colour ranges.

Nest box program results

Hohnes Hill: Four nest boxes designed for sugar gliders were placed at this site on 3/6/96. They were first checked on 1/7/96 and were unoccupied, however, each entrance hole had been marked. They were checked again on 8/10/96 and each box was found to contain a nest of the Common Starling.

Diamond Creek and Eltham Lower Park: Twelve nest boxes were placed in these areas, four on 5/6/96, four on 1/8/96 and four on 19/8/96. Five of these boxes were designed for small parrots and seven for sugar gliders. All twelve boxes were checked on 9/10/96 and seven were found to contain Starling nests, one contained the nest of a Common Mynah, one contained the nest of an Eastern Rosella (one egg) and three were unoccupied.

Discussion

The study site is typical of areas very close to suburban housing that have become heavily degraded by a range of invasive weeds. Much of the original understorey, shrub layer and ground cover has disappeared and in most of the study area only the tree cover remains.

The avifauna in the area is dominated by the aggressive Noisy Miner. Dr. Douglas Dow, Queensland University (Pizzey 1991), found the Noisy Miner's unpleasant trait of directing loud, concerted aggression against almost every other bird unfortunate enough to enter its territory makes it unique among birds and possibly among all known animals. Noisy Miners were seen to chase and harass nearly every other species observed during the survey. As with other areas dominated by this species, no small honeyeaters were recorded during the study. The White-plumed Honeyeater, a species common throughout Melbourne, was not seen during the study. This species is also absent from other parts of Eltham where Noisy Miners occur in numbers. Small birds such as the Superb Fairy-wren and the White-browed Scrubwren were confined to the few areas with thick undergrowth along the banks of the two streams. The Rufous Whistler *Pachycephala rufiventris*, a species that would be expected to arrive in areas such as this during early spring (Simpson and Day 1996), was not recorded during the study.

The oldest revegetation site (1993) along the Yarra River is inhabited by the Black Rat, House Mouse and Common Wombat. A drey, occupied by a ringtail possum, was also found at this site in an old Tree Violet and Superb Fairy-wrens, White-browed Scrubwrens and Brown Thornbills were often seen at this location. Several Noisy Miner nests and one Blackbird nest were found in revegetated areas and Brown Thornbills with dependant young were observed in a revegetation area along Diamond Creek. Jute-matting has been used extensively to suppress weeds in the revegetation sites and many Garden Skinks were found under this material, however, Weasel Skinks were only found under heavy litter amongst Spider Wort, and none were found in the revegetation areas. Water Skinks were observed close to both streams at two sites, one degraded and one rehabilitated. There were no amphibians recorded for any of the riparian revegetation sites, however, Eastern Banjo Frogs, Spotted Grass Frogs, Common Eastern Froglets and Brown Tree Frogs were found in, and heard calling at, artificial wetlands.

No small terrestrial native mammals were recorded for the study area and the only native rodent recorded was the aquatic Water Rat. The introduced Brown Rat *Rattus norvegicus* was not found during the survey. On several occasions Koalas *Phascolarctos cinereus* were observed in Manna Gum on the Templestowe (south) side of the Yarra River, however, none were seen in the study area. No evidence of Echidnas *Tachyglossus aculeatus* was found during the survey, although this species has been recorded in other parts of Eltham (Menkhorst 1995).

The large number of hollows in the area are used extensively by the introduced Common Mynah and English Starling. Several trees and hollow limbs fell during the time of the survey, many of which contained disused Mynah nests constructed with plastic and other man-made materials, items commonly used as nesting material by this species (Beruldsen 1980). Starlings were seen to enter several hollows during the breeding season and their dominance of the artificial nest boxes was overwhelming. European bees were also seen to occupy several hollows. However, all the parrots (except the Yellow-Tailed Black Cockatoo) observed during the survey were seen entering hollows at various times, but breeding could only be confirmed for the Eastern Rosella (nest box) and the Rainbow Lorikeet (dependant young out of nest at Hohnes Hill).

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Environment. The Shire of Nillumbik, as the local land manager, provided important advice and assistance. Equipment for pitfall traps was lent by the Fauna Survey Group, FNCV, and several members of the group including Ray White, Russell Thompson and Ray Gibson provided valuable advice.

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Climate Change 1995 – Impacts, Adaptations and Mitigation of Climate Change: Scientific-Technical Analyses

Editors Robert T. Watson, Marufu C. Zingowerd, Richard H. Moss and David J. Dokken

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This comprehensive volume provides a roadmap for navigating the sometimes divisive public debate about the consequences of climate change. It reviews what is known, unknown, uncertain and controversial about the potential impacts of climate change and finds that:

- the composition and geographic distribution of many ecosystems will shift;
- some regions, especially in the tropics and subtropics, may suffer significant adverse consequences for food security, even though the effects of climate change on global food production may prove small to moderate;
- there could be an increase in a wide range of human diseases, including mortality, and illness due to heat waves and extreme weather events, extensions in the potential transmission of vector-borne diseases, such as malaria, and regional declines in nutritional status;
- some countries will face threats to sustainable development from losses of human habitat due to sea-level rise, reductions in water quality and quantity, and disruptions from extreme events;
- technological advances have increased the range of adaptation and mitigation options, and offer exciting opportunities for reducing emissions, but are not currently available in all regions of the world.

This volume will be of great value to decision-makers, the scientific community and students.

The Intergovernmental Panel on Climate Change (IPCC) was set up jointly by the World Meteorological Organisation and the United Nations Environment Program to provide an authoritative international statement of scientific opinion on climate change. The IPCC prepared its first comprehensive assessment report in 1990, with subsequent supplementary reports in 1992 and 1994. *Climate Change 1995* is the first full sequel to the original assessment. Several hundred scientists and contributors, recognised internationally as experts in their fields, were brought together in three working groups to assess climate change for this Second Assessment Report. During drafting, the chapters were exposed to extensive review by many other independent experts, and subjected to full governmental reviews.

A List of Native Mammals of Wilsons Promontory National Park

Peter Menkhorst[1] and John Seebeck[1]

This list of native mammal species recorded from Wilsons Promontory National Park is derived principally from the Atlas of Victorian Wildlife, a database maintained by the Department of Natural Resources and Environment, Victoria, and which was used to prepare the distribution maps and species accounts in *Mammals of Victoria* (Menkhorst 1995). Much of the information concerning the native mammals of Wilsons Promontory was gathered during surveys carried out by the Department of Natural Resources and Environment (under earlier names) during the 1970s, but it has been enhanced by recent additions from incidental sightings and special surveys. The bat fauna is poorly documented and further survey is warranted. The list is arranged as follows: vernacular name; scientific name; year of most recent record in the Atlas; our subjective assessment of the animal's status at Wilsons Promontory and comments. Details of introduced mammals found at Wilsons Promontory are provided by Seebeck and Mansergh (1998).

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Species Vernacular name/ Scientific name	Most recent record	Status	Comments
MONOTREMATA			
Short-beaked Echidna *Tachyglossus aculeatus*	1998	Common	
Platypus *Ornithorhynchus anatinus*	ca 1940	Presence doubtful	Only records are literature reports
MARSUPIALIA			
Dasyuridae			
Agile Antechinus *Antechinus agilis*	1998	Common	Formerly Brown Antechinus *A. stuartii*
Swamp Antechinus *A. minimus*	1997	Locally common	Abundant on Great Glennie and Rabbit Islands; unconfirmed reports from Kanowna Island
Dusky Antechinus *A. swainsonii*	1996	Uncommon	
Spot-tailed Quoll *Dasyurus maculatus*		Presence unconfirmed	Literature records only
White-footed Dunnart *Sminthopsis leucopus*	1992	Uncommon	
Peramelidae			
Southern Brown Bandicoot *Isoodon obesulus*	1994	Uncommon	
Long-nosed Bandicoot *Perameles nasuta*	1997	Rare	
Phalangeridae			
Common Brushtail Possum *Trichosurus vulpecula*	1997	Locally common	
Mountain Brushtail Possum *T. caninus*	1974	Presence unconfirmed	Single sight record only
Pseudocheiridae			
Common Ringtail Possum *Pseudocheirus peregrinus*	1998	Common	

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Petauridae			
Sugar Glider *Petaurus breviceps*	1998	Rare	
Acrobatidae			
Feathertail Glider *Acrobates pygmaeus*	1986	Uncommon	
Burramyidae			
Eastern Pygmy-possum *Cercartetus nanus*	1996	Locally common	
Phascolarctidae			
Koala *Phascolarctos cinereus*	1995	Uncommon	Significant remnant population NOT derived from translocated stock
Vombatidae			
Common Wombat *Vombatus ursinus*	1998	Common	
Potoroidae			
Long-nosed Potoroo *Potorous tridactylus*	1998	Uncommon	
Macropodidae			
Eastern Grey Kangaroo *Macropus giganteus*	1998	Locally common	
Tasmanian Pademelon *Thylogale billardierii*	ca 1850	Extinct	Wholly extinct in Victoria
Black Wallaby *Wallabia bicolor*	1998	Common	
CHIROPTERA			
Molossidae			
White-striped Freetail Bat *Tadarida australis*	1998	Uncommon	
Vespertilionidae			
Chocolate Wattled Bat *Chalinolobus morio*	1997	Uncertain status	
Common Bent-wing Bat *Miniopteris schreibersii*	1971	Rare	Only a single record
Lesser Long-eared Bat *Nyctophilus geoffroyi*	1997	Common	
Gould's Long-eared Bat *N. gouldi*	1983	Uncertain status	
Large Forest Bat *Vespadelus darlingtoni*	1990	Uncertain status	
Southern Forest Bat *V. regulus*	1997	Uncertain status	
Little Forest Bat *V. vulturnus*	1997	Uncertain status	
RODENTIA			
Bush Rat *Rattus fuscipes*	1998	Common	Animals on Great Glennie Island very large
Swamp Rat *R. lutreolus*	1997	Locally common	
Water Rat *Hydromys chrysogaster*	1998	Rare	
Broad-toothed Rat *Mastacomys fuscus*	1990	Rare	
New Holland Mouse *Pseudomys novaehollandiae*	1996	Rare, but may be locally common	One of only four Victorian populations
CANIDAE			
Dingo *Canis latrans*		Probably extinct	Replaced by feral Dog, *Canis familiaris*
OTARIIDAE			
Australian Fur Seal *Arctocephalus pusillus*	1998	Common	One of four Victorian breeding colonies occurs on Kanowna Island
PHOCIDAE			
Leopard Seal *Hydrurga leptonyx*	1996	Rare visitor	

The following letter was received from a member, Nick Romanowski, in reponse to an article in *The Victorian Naturalist* **115** (2). 1998. 56-62 by Golam Kibria and co-authors. The paper reviewed the biology and aquaculture of Silver Perch *Bidyanus bidyanus.*
Golam Kibria's response follows Nick's letter.
The editorial policy of *The Victorian Naturalist* is to publish a wide-range of papers touching on all aspects of natural history. We are always interested to receive comments from members on the content of the journal. Editor

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Dear Editor

What is an article on aquaculture of Silver Perch *Bidyanus bidyanus* (Kibria *et al.* 1998) doing in *The Victorian Naturalist*? It could be justified if it really was a summary of the biology of this species, but like many aquaculture articles this one deals almost entirely with growth responses under highly unnatural conditions – from spawning induced by injection of hormones, to growth rates on artificial diets at stocking rates far in excess of anything ever recorded in the wild.

What little mention is made of natural history in the article does not even report earlier work accurately. For example, 'competition for food from introduced cyprinids, and predation by English Perch *Perca fluviatilis*, have *probably* [my italics] played a part in [Silver Perch] decline' (Cadwallader and Backhouse 1983) remains an unsubstantiated, though plausible, guess. However, this has been completely rephrased as 'its population has been greatly reduced due to competition from introduced cyprinids [and] predation by the English Perch'.

The suggestion that aquaculture might have a role to play in rehabilitation of this species is spurious. All domesticated animals change both genetically and behaviourally from wild populations, although such changes may not be obvious in the first few captive generations. In the case of Silver Perch, many captive populations are derived from the original aquaculture stocks developed in southern NSW around forty years ago (Lake 1967). These were bred from small initial populations collected from a relatively small part of the range of the species, ideal conditions for initiating genetic drift.

If overseas aquaculture stocks of long standing are any guide, Silver Perch will gradually change in appearance from wild fish, becoming fleshier and less active, among other changes. Compare the thick-bodied, almost scale-less Mirror Carp *Cyprinus carpio* to any wild fish of the same species for an example of changes under domestication in less than a century, for just one obvious example.

All documented captive breeding programs for fishes, whether aquaculture-oriented or not, have started from a very limited genetic base – often as few as a half-dozen adult fish (Romanowski 1996: Caughey *et al.* 1990). The stocks produced by such programs are already a long way from being representative of their species, and reintroducing their offspring into natural waters on a large scale will only dilute whatever variability still exists in wild populations. This can also be a way to release new disease strains such as the piscine tuberculosis now common in probably all captive-bred Australian and New Guinea Rainbowfishes (*Melanotaenia, Glossolepis* and *Chilatherina*) (Tappin 1998).

The most irritating aspect of the article in question is that it is not an unbiased appraisal of the future of Silver Perch in aquaculture at all, but a selective promotion of the species. A close look through the apparently exhaustive reference list shows that the authors have omitted any that don't support their contention that 'demand to cultivate the species is increasing both in Australia and in nearby Asia'. Silver Perch is certainly the best prospect available for Australian freshwaters, unless we are prepared to take the potentially disastrous risks with introduced fish that have already destroyed a variety of indigenous fisheries overseas.

However, I have long warned (Romanowski 1994) that Silver Perch would not be so readily accepted overseas as its promoters would have us believe. More recent information from Taiwan (Walker 1996) makes it plain that the Taiwanese have already rejected this as a quality fish, with production there falling from a peak of 500 tonnes in 1994, to 100 tonnes in 1995. Prices of around $5 per kilogram at the time make it clear that this is regarded as a middle-quality fish only, and that acceptance was poor against the wide variety of comparably priced species already available there.

Other obvious biases in the article include a claim that Silver Perch 'represent the main endemic freshwater aquaculture industry in Australia'. With a peak production of around 50 tonnes for the entire country in 1994/1995 (Kibria *et al*., 1998), this seems insufficient to compete with the 300 plus tonnes of freshwater crayfish produced in Western Australia alone (O'Sullivan 1995) in approximately the same time span.

There have been some excellent articles on the biology of native fishes in *The Victorian Naturalist* over the years, and I would certainly like to see more of them. However, I don't feel that aquaculture adds anything of value to a natural history magazine. If the word 'Biology' had been taken out of the title 'Biology and Aquaculture of Silver Perch' it would have been a more accurate statement of what it was really about, and also made it clear where it really belongs – in an aquaculture magazine.

All the best
Nick Romanowski

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Dear Editor

Response to Nick Romanowski regarding our review paper ' Biology and aquaculture of Silver Perch – A review' (Kibria *et al.* 1998).

This is a review paper of an Australian native fish, Silver Perch *Bidyanus bidyanus* based on published information of the species. The paper reviewed 'biology and aquaculture of Silver Perch' in the context of its natural history, natural habitats, biology, natural food and feeding habits, aquaculture and pollution potential. The review could be of interest to a wide of range of readers from naturalists to conservationists, aquaculturists, biologists and environmentalists. This paper was refereed and the summary of referee's comments may reflect the intention of the review: 'the paper is a comprehensive review of the current status of Silver Perch in terms of its known biology, conservation status and aquaculture'. Regarding the comments of Nick Romanowski about the paper, we would like to submit the following:

1. Causes of decline: we have combined the three main reasons for the decline of the Silver Perch population: (a) competition for food from introduced cyprinids, (b) predation by the English Perch and (c) the construction of dams that has prevented upstream migration, affecting the reproductive success. However, the last and most important point, which is the main cause of decline of Silver Perch populations in the wild, has been omitted.

2. Rehabilitation through aquaculture is spurious?: This statement is incorrect. Fisheries and aquaculture are interrelated disciplines, and aquaculture has been practised world wide not only to increase fish production but also to enhance natural fisheries through stocking with fry and fingerlings into dams, reservoirs and open waters. Rowland (1995) suggested that the

stocking of hatchery reared fingerlings can significantly enhance Australian native fish stocks (including Silver Perch) in natural waters whose populations have declined due to modification of freshwater environments. To rehabilitate native fish, State Government hatcheries in NSW and Victoria annually produce fish for stocking public waterways for both recreation and conservation purposes (Gooley and Rowland 1993). Furthermore, to establish and maintain recreational fisheries, NSW fisheries have so far stocked 11 million Silver Perch, Golden Perch and Murray Cod fingerlings into impoundments since 1976 (Rowland 1995). Additionally, fingerlings of native endangered Trout Cod (*Maccullochella macquariensis*) and Eastern Freshwater Cod (*M. ikei*) produced from hatchery were also stocked into waters where they had become extinct (Rowland 1995). However, it was mentioned that aquaculture of Silver Perch is not a solution to rehabilitate the species. If aquaculture is not a solution, what are the solutions? Unfortunately there was no solution given in the letter. If there are no measures taken then the Silver Perch population will continue to decline in the wild and will soon reach the 'endangered' category from the present 'vulnerable' category.

Secondly, it is widely accepted that overexploited and depleted fisheries can be rehabilitated through programs of artificial breeding, rearing and restocking in natural habitats (New 1991; Casvas 1995; Gjedrem 1997). The captive breeding programs are useful in conservation of aquatic organisms, in particular commercial species, since artificial breeding creates the opportunity to preserve ova or embryos (cryopreservation) and the establishment of gene banks for future use. Therefore these programs can be the basis for maintaining biodiversity of aquatic organisms that are most threatened by the impact of human interventions (Pullin 1993; Purdom 1993). Furthermore, androgenesis techniques open the way for germ plasm maintenance and the conservation of endangered fish species (Thorgaard 1986; Thorgarrd *et al.* 1990). Aquaculture has brought hope for the restoration and conservation of endangered fish species in many countries, for example, Reeves Shad in China, and American Shad in USA, where induced breeding, and a program for the release of hatchery-produced larvae and juveniles has been carried out to supplement the stocks in rivers (Hanping 1996). Salmon larvae, fry, fingerlings, and smolts are stocked to restore populations destroyed by acid precipitation and hydro-electric facilities in Norway (Torrissen *et al.* 1995). To increase the marine resources in Japan, several millions of fry of Kuruma Shrimp *Penaeus japonicus* are released every year, whereas in the USA salmon enhancement programs have been based on hatchery production of juveniles (Pillay 1990). In short, aquaculture can play a significant role in conservation of aquatic biodiversity and genetic resources (Anon 1998a).

3. About 'initiating of genetic drift': The high costs of keeping aquatic organisms encourage farmers to use small broodstock populations which can lead to inbreeding and negative consequences for farmed or released stocks. This problem could arise due to lack of knowledge of the basic principles of the brood stock maintenance. However, the majority of aquatic species used in aquaculture today are little changed from their wild relatives with the possible exception of Common Carp and ornamental fish (Anon 1998b). Most hatchery populations of Rainbow Trout *Salmo gairdnerii* have approximately the same amount of genetic variation as natural populations (Allendorf and Utter 1979; Busack *et al.* 1979). Despite all, there has been considerable progress on fish genetics to tackle the inbreeding problem. Research done overseas suggests that by maintaining effective breeding numbers (N_e), it is possible to avoid inbreeding or genetic drift problems (Douglas 1992). For example, Ryman and Stahl (1980) suggested that N_e could be at least 60 whereas the Food and Agriculture Organisation of the United Nations (FAO) recommends that N_e be at least 50 for short term work and 500 for long term work (FAO/UNEP 1981). Allendorf and Ryman (1988) and Tave (1993) have given a specific N_e of fish to be stocked in rivers and lakes for fisheries management programs or ocean ranching. The following publications deal with N_e of different species: Common, Chinese and Indian Major Carp (Jhingram and Pullin

1988), *Tilapia* (Tave 1986; Smitherman and Tave 1987; 1988) and Brown Trout (Ryman and Stahl 1980).

4. About 'dilution of the wild population and disease concern': There has been much development in the field of fish genetics for sustainable aquaculture and fisheries production. Through selective breeding or genetic transformation (transgenic species) of fish and crustaceans, it has been possible to produce strain resistance to diseases and parasites (Gjedrem 1995; Bachere *et al.* 1997). Therefore genetic transformation or selective breeding is also a solution to eliminate the spread of diseases at regional or international levels (Bachere *et al.* 1997). Some selection experiments have shown genetic improvements for disease resistance against dropsy disease in Common Carp (Ilyassov 1987), furunculosis in brown trout (Cipriano and Heartwell 1986; Dunham 1987) and Brook Trout (Embody and Hayford 1925; Dunham 1987). Moreover, the creation of sterile transgenic aquaculture species will avoid any spreading of the strains in the natural environment (Bachere *et al.* 1997). Aquaculture creates the opportunity to produce triploids which are sterile fish that can be cultured on farms or used in natural resources management. This process is an excellent way to utilise even exotic fishes for fisheries management while minimising adverse environmental impacts (Tave 1993). Triploids have been an important fish for stocking public waterways in the USA. For example, Striped Bass is one of the premier sport and commercial species in the USA. Fishing pressures, pollution, and destruction of spawning grounds and nursery areas caused the dramatic depletion of many stocks of Striped Bass. Sterile Striped Bass (produced by crossing Striped Bass with White Bass) are being stocked in rivers and lakes around USA to help relieve the fishing pressure on Striped Bass and to help restore local fisheries, without adverse environmental consequences (Tave 1993). It has been reported recently that the Commonwealth Scientific and Industrial Research Organisation (CSIRO) is researching on a transgenic technology to develop aquaculture species which will complete their life cycle only on the farm. If the cultured stock escaped into the wild, their larvae and juveniles from wild spawning would die. This technology will improve fish production and will not pollute wild stocks (Anon 1998c).

5. About 'most irritating aspect and selective promotion of the species': It appears from the above comment that we wrote the review to promote the species and perhaps we are running a fish selling business! This was further linked to an exhaustive reference list. Silver Perch is a well known endemic freshwater species with a high aquaculture potential and does not need any promotional drive, and this fact was also acknowledged in the letter 'Silver Perch is certainly the best prospect for aquaculture in Australia'. The impression was also expressed that we have omitted some references but the list of those references was not given. However, referees who reviewed the paper commented that 'it is clear that the authors have conducted an extensive literature review'.

6. About 'represent the main endemic freshwater aquaculture production': The first line of our paper clearly indicated that 'the Silver Perch *Bidyanus bidyanus* is the most important **fish** contributing to major endemic freshwater aquaculture production (see the first line of the abstract in our paper). Secondly, production has been compared with Silver Perch and other native fish, but not with crustaceans (see Table 2 in Kibria *et al.* 1998).

Table 1. Topics covered in Kibria *et al.* (1998) and number of references quoted.

Title	Number of references quoted
1. General biology of silver perch	
(a) history, natural habitats, status	10
(b) biological characteristics of silver perch	19
(c) natural food and feeding	7
	36
2. Environment	
(a) salinity tolerance and distribution in salt water	4
(b) pollution potential	3
	7
3. Aquaculture of silver perch	
(a) aquaculture of silver perch	15
(b) artificial breeding	3
(c) nutrition	10
(d) growth and production	10
	38

7. About 'taking out the word biology from the title': This paper was reviewed by referees, accepted by the editor and published and no suggestion was put to us to change the title. Table 1 gives a break down of the areas covered and the number of references quoted.

8. Conclusion

We hope from the above discussion, that it is clear that aquaculture has a significant role in natural stock enhancement, conservation of aquatic biodiversity and genetic resources, endangered species restoration, and aquatic resource management. Aquaculture is currently providing much needed support to recreational and commercial fishers. Our review on the 'biology and aquaculture of Silver Perch' dealt with a native species, a species which is vulnerable and is of interest to recreational and commercial fishers. The species is being stocked in Victoria's natural waterways with fingerlings produced from aquaculture in order to enhance the state's fisheries. Aquaculture is an infant industry in Australia and therefore much of its benefits may not be known.

The primary threats to fish species are mainly due to destruction of habitat essential for reproduction and recruitment and competition with introduced species. Genetic threats are lowest (Purdom 1993). We hope that research on fish genetics being carried out under different projects such as the International Network of Genetics in Aquaculture (INGA), Gene Banking and Conservation of Freshwater Fish Project (GBCFFP), Genetic Improvement of Farmed *Tilapia* (GIFT), and locally by CSIRO will bring some more fruitful results for conservation of aquatic organisms, and sustainable aquatic food production. It should be mentioned here that genetically modified organisms (GMO) from aquaculture or their release for aquaculture and fisheries enhancement cannot be predicted with certainty, and in aquaculture and fisheries development, as as in agriculture and forestry (Pullin 1994), some loss of biodiversity is unavoidable. Therefore, it is necessary to assess risk and weigh potential benefits against environmental costs. We do agree with Pullin (1994) who stated that where GMO's are already the basis of important aquaculture and enhanced fisheries with no evidence of their having caused significant environmental harm, then it would be reasonable to pursue further development of such aquaculture or fisheries. We believe in ecologically sustainable development (ESD) as set out in the National strategy for ESD (NSESD) (Deville *et al.* 1995) and the same view has been reflected in the conclusion of our review.

Thank you.
Sincerely yours,
Dr Golam Kibria

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Saving the Environment: What Will it Take?

by Ted Trainer

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The environmental movement has been claimed to be the most significant social movement to have occurred internationally since the emergence of socialism. Ted Trainer argues that environmental policies in the 1990s are failing to deal with the underlying causes of environmental decline, and presents key arguments for limiting economic growth.

Most people, including those who staff the government and non-profit environmental agencies, such as the Australian Conservation Foundation, assume that we can solve the environmental problem by more recycling, greater energy efficiency, stricter anti-pollution legislation, more national parks and greener codes for building, planning and products. Trainer argues that this emphasis is distracting governments from the real social and cultural causes of environmental decline. We are over-producing and over-consuming, he argues, and solutions to the environmental problem will fail unless we recognise this fact.

A US study shows that the average person consumes 20 tonnes of new material every year. Trainer argues that our society is more than 'somewhat' unsustainable: *'it is far beyond the levels of resource consumption and environmental impact that could be sustained'.*

Dr Ted Trainer teaches at the School of Social Work at the University of New South Wales. He has published extensively on environmental issues, and his books include *The Conserver Society* and *Towards a Sustainable Economy*.

Daniel Ernest McInnes
1906–1998

It was with great sadness that we learned that Dan McInnes had died on 24 September 1998, just short of his 92nd birthday. It was also difficult to comprehend. Dan had been such an active member for so long that one could not believe that he would not be found, still busy, somewhere in the Club.

Dan McInnes was elected a member of the Club at the AGM on 7 June 1954 when the Microscopical Society of Victoria was incorporated with the Field Naturalists Club of Victoria. In 1957 he became a member of Council, and from 1958 to December 1995 Dan is listed, in one capacity or another, in *The Victorian Naturalist*. He was Vice-President 1958–1959, President 1959–1962, and Immediate Past President from 1962–1967. A break from official duties might have been expected, but in September 1967 the Treasurer resigned and, typically, Dan offered to carry on until a new Treasurer was appointed. At the AGM in 1968 Dan became Treasurer, and in effect held this position until 1980, although at intervals during this period the position was officially vacant. In the Annual Report 1979/80 the President, Dr Brian Smith, paid tribute to the retiring Treasurer for his untiring work for the Club: 'His advice on Club matters in general as well as his sound financial guidance has been of incalculable value to the Club.' When the appointment of a new Treasurer was announced six months later the Club Reporter commented 'Actually the Club has been without a Treasurer since the last Annual General Meeting but Mr McInnes (being Mr McInnes) has continued to see us through although officially he was merely a "bookkeeper"'. The Club was very dear to Dan's heart and he would not let it falter for want of a helping hand. From 1977–1983 he was Book Sales Officer, providing a much-appreciated service, as well as making a considerable profit for the Club, and he continued looking after the sale of back issues of *The Victorian Naturalist* stored in his old shop at 129 Waverley Road until 1995.

Dan may not have been in favour of the incorporation of the Microscopical Society with the Club, but from the outset he threw himself into the life of the FNCV. The Microscopical Group was formed immediately, Dan was the Excursion Leader, and the first excursion was to Albert Park Lake, one of his favourite hunting grounds. Pond life was his abiding interest, and many times members will have heard him say at a General Meeting that he had popped down to the lake for a jam jar full of water because he knew there was bound to be something of interest in it for him to exhibit under a microscope. Most likely nothing new to him, but it enabled him to pass on some item of knowledge to others, and that was equally important to him. He was never at a loss to find something to exhibit, and the breadth of his interests is revealed in the variety of specimens he displayed: the blood circulation of a tadpole;

a nautilus shell, the animal and its eggs, found at Middle Brighton; rock sections; the proboscis of a blowfly; fossil coral from Lilydale Quarry; rotifers; live cheese mites from matured cheese (probably found in his delicatessen stock); Wolffia and liverworts to name but a few. His exhibits were always accompanied by notes, and he would frequently draw members' attention to further information to be found in books in the library. In this connection it is interesting to read the report of the meeting of the Microscopical Group which was held in the Herbarium Hall in January 1955, when 'Mr D. McInnes stressed that all members attending a future meeting should bring a microscope, irrespective of whether they have a specimen or not at the time. A slide will be supplied, and if the member is diffident about making the few necessary remarks relevant to the slide, then arrangement will be made for a substitute to do this for him.' People were to be involved and encouraged, and one of the things that impressed Ray Power was Dan's 'ability to put on a talk at a moment's notice'.

Besides his involvement with the Microscopical Group, Dan was also a member of the Entomology and Marine Biology Group, the Geology Group, and in time, the Day Group. This latter was formed in 1972 to cater for leisured and retired members who did not want to attend meetings at night. Their inaugural excursion was to the Botanic Gardens. It was reported that 'Mr McInnes took us to see an unusual Chinese Oak tree.'

Although not a founder of the Hawthorn Junior Field Naturalists Club, Dan was closely connected with it for many years, and was President from April 1962, stepping in after the sudden death of their President, until August 1971. Many members, and future Office Bearers of the FNCV, had their interest in natural history fostered by Dan, and for one member at least there has been the recent joy of having her child inspired by Dan, as she was. In 1969 he was made a Life Member of the Hawthorn Junior FNC.

Dan was essentially a practical man, and nowhere is this revealed more clearly than in the construction of the FNCV microscope. In a series of articles in *The Victorian Naturalist* he outlined the problem with cheap commercial microscopes, which were unsatisfactory for both children and adults starting to use them, and explained his design which had been constructed by W.C. Woollard, an engineer and keen microscopist, who had developed the original idea into 'a really practical, first-class microscope'. So popular was this microscope, sold at a very reasonable price, that over 140 of them were made for members. Dan and W.C. Woollard both received Honorary memberships in May 1964 in recognition of this work.

One of the major Club events from very early days was the annual Nature Show, held in the Lower Melbourne Town Hall. During the 1960s and 1970s Dan was chairman of the Nature Show Committee, and Jim Willis, in his centenary history of the FNCV, described Dan's indefatigable leadership' in organising these Shows. Each one featured a particular theme. The Hawthorn Juniors played a significant part, and as an indication of the amount of work involved the report on the 1967 Show states 'D. McInnes and the Hawthorn Juniors are the proprietors of Instant Caves Ltd: the caves come in assorted sizes complete with stalactites and stalagmites. We understand that with modern methods the manufacturing time has been cut from several million years to 26 weeks.' In 1964 the Hawthorn Juniors mounted a 'realistic beach scene' and demonstrated making rock slides under the FNCV microscope. On another occasion a geological scale model of the Yarra Valley was constructed under Dan's guidance.

Dan wrote a number of articles for *The Victorian Naturalist*, and the one called *A Pond Hunter's Dream*, published in 1990, wonderfully transmits his abiding interest in pond life. He describes the pond hunter as 'that odd person who may be seen occasionally, dipping with his pond net into a lake' and says that 'pond hunters in their rambles always have that dream of the pond that has all the interesting forms of life they read about but never come across in their samples of pond life.' He goes on to describe such a dream pond. The article conveys the excitement of finding all sorts of fascinating life, and also contains much practical advice on equipment and methods. It is not written to show off some obscure knowledge, but to make others aware of the subject, and to assist anyone to develop an interest of their own. An interesting article on *Wolffia australiana* was the result of his being asked whether he had ever seen this tiny duckweed in flower. He hadn't, so he investigated. Dan's keen interest and sharp eye finally led him to the discovery in 1983 of a species previously unrecorded for Australia, a foraminiferan, *Shepheardella taeniformis*, in material collected from Black Rock. Subsequent trips to Port Phillip Bay revealed more specimens, which led Dan to speculate that this foram was fairly plentiful; but it had taken his keen observation and wide knowledge to identify it.

The fact that Dan was never Club Librarian, nor Editor of *The Victorian Naturalist* did not mean that he had no involvement in these aspects of the Club. He was always willing to lend a hand in the library, he looked after the binding, and when the library went into storage he listed all the books kept out for use by the Microscopical Group. The geological map and reports collection also bears witness to his organisation. As time went on it became increasingly obvious that a supplement to the cumulative indexes to *The Victorian Naturalist*, which covered issues only to 1978, was necessary. Dan, embracing new technology, acquired his own computer, and in collaboration with Pat Grey, produced an index covering the next ten years.

When Dan became President in 1959 he introduced the idea of name cards for members at meetings. He wanted everyone to feel involved, and he saw it as part of his job to talk to people at General Meetings. A revealing item appeared in the report of the January meeting in 1960 when he appealed for people who arrived early to help set up tables, lights, microphone etc. so that he could have more time to greet and get to know members. This says as much about Dan's activities in the background as about his view of his responsibilities as President. He was always very generous with appreciation of other people's efforts. When in 1985 a presentation was made to Marie Allender 'For Outstanding Service' it was Dan who compiled a list of excursions Marie had arranged, and spoke of her record in this capacity and as a Councillor. I, too, have reason to be grateful to Dan. It was he who recommended to Council that as I had been Club Librarian for eleven years, as well as holding various other offices from time to time, I should receive an Honorary membership. That was when Dan was 90, and his interest in Club affairs was still as keen as ever. Delve into the Club's activities anywhere in the last 44 years, and you will almost certainly find Dan, contributing. He will be greatly missed.

Our sympathy goes to Chriss McInnes, herself a member for the last 40 years, and to the family.

Sheila Houghton
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Gisborne, Victoria 3437.

I am indebted to Tom May
for assistance with this obituary.

(Photo of Dan taken at the FNCV Centenary Meeting, 5 May 1980)

Vale
Norman Stanford

We regret to announce the death of Norm Stanford on 26 November, 1998. Norm was elected to the Club in February 1983, and was Subscription Secretary from 1986 to 1988. Microscopy was his chief interest, and although he resigned from the Club when he and Helen moved from Melbourne, he continued to attend some meetings of the Microscopical Group as a member of an affiliated Club. Norm was re-elected to the FNCV in July 1997, and attended meetings until shortly before his death. Our condolences go to Helen Stanford, who was Book Sales Officer for several years.

Sheila Houghton

A Long Walk in the Australian Bush

William J. Lines

Publisher: *University of New South Wales Press Ltd., 1998. RRP $19.95.*

The vexed question of land utilisation in general and forestry in particular has exercised the mind of Bill Lines since he was a boy growing up at Gosnells, near Fremantle in Western Australia. His formative years are described in his publication 'Taming the Great South Land' (Allen & Unwin Ltd. 1991). As a boy he watched the sand track on which his parents lived become the Fremantle Road as bush was cleared, swamps drained and the land became yet another subdivision.

The work under review is concerned with a physical and philosophical journey along the Bibbulmun Walking Track, undertaken in the spring of 1993. The Bibbulmun Track commences at Kalamunda, only a few kilometres from Gosnells, in an area Lines has been familiar with all of his life. The track, covering a distance of 650 kilometres, followed mainly along old logging and fire roads, and the various sections provide the story of the forest during the past 170 years. The first logs were taken in 1829, when timber was required for repairing HMS *Sulphur*. The British Admiralty was so impressed with the work that 200 tons of timber were ordered in 1831, followed by further orders in 1837. Over the next few decades intermittent logging occurred, but began in earnest during the 1870s as the 'inexhaustible abundance' began to be exploited. Baron Ferdinand von Mueller visited the region on two occasions during this period and recommended that a bureaucratic structure be established to exercise surveillance, prevent waste and encourage the natural upgrowth of young trees.

As Lines and his companion travel along the track it is made abundantly clear that rather than exercising such care, much of the forest has been used rather as a quarry. That clearing for agriculture, some selective logging for timber, and a great deal of clear felling for wood-chipping for the Japanese market occurred becomes apparent as the walk progresses. Complete utilisation of the forest appears to be the aim of foresters and, in 1968, the then conservator of forests in Western Australia saw wood-chipping as the realisation of this dream. In addition, the damming of rivers and streams and their pollution by agricultural and industrial run-off have added to the destruction. As in so many other parts of the continent, salinisation has occurred on a large scale, particularly where the forest has been cleared for broad-acre farming.

Distinctions are made between natural calamities and those visited upon the forest by human interference. In particular, much reference is made to the differences in land utilisation by the original inhabitants and those who displaced them. The author is at pains to emphasise the importance of the forest for its own sake and not for utilitarian purposes, however laudable. He implores nature lovers to base their efforts at preservation on the fundamental ethic that plants and animals have a right to exist and to be left alone because they exist.

Although dealing with a relatively small part of the south west of Western Australia, a narrow belt of very distinctive land between Perth on the west coast and Walpole on the south coast, the implications of the story have universal application. As David Suzuki said in another place, 'we assault the planet as if it is limitless and endlessly self-renewing'. This emphasises the fact that the story Bill Lines tells is not unique to the south west, or even to Australia, but is being repeated over and over in different parts of the world.

The book, a paperback of about 200 pages, is recommended for the important observations made concerning the use and abuse of the planet. Although it makes no difference to the message that Lines is conveying, it is noted that the track that he and his companion walked is not now in use. A new, purpose built and recently completed

Bibbulmun Track, to the east of their route and mainly through conservation areas, is now the official route and extends the track a further 180 kilometres eastwards to Albany. It has numerous campsites, each about a day's walk apart and with conveniences to make the long walk more pleasureable. Whether it has the same impact is another story.

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George Caley, Nineteenth Century Naturalist

by Joan Webb

Publisher: *Surrey Beatty & Sons, 1995. 185 pp., many illustrations (black & white, colour). R.R.P $37.95.*

Not far from the Botanic Gardens in the Blue Mountains, NSW, a peak carries the name Mount Banks. It was given by an English botanist, George Caley, to commemorate Joseph Banks, for whom he collected many Australian plants early in the nineteenth century. Caley was explorer as well as botanist and is commemorated physiographically and botanically – mainly in NSW. Three peaks, one genus and several species of Australian plants still carry his name. Robert Brown, another of Banks' botanists, gave Caley's name to an orchid genus – *Caleana* – and described Caley as '*botanici periti et accurati*' – a skilful and accurate botanist. Non-Victorian species of *Banksia*, *Grevillea* and *Eucalyptus*, retain the specific name *caleyi*. Victoria's swamp violet, *Viola caleyana* G. Don, also commemorates Caley.

George Caley collected only very fleetingly on the coast of what would later become the colony of Victoria, but because his recent biography is of general botanical interest, I think it deserves mention in *The Victorian Naturalist*. My more detailed review is published in *Historical Records of Australian Science*, vol. 12, June 1998.

During Flinders' coastal survey of New Holland (1802-5), Brown collected thousands of plants for Banks and named many in his substantial *Prodromus Florae Novae Hollandiae et Insulae Van Dieman* (1810) and supplement – *Supplementum Primum Proteaceas Novas* (1830). Some he collected with Caley in the vicinity of Sydney and the Blue Mountains. Brown's influential role in Australian botany is widely recognised. But Caley, who collected in New Holland over a longer period of time and may have foot-slogged a greater total land distance, published nothing, and is relatively unknown.

Assisted by botanists and librarians, Joan Webb investigated herbarium specimens as well as correspondence, journals, maps and reports at the present herbarial home of Banks' and Brown's botanical collections – the Natural History Museum in London – and other European, American and Australian herbaria. In *George Caley, Nineteenth Century Naturalist*, the product of her extensive detective search for Caley, Webb discusses his Australian botanical work between April 1800 and May 1810, and the botanical consequences of that work.

In 1795, Caley wrote to the great botanist Banks to introduce himself and enquire about employment. Caley mentioned that he was born on a memorable day for Banks – in June 1770, when Captain Cook's *Endeavour* was almost wrecked on the Barrier Reef and Banks feared for the survival of the rich plant collection from the aptly named 'Botany Bay'. Later Caley accepted Banks' offer of employment and collected for him in New Holland. Of the relatively few Australian plants described by 1800, Caley had studied those cultivated in English gardens and described in botanical publications.

Caley made three sea voyages from Sydney. One was an exploratory expedition in 1801 to survey Bass Strait and Western Port on the *Lady Nelson* under Lieutenant James Grant. Webb could find no Caley journal for this expedition, although he wrote to Banks that

> when I have nothing to do I shall write out my voyage to Western Port, but had it been more interesting I should have done so long ago.

Webb mentions that Caley found few plants he had not already seen, but not whether any of Caley's expedition specimens survive.

In 1805, Brown took his massive New Holland collection, including some Caley specimens, back to Banks and began documenting it. In his *Prodromus* Brown established many new genera, including two orchid genera, *Caleana* and *Pterostylis*, for which he named and described many species, including *Caleana major*, *Caleana minor* and about a dozen species of *Pterostylis*, which are now recognised as Victorian. Meanwhile, in the antipodes, Caley was using a taxonomic system being discarded by Brown and genera established before 1801. Caley was more than a mere collector and provided new specific names for genera he recognised and sometimes ventured to create new generic names. He had a substantial orchid collection and recognised that certain hooded orchids could not be accommodated in any established genus and deserved their own genus. Because they reminded him of the hooded Druids, he called the new genus *Druid's Cap*, which Brown latinized and used until he established the genus *Pterostylis*.

Caley provided specimens and names for other botanists to use. Some of Caley's many Australian specimens, especially in the Proteaceae and Orchidaceae, are type specimens for taxonomic names published by others, usually Robert Brown. Furthermore, some of the published names are Caley's manuscript names. Webb found evidence of the publication of eleven of Caley's manuscript names. Some are for species indigenous to Victoria, including four published in Brown's *Prodromus* - *Leucopogon juniperinus* R.Br., *Thelymitra pauciflora* R.Br., *Scutellaria mollis* R.Br. and *Xanthorrhoea minor* R.Br. – and one in his *Proteaceas Novas* – *Persoonia rigida* R.Br. On his herbarium label Brown wrote '*Persoonia rigida* Caley', but because he rather than Caley published that name, Brown's rather than Caley's name remains attached to that plant name.

Webb's book includes maps and illustrations including Bauer's exquisite depiction of *Caleana major*, which are clear and informative; there are useful appendices, including 'Plants named after Caley' and 'Caley's Eucalypts', and a good bibliography. Unfortunately, the index lacks taxonomic names – not even Brown's genus *Caleana*! I admire Webb's persistent detective effort in her search for clues about Caley and his collections and recommend *George Caley, Nineteenth Century Naturalist* to *Vic. Nat.* readers who share my interest in Australian botanical history.

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The Victorian Naturalist

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New Zealand Fungi: an illustrated guide
(Revised edition)

by Greta Stevenson

Publisher: *Canterbury University Press, 1994.*
Paperback, 126 pp., 15 colour illustrations. RRP $19.95.

These are indeed fortunate times for those field naturalists whose interests include fungi. The appearance over the past decade or so of several excellent mycological publications, as well as initiatives such as the Fungimap project, are indicative of a positive period in mycological research in Australasia. This review of Greta Stevenson's publication *New Zealand Fungi: an illustrated guide* is placed within this context.

First published in 1982, under the title *Field Guide to Fungi*, this book includes a table of contents that would have presumably been eagerly sought by field mycologists. The introduction and following chapter attempt to define fungi in terms of their position in a broad hierarchy, and by some explanation of fungal life cycles and reproduction. Information is provided on detrimental and beneficial roles of fungi, including the important concept of mycorrhizal associations.

Two very brief chapters on finding and collecting fungi are followed by a more detailed series of chapters dealing with the recording of information, and preservation of collected specimens. These chapters utilise illustrations of both macroscopic and microscopic detail, as well as providing a scheme for compiling notes on specimens.

After a skeletal explanation of the process of nomenclature, a brief description of the four classes to be dealt with, and a blunt explanation of the author's choice of classification, there is a hiatus created by the insertion of a short chapter on reference literature plus a bibliography.

The remaining one hundred pages of the book contain descriptions of taxa from only two of the classes mentioned above. This section includes a key to some genera of the *Agaricales* (with a table-format guide to genera of gilled fungi), a key to orders of the Gasteromycetes, as well as a few illustrations and the 15 coloured plates. The book concludes with a reasonable glossary and index.

The overview provided above presents a book that seems to contain most of the topics sought after in a publication of this type. A more critical look, however, reveals several features of considerable concern.

The publisher's note at the opening of the book acknowledges that a number of fungi have undergone taxonomic revision since the first edition in 1982. There seems to have been no attempt to accommodate these changes in the revised edition of 1994. In fact, no editorial changes seem to have been made at all in the revised edition. This may be a result of adhering to Stevenson's conservative line of classification, expressed in Chapter 9. Although some explanation of the author's choice of classification is welcomed, the divisive discussion dealing with this issue could well have been expressed through a more appropriate forum.

The use of a wide left margin to comment on points of classification, and for specific referencing, is to be commended. However, the overall referencing style lacks consistency and informative detail.

A lack of attention to grammar and sentence structure is reflected in a somewhat clumsy style of writing, and results in a loss of clarity in the text. This lack of attention to editorial detail is also exemplified in the entry for *Gomphus*, where Stevenson acknowledges that 'two new species have been described recently by Dr Barbara Segedin in Auckland Fig. 14.1'. No reference is given as to where to find these descriptions; no illustration of *Gomphus* appears in Fig. 14.1, which illustrates *Podoserpula pusio*, *Schizophyllum commune*, *Stereum hirsutum* and *S. pur-*

pureum; and both *Podoserpula* and *Schizophyllum* are misspelt!

The colour plates are a welcome addition to the revised edition and, although half of those presented are very small, the quality allows recognition of the main diagnostic features. Once again, however, the editorial standard could be improved. The colour plate of *Morchella conica* is not supported by a description in the text, and does not appear in the index.

A redeeming feature of this publication is the numerous descriptions of both genera and species. It is unfortunate that here too there are issues of concern. For the large and important genus *Cortinarius*, it is acknowledged by Stevenson that 'the majority of species are mycorrhizal and seem to be specific to one species of tree', and 'in the *Nothofagus* forests they abound', and yet no species of *Cortinarius* gets a mention anywhere in the book. A coloured plate depicting an unidentified species of *Cortinarius* was selected to represent the genus.

To conclude, expectations of an improvement in quality in the revised edition of this book have certainly not been fulfilled. If a reliable, modern field guide is what you're looking for, *New Zealand Fungi: an illustrated guide* is regrettably a publication that should be overlooked by discerning field naturalists in Australasia.

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Some Records of the Fungus Blackfellows' Bread *Polyporus mylittae*

Travelling along the Grand Ridge Road through the Eastern Strzeleckis in May 1970, I stopped to take a look at a freshly-cleared area, clear-felled, behind the cathedral arches of the tall Mountain Ash that fringed the roadside. It was a scene of desolation, the southern hill slope was devastated save for a small group of enormous old trees that the bulldozer wouldn't tackle. They stood forlornly open to the four winds. The good earth had been torn to pieces, bashed and pounded and left in deep holes and humps. There had been some rain since the felling, and on any bruised but unbroken stretch of this moonscape a crop of big white mushrooms, each one solitary, gilled and tough, had appeared. I knew them for the fruiting bodies of Blackfellows' Bread and a little delving in the soil confirmed this. Evidently the disturbance of the soil, or the removal of the overhead cover, combined with the overnight rain had induced all this fungus to fruit.

On a long-cleared and grassed-down farm at Nerrena, in the autumn of 1968 the farmer began to cultivate a paddock that had not been broken for a generation. The plough turned up dozens of large sclerotia, many in the soft, fresh stage when they resemble coarse sponge or honeycomb. In the hard stage this polypore is shiny and hard like a lump of horn. In another instance, a nurseryman at Leongatha North moved onto a bush block and began to clear an area for an orchard. He too turned up many big hard sclerotia which makes me think that in our high rainfall part of Victoria at least, this fungus must be quite plentiful under forested or long-untilled earth. It would not be noticed unless it fruited.

Questioning the edibility of this fungus I once asked an Aboriginal man from the Western District if the native peoples really had used it as a food item. His reply, 'My word yes! When we could get it fresh', makes me wish to try it myself.

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The *Cordyceps* Update

Well, another Cordy season is just about over – and just as well, too, seeing as how I've foolishly become a student again and this year's 'peak' coincided nicely with semester one's assignments! I keep thinking 'this year there won't be many – surely they've wiped out the caterpillars by now'. And each year, for the last five years, up they've come!

For those rapidly reaching the conclusion that we have here a raving lunatic, you are most probably right, but what I'm raving about is the common vegetable caterpillar fungus, *Cordyceps gunnii* (Figs. 1, 2).

Cordyceps is a genus of some 300 species, the large majority of which are predators of various arthropods, mostly insects, during the 'sexual' phase of their life cycle. They are represented worldwide in temperate and particularly tropical environments, with several species known in Victoria, of which *C. gunnii* is probably the most common. I was delighted to see the inclusion of this and *C. hawkesii* as target species in the updated fungimap project. My observations and records suggest this species will be found over a wide range of habitats, usually in the 'wet' season. At my place, outside Healesville, they are in evidence from March to July (sometimes a bit earlier and/or later), although no individual specimen lives that long.

You will remember that I described these bizarre organisms as predators, rather than as parasites, their usual description. Consider the probable lifecycle of *C. gunnii*. Their spores in the soil encounter the cuticle of either one species or a few related species of ground living 'goat-moth' caterpillars (family Hepialidae). They 'recognise' this as a place to grow, and germinate, producing an array of enzymes and using mechanical action to penetrate into the larval haemocoel (the sloppy insides of an insect). If successful, the fungus then reproduces asexually, attempting to avoid the insects' fairly primitive immune response. There may or may not be a 'wait period' involved here, depending on exactly when the caterpillars are first penetrated. The fungus only appears to be active in 'full-sized' caterpillars, but I have no idea as to whether they are only attacked late in their life cycle (perhaps as they prepare their burrows for pupation and eventual exit), or earlier. The latter seems to imply a wait and also a trigger to activate the fungus, which could be the hormonal surges associated with pupation. The fungal mass eventually completely fills the haemocoel – in effect, the entire body of the caterpillar is consumed and becomes fungus (Fig. 3). Most other species of *Cordyceps* also consume the body of their victim in this manner. Thus, I suggest that these organisms be more correctly classified as predators.

Beginning late summer-early autumn, the fungus begins growing upwards through the caterpillars tunnel. They usually begin to appear above ground in numbers after the first good rains, but some appear, albeit usually small, even in drought conditions. There is a surprisingly large variation in both the life span and size of the fertile stroma – the dark olive to black, finger to

Fig. 1. *Cordyceps gunnii* Healesville, 1995. The specimen is approximately 60 mm high and 10 mm in diameter.

Fig. 2. *Cordyceps gunnii* Healesville, 1996. A 'double-header'.

Fig. 3. *Cordyceps gunnii* Healesville, 1996. The 'double-header' exhumed, clearly showing the caterpillar's remains.

club shaped part of the fungus we actually see. Some last for only a week or two, others for several months. Some may reach 15 mm, others 150 mm, though most are around 50 mm high by 10–15 mm wide, and are generally smaller when it is drier.

Unlike some of the other local species, for example *C. robertsii* and *C. taylori*, that produce stroma for several years from the same caterpillar, *C. gunnii* converts the caterpillar to as many spores as possible within a single season, probably using one of several strategies. These range from the tortoise – long life, slow spore production, to the hare – short life, fast spore production. After a period of fine weather, some specimens can be found with a cotton wool covering of millions of spores, which will all be 'gone' after the first rain – into the soil, to await the arrival of the next generation of unfortunate insects. For the past five years, roughly half the caterpillars in my study area have become such unfortunates.

Sometimes more than one stroma can be observed growing from a single caterpillar. Fungi can have some complex mating systems, and it may be that such 'multiple-headers' represent the end result of incompatible mating types 'fighting' for their share of the caterpillar – intraspecific competition at very close quarters! Some preliminary DNA analyses were 'suggestive', but unfortunately my technique did not prove equal to a final resolution at that time. I hope to complete this study with a specialist in this area at a future date.

All parts of the fungus except the fertile layer of the stroma are eventually attacked by the larvae of fungus gnats and an assortment of other tiny arthropods. The stroma may break off the stipe, or be scratched out by an assortment of mammals and birds. The fertile layer will keep producing spores regardless, until it has exhausted its food supply, or becomes food itself for other fungi. The soil around here must be saturated with spores – it's amazing any caterpillars escape!

Entomopathogenic fungi have not been seriously investigated in mainland Australia. Nor have there been many long-term ecological or population studies of any fungi. The same can be said for a number of other phyla, let alone genera and species. It took me a long time to realise that a good place to look was in your own yard and I'm not even going to be able to work out the entire life cycle of just this one fungus. There's plenty to do!

Cheers, Rod.

P.S. I've accumulated a fair amount of literature on entomopathogenic fungi, particularly *Cordyceps*, and may be able to help others in this area. The best publication in English is Samson, Robert A., Evans, Harry C. and Latge, J. P., *Atlas of entomopathogenic fungi*, Berlin: Springer-Verlag, 1988.

Glossary

entomopathogenic – organisms that cause disease in insects; in this case, fungi but they are also attacked by bacteria and viruses.

haemocoel – fluid-filled body cavity of an insect.

stroma – the fertile or spore-producing part of a fungus, usually a 'mushroom' or 'toadstool', in this case a 'club'.

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The Field Naturalists Club of Victoria Inc.

Reg No A0033611X

Established 1880

In which is incorporated the Microscopical Society of Victoria

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

Membership is open to any person interested in natural history and includes beginners as well as experienced naturalists.

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Emperor: the Magnificent Penguin

by Pauline Reilly

Publisher: *Kangaroo Press (Simon & Schuster), Sydney 1998*
32 pp, paperback, RRP $9.95

'This is a story of outstanding endurance in the coldest, windiest, driest place in the world.' So begins Pauline Reilly's book 'Emperor: the Magnificent Penguin', an account of the lives of Emperor Penguins *Aptenodytes forsteri* in Antarctica. Living and breeding in these conditions, Emperor Penguins appear to have a woeful existence until one becomes aware of some of the adaptations acquired through 55 million years of evolution (the estimated age of the earliest fossil penguin). Emperor penguins standing on ice with young sitting on their feet are one of the most durable of Antarctic images and indicative of the sorts of intriguing physiological and behavioural adaptations to environmental extremes which are a part of Emperor Penguins' lives. At first glance much of what these birds are capable of doing appears to be more science fiction than fact. They can fast for five months, dive to depths of 400 metres, survive temperatures of minus sixty degrees Centigrade, raise young in the darkness of the Antarctic winter and travel up to 200 kilometres across ice to their breeding colonies. The author weaves these feats into the annual cycle of 'Emperor', the focal male of this account as he and his mate successfully rear an offspring. The acknowledgement of Drs Barbara Wienecke and Roger Kirkwood in the text (two of the world's leading authorities on this species) is testimony to the factual authenticity of the account.

The book is well written in a style aimed at a wide section of the community with a benign level of information and complexity. There are colour photographs on every page and these provide a spectacular complement to the narrative. Some of the photographs are particularly compelling: 'Moonlight in winter' (by D. Murphy), 'A small huddle', and 'A thriving colony' the centrepiece (by G. Robertson) and another, erroneously captioned, 'Moonlight in winter' (by R. Kirkwood) beautifully depict aspects of the lives and habitats of the penguins. The map of Antarctica on page six is not particularly useful and is, in my opinion, a missed opportunity to give some indication of where 'Emperor' breeds and feeds. It would also have been helpful to include a map of known breeding colonies and perhaps plots of where individual penguins have been tracked by satellites on their foraging trips.

The author of this book is an interesting story in herself and well-qualified to write about penguins. Born in Adelaide, she worked as a secretary until the outbreak of World War II and then as a censor before going to Army intelligence and finally in anti-aircraft duties. After raising a family she commenced ornithological studies and, over a 40 year period, has achieved an impressive list of honours and publications. She was the first female President and first female elected fellow of the Royal Australasian Ornithologists Union (now Birds Australia), has been to Macquarie Island twice and carried out research studies of both Little *Eudyptula minor* and Gentoo *Pygoscelis papua* Penguins. Her study of Little Penguins on Phillip Island began in 1968 and continues today under the co-ordination of the Penguin Study Group. It has become one of the longest running studies of a bird in Australia.

I think 'Emperor: the Magnificent Penguin' will open the eyes of many people to this beautiful bird and its remarkable adaptations at a time when its future may be determined by processes resulting from our activities such as global warming and the exploitation of marine resources. It is an interesting and attractive production that should appeal to readers of all ages and interests.

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The

Victorian Naturalist

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Editor: Merilyn Grey

Index to Volume 115, 1998 is in the centre of this issue

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Cover: Miss Jean Galbraith (1906-1999), in later years. Jean's book, *Garden in a Valley*, republished in 1985, is on her lap. (See Tribute on page 73.) Photo kindly supplied by Ian Hyndman, Beechworth.

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Patchiness of a Floral Resource: Flowering of Red Ironbark *Eucalyptus tricarpa* in a Box and Ironbark Forest

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Abstract

Red Ironbark *Eucalyptus tricarpa* is considered an important winter food resource for nectar-feeding birds which are a characteristic component of the fauna of Box and Ironbark forests. However, little is known of the flowering patterns of eucalypts within these forests. This study describes a 'snapshot' survey of flowering of Red Ironbark in a Box and Ironbark forest at a single point in time during the peak annual flowering period for this species. The flowering status of trees was assessed across several spatial scales; including individual trees (of different size classes), forest stands and geographic areas within the Rushworth, Redcastle and Costerfield State Forests, Victoria. Flowering showed high levels of heterogeneity, or patchiness, at each level and was recorded in only three of five geographic areas. In these areas, the percentage of trees observed flowering along transects ranged from 0-42%. There was a significant difference between size classes of trees, with more larger trees flowering than smaller trees. Flowering occurred in a greater proportion of trees with access to free-water (within 5 metres of a dam edge) than for those trees without access to free-water. In most box and ironbark forests, large, old trees have been replaced with many, relatively densely-packed, smaller trees and this shift in age structure, along with the apparent patchiness of flowering in these forests, may have important implications for the movements and ecology of nectar-feeding animals. (*The Victorian Naturalist* **116** (2), 1999, 48-53).

Introduction

Despite the dominance of eucalypts in the Australian environment, and the importance of many eucalypt species to nectar-feeding animals, relatively little is known of the flowering patterns of species within this genus. Our current knowledge of the reproductive biology and ecology of *Eucalyptus* spp. is based on a small number of species (House 1997). Studies of the flowering patterns and floral morphology of eucalypts have largely been confined to species used for timber, such as Mountain Ash *E. regnans* (e.g. Ashton 1975; Griffin 1980), and, occasionally, rare species have been studied (e.g. Fripp 1982; Sampson *et al.* 1989).

Nectar-feeding birds are thought to be important pollinators of many *Eucalyptus* species, and in turn, the trees provide nectar for birds (Paton and Ford 1977; Ford *et al.* 1979; Hopper and Burbidge 1982). Flowering also attracts invertebrates, providing a secondary source of food. The distribution of nectar-feeding birds is often patchy, and their abundance within an area may change greatly through time (e.g. Keast 1968; MacNally and McGoldrick 1997). There is some contention concerning the extent to which the distribution of nectar-feeding birds results from their movements to track floral resources, or whether other factors contribute to the observed distributions (Ford 1979; Collins and Briffa 1982; Paton 1985; MacNally and McGoldrick 1997; *cf.* Pyke 1983). A better understanding of the ways in which nectar-feeding birds respond to the distribution of resources may come from a better understanding of spatial variation in flowering patterns.

The distribution of box and ironbark forests is defined by altitude, geology and climate (Muir *et al.* 1995; Environment Conservation Council 1997). In Victoria, these dry forests and woodlands encompass the inland hills of the Great Dividing Range and the Northern Plains (Environment Conservation Council 1997). Here we refer primarily to forests on the inland hills of the Great Dividing Range. These forests have undergone major changes due to clearing, logging and mining, resulting in a fragmented forest system that now covers approximately 15% of its former area (Robinson 1993). Exploitation of natural resources over many years, such as logging for fence posts and firewood, has lead to a change of age structure within these forests in that older, large, widely-spaced trees have been replaced by younger and relatively dense stands of smaller trees (Newman 1961; Environment Conservation Council 1997). Several authors have speculated that large trees may be a particularly important source of nectar for birds (Traill 1995; Webster and Menkhorst 1992). However, the relationship between tree size and flowering has not been quantified for

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eucalypts in these forests.

Muir *et al.* (1995) record 29 species of *Eucalyptus* in box and ironbark forests of the inland hills in Victoria, with Red Ironbark *E. tricarpa*, Mugga Ironbark *E. sideroxylon*, Grey Box *E. microcarpa*, Yellow Gum *E. leucoxylon* and Red Box *E. polyanthemos* being dominant. The Ironbarks *E. tricarpa* and *E. sideroxylon* (previously subspecies) are geographically separated with *E. tricarpa* occurring in central Victoria while *E. sideroxylon* occurs mostly in inland New South Wales (Costermans 1994). The diversity of eucalypt species within these forests is believed to be important in providing a year-round source of nectar for a suite of nectar-feeding birds, some of which are resident, some nomadic, and others migratory (Environment Conservation Council 1997). Common nectar-feeding birds in these forests include the Fuscous Honeyeater *Lichenostomus fuscus*, Yellow-tufted Honeyeater *L. melanops*, Black-chinned Honeyeater *Melithreptus gularis*, Musk Lorikeet *Glossopsitta concinna*, Little Lorikeet *G. pusilla*, Purple-crowned Lorikeet *G. porphyrocephala*, Red Wattlebird *Anthochaera carunculata* and Noisy Friarbird *Philemon corniculatus*. At times, these species may occur in dense aggregations when trees are flowering heavily. *E. tricarpa*, in particular, is an important winter food source for many birds (MacNally and MacGoldrick 1997). This includes threatened species such as the Swift Parrot *Lathamus discolor*, which arrives from Tasmania to overwinter in these forests.

This study describes a 'snapshot' survey of flowering of *E. tricarpa* in a Box and Ironbark forest in July 1997, during a peak flowering period for this species (Goodman 1973). The aim was to provide an initial description of the extent of spatial variation in flowering of *E. tricarpa* trees in a forest by sampling across several spatial scales: individual trees (including different size-classes of trees), forest stands, and geographic areas within a forest block. The survey also examined whether trees with ready access to water flower more intensely and in greater frequency than those with limited access to water.

Study Area

Rushworth, Redcastle and Costerfield State Forests are a contiguous area of box and ironbark forest in central Victoria, covering approximately 25,000 hectares, in an area between the towns of Rushworth, Heathcote and Nagambie (here, 'Rushworth Forest' is used to jointly refer to these three State Forests). These forests lie between latitudes 37°35' to 37°52'S and 144°45' to 145°10'E. Rushworth Forest, like much of the box and ironbark ecosystem, is characterised by open-forest on soils which have low fertility and poor water holding capacity (Environment Conservation Council 1997) with a mean annual rainfall of around 430 mm in the north to 560 mm in the south of the forest (Land Conservation Council 1978). *Eucalyptus tricarpa* and *E. microcarpa* dominate much of the forest, over an open shrubby understorey, generally including Golden Wattle *Acacia pycnantha*, Twiggy Bush-pea *Pultenaea largiflorens*, and Shiny Everlasting *Bracteantha viscosum* (Muir *et al.* 1995). The ground layer is sparse, with common species including Black-anther Flax-lily *Dianella revoluta*, Bristly Wallaby-grass *Danthonia setacea*, and Spiky Guinea-flower *Hibbertia exutacies* (Muir *et al.* 1995). The forest is managed primarily for the production of firewood, railway sleepers and fence posts, but also for honey production, gold mining and the production of eucalyptus oil. Around 10% of the forest is managed as historic or conservation reserves (Environment Conservation Council 1997).

Methods

The survey was carried out in July 1997, at the apparent peak flowering time of *E. tricarpa* in Rushworth Forest. The forest was divided into five areas of approximately equal size (about 5000 ha): 'north', north-east', 'central', 'south' and 'south west'. In each area, stands of trees dominated by *E. tricarpa* were mapped by driving along major roads and within these mapped areas, starting points of 25 transects (5 in each geographic area) were randomly selected. From each starting point a 400 m transect was surveyed by walking along a compass bearing approximately perpendicular to the road and the size class and flowering intensity of all *E. tricarpa* trees within 5 m on either side of the transect line were recorded. Due to the random nature of selecting the transects, there may have been greater distances between transects within geographic areas than between 'edge' transects in adjacent geographic areas.

Size classes of trees were based on the diameter at breast height (DBH) as follows: very small, 5 to <20 cm; small, 20 – <40 cm; medium, 40 – <60 cm; large 60 + cm. Flowering intensity was estimated on the basis of the area of foliage covered by fresh flowers (staminodes bright and 'fluffy'). The categories were:

0 no flowers,
0.5 1 flower to 5% foliage cover,
1 5 – 10%,
2 10 – 20%,
3 20 – 30%,
4 30 – 40%,
5 40 – 50%,
6 50 – 60%.

In addition, the size class and flowering intensity for every *E. tricarpa* tree within 5 metres of the edge of a dam were recorded for two dams within each geographic area. These dams were selected opportunistically.

Results

Individual trees

A total of 2040 *E. tricarpa* trees was recorded from the 25 transects surveyed in Rushworth Forest (Table 1). Over 90% of trees were less than 40 cm DBH, while the overall average tree density was 204 stems/ha.

Across all transects in the forest, 6.7% (137/2040) of *E. tricarpa* trees were flowering. Fig. 1 shows the percentage of trees in each size class that were flowering compared with the percentage of trees present in all transects. There was a highly significant difference between size classes, whereby a greater proportion of larger trees were flowering than smaller trees (χ^2 = 48.75, df = 3, p < 0.0005). However, for those trees that were flowering, there was no significant difference in flowering intensity between size classes (ANOVA F 2.67, df 3, p 0.29).

Transects

Of the twenty five transects, 13 contained trees that were flowering while 12 had no trees flowering. In those transects with flowering, the percentage of trees flowering ranged from 1.2% – 42.2% (Fig. 2) and in each geographic area in which flowering was recorded, there was a significant difference between transects in the proportions of trees flowering (χ^2 tests, df = 4, p < .001).

Geographic areas within the forest

Trees were recorded flowering only in the 'north', 'north-east' and 'central' areas within Rushworth Forest. When all five areas were compared there was a significant difference in the overall proportions of trees flowering in each area (χ^2 = 99.8, df = 4, p < 0.0005) but when comparing only the three geographic areas where flowering was recorded the proportions did not differ (χ^2 = 3.34, df = 2, p > 0.15).

Trees associated with dams

One hundred and thirty six *E. tricarpa* trees growing within 5 metres of a dam edge were sampled and, of these, 59% (81/137) were flowering. This was a sig-

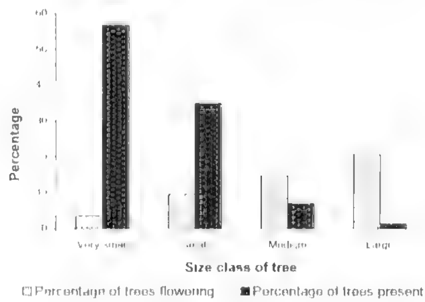

Fig. 1. The percentage of *E. tricarpa* trees in each size class that were flowering compared with the percentage of trees recorded for all transects over Rushworth Forest.

Table 1. The number and percentage of *E. tricarpa* trees in each size class for five geographic areas in Rushworth Forest.

Geographic area	Tree size class (DBH) Very small <20 cm		Small >20 – 40 cm		Medium >40 – 60 cm		Large 60+ cm		Total	
	n	%	n	%	n	%	n	%	n	%
North	199	*50*	156	*40*	31	*8*	7	*2*	393	19.2
North-east	263	*60*	142	*33*	28	*6*	3	*1*	436	21.4
Central	219	*53*	161	*39*	29	*7*	3	*1*	412	20.2
South	292	*61*	129	*27*	43	*9*	15	*3*	479	23.5
South-west	184	*58*	123	*38*	12	*3.7*	1	*0.3*	320	15.7
Total	**1157**	*(57)*	**711**	**(35)**	**143**	**(7)**	**29**	**(1)**	**2040**	***100***

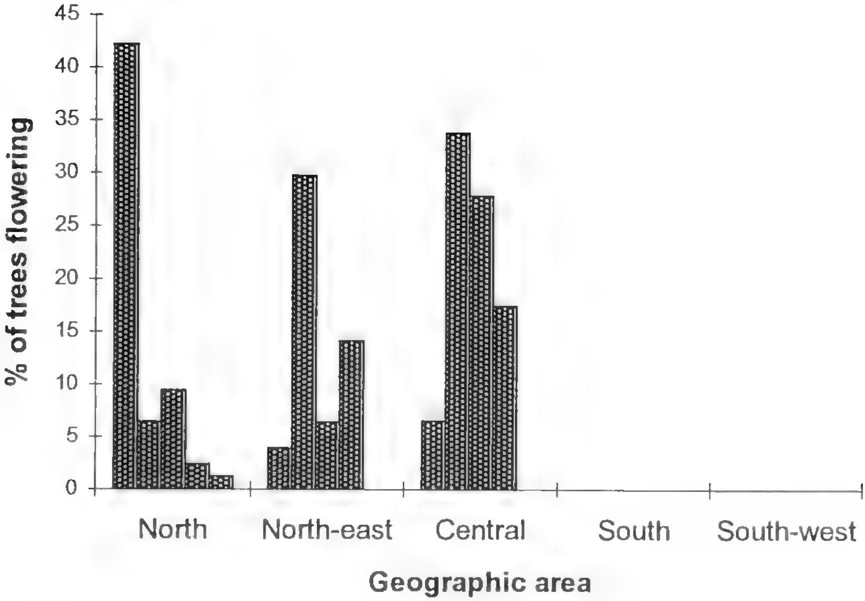

Fig. 2. The percentage of *E. tricarpa* trees in each transect that were flowering in each geographic area within Rushworth Forest.

Table 2. The number of trees and the percentage of *E. tricarpa* trees recorded flowering within 5 m of a dam edge, and from forest transects, for each of five geographic areas within Rushworth Forest. Key: No., total number of trees; %, percentage of trees flowering.

Area	Dams		Transects	
	No.	%	No.	%
North	64	62.5	393	10.9
North East	21	61.9	436	9.2
Central	20	52.3	412	13.1
South	20	40.0	479	0
South West	11	0	320	0

nificantly greater proportion than for trees sampled along forest transects ($\chi^2 = 360$, df = 1, $p < 0.0005$). In each area a greater proportion of trees around dams were flowering than trees on transects (Table 2). In the 'south-west', no flowering was recorded for trees on transects or at dams, while in the 'south' no trees on transects were recorded flowering, but one dam had trees flowering nearby.

When a comparison was made between the size classes of trees on dam edges and those on transects, a significant difference was evident ($\chi^2 = 39.8$, df = 3, $p < 0.0005$), with fewer 'very small' trees and more larger trees associated with dams. However, when flowering was compared for trees of the same size class, the proportion of trees flowering was greater for trees associated with dams than for those sampled along forest transects ($\chi^2 = 413.5$, df = 1, $p < 0.0005$) (Table 3). The mean flowering intensity for flowering trees associated with dams and forest transects did not differ (t-test $p = 0.74$) (Table 3).

Discussion

This survey has revealed marked spatial variation, or patchiness, in the flowering of *E. tricarpa* in Rushworth Forest in central Victoria. During the peak flowering period for this species in 1997, flowering was widespread in three geographic areas in the northern parts of the forest but was not recorded in two areas in the south. In the areas where flowering was recorded, there was marked variation in the percentage of trees flowering along each transect, ranging from 0-42% of trees per transect. Finally, at the level of individual trees, there was significant variation between size classes of trees in the proportion that were flowering, with greater likelihood of flowering for larger trees (Fig. 1).

Table 3. Comparisons between *E. tricarpa* trees within 5m of a dam edge and trees on transects in Rushworth Forest in relation to numbers of trees, size class distributions, percentage of trees flowering and mean flower cover of flowering trees

Tree Size Class (DBH cm)	Number of trees		Percentage of trees in each size class:		Percentage of trees flowering		Mean flower cover (± 1 S.E.)	
	Dams	*Forest*	*Dams*	*Forest*	*Dams*	*Forest*	*Dams*	*Forest*
Very small (5 – <20)	46	1157	33.8	56.7	58.7	3.5	0.7 (0.1)	0.7 (0.1)
Small (20 – <40)	57	711	41.9	34.9	49.1	9.7	0.9 (0.1)	0.9 (0.1)
Medium (40 – < 60)	27	143	19.8	7.0	74.1	14.7	1.0 (0.2)	1.05 (0.1)
Large (60+)	6	29	4.4	1.4	100	20.7	1.0 (0.5)	1.0 (0.2)

Is a snapshot survey such as this study representative of the overall flowering pattern of a tree species? Could the absence of flowering be an artifact of a single sample in time, with flowering of certain trees occurring either later or earlier than the survey? Other evidence from the study area suggests that the patchiness shown in this snapshot survey is not an artifact but is typical of the flowering of this species. Regular monitoring of flowering at a number of other forest stands in the southern section of the forests showed an almost total absence of flowering of *E. tricarpa* throughout 1997 (J. Wilson, A. Bennett, *unpubl.*). Similarly, ongoing monitoring of the flowering of individual trees in this forest (J. Wilson, *unpubl.*) has also revealed significant differences in flowering in relation to tree size.

Variation in flowering between size classes of trees adds support to previous contentions that large trees are particularly important as sources of nectar for nectar-feeding birds (e.g. Webster and Menkhorst 1992; Traill 1995). Two factors appear to contribute to the importance of large trees. First, because a significantly greater proportion of large trees flower than small trees (Fig. 1), forest stands with large trees are likely to be a more reliable source of nectar from year to year. Second, although no significant difference in intensity of flowering was evident (measured as % foliage cover), large trees have a greater area of canopy foliage than smaller trees and will, for the same flowering intensity, support a larger number of flowers per tree. For example, Ashton (1975) reported that mature *E. regnan* trees produced between 1.6-15.5 times as many flowers as small trees ('pole' and 'spar' stages).

A significant difference between trees close to dams and those along forest transects in the proportion of trees flowering (Table 3) suggests that availability of moisture may be an important influence on the initiation of flowering for this species. Water deficits can cause inhibited growth at all stages of tree reproduction (Kozlowski 1982). Better knowledge of the factors that determine the initiation, timing and frequency of tree flowering is central to developing an understanding of the potential availability of nectar resources for birds in these forests. It is likely that flowering is influenced by genetic attributes and also by environmental features such as soil types, access to moisture, tree health and conditions in previous years (Florence 1964; Ashton 1975; Bolotin 1975; Porter 1978; Griffin 1980; Potts and Wiltshire 1997). Porter (1978) reported that temperatures and rainfall in the two to five years before flowering influenced tree growth and honey production of *E. tricarpa* (reported as *E. sideroxylon*), and that a wet winter two years prior to flowering encourages the initiation of a large bud crop. Two years prior to this study (i.e. 1995), Heathcote, Rushworth and Nagambie all received higher than average rainfall over the winter months (Bureau of Meteorology 1998). However, in July 1997 flowering was not heavy or widespread, and variation in rainfall does not account for the geographic patchiness in flowering between different parts of the forest.

Box and Ironbark forests in Victoria have experienced profound changes in the past 200 years of settlement with obvious impacts being the clearing of the majority of the ecosystem and the degradation of most remaining forest fragments (Environment Conservation Council 1997). Although historical data are sparse, available evidence indicates that there has been substantial change in forest structure and tree density (Newman 1961; Environment Conservation Council 1997). The effects of altered forest structure on the availability of suitable hollow-bearing trees for birds and mammals that are obligate hollow-users has received some attention (Meredith 1984; Traill 1991; Bennett 1993). However, the present results suggest that forest structure also has implications for the presence and abundance of nectar as a resource for nectar-feeding animals. Many birds and mammals, including threatened and migratory species, are dependent on eucalypt nectar in box and ironbark forests. This study has obvious implications for wildlife conservation and forest management. Spatial and temporal patterns in flowering of eucalypt species in box and ironbark forests, and processes influencing these patterns, are being investigated further in ongoing studies.

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Effect of a Flood Retarding Basin Culvert on Movements by Platypus *Ornithorhynchus anatinus*

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Abstract

Live-trapping and radio-tracking methods were used to investigate the movements of Platypus *Ornithorhynchus anatinus* through a sizeable concrete culvert (45 metres long), which was built under a soil embankment as part of a flood mitigation system in Melbourne's southeastern suburbs. Five adult or subadult males were recorded crossing the embankment, demonstrating that the culvert does not constitute a barrier to movements by the animals. However, available evidence suggests that Platypus may avoid entering the culvert when engaged in routine foraging, presumably because there is little or no prospect of obtaining food (in the form of aquatic invertebrates) along its length. (*The Victorian Naturalist* **116** (2), 1999, 54-57)

Introduction

By definition, streams and rivers are long and thin. As natural corridors, they serve to facilitate travel, both routine and occasional, by a wide variety of species (Bennett 1990). Creating barriers along linear waterways may be correspondingly detrimental insofar as natural patterns of dispersal or migration are restricted (Koehn and O'Connor 1990) or populations become separated into smaller units that are more vulnerable to local extinction than would otherwise be the case (Shaffer 1981).

Concrete culverts are one of the commonest types of man-made structures found along waterways. We report here on the results of mark-recapture and radio-tracking studies undertaken to assess the potential of a relatively long culvert, built as part of a flood mitigation system, to act as a barrier to Platypus *Ornithorhynchus anatinus*.

The Study Area

Monbulk Creek is a perennial waterway rising on the forested slopes of Dandenong Ranges National Park in the Dandenong Creek catchment. Once outside the park, it flows for about 15 kilometres through public reserves, horse and cattle paddocks, market gardens, and tracts of residential housing before merging with Ferny Creek to form Corhanwarrabul Creek. To reduce the risk of floods occurring along the lower reaches of Monbulk Creek, a flood retarding (or retention) basin was built about 9 kilometres upstream of the Ferny Creek confluence in 1980. The basin includes two lakes which are sufficiently large to hold much of the extra water generated by normal storm run-off. If the capacity of the lakes is surpassed after extremely high rainfall, surplus water is contained by a large grassy embankment located immediately downstream. In both dry weather and after storms, water flowing along the Monbulk Creek channel is conveyed through the embankment by means of a concrete culvert, circular in cross-section, measuring 45 metres in length and 1.35 metres in internal diameter (grade = 1 in 87.5 or 1.1%). Except in the wake of major rainfall, the depth of water flowing through the culvert is typically less than 25 centimetres (Fig. 1).

Methods

Seventeen trapping sites for Platypus were established along Monbulk Creek between Dandenong Ranges National Park and the Ferny Creek confluence, at sites located both upstream and downstream of the retarding basin embankment. The animals were captured in fyke (or eel) nets, set with the length of each net partly suspended out of the water (Serena 1994). Nets were set in pairs in the afternoon, with one net facing upstream and the other facing downstream, and checked throughout the night. Captured Platypus were held in dry calico bags until they could be released at the exact point of capture. Each Platypus was permanently identified with a Trovan transponder tag (Grant and Whittington 1991). Sex and age class were assigned according to spur characteristics,

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Fig. 1. Upstream end of the culvert conveying water from Monbulk Creek through the flood retarding basin embankment

which enabled juveniles (<1 year old) to be distinguished reliably from older animals. In the case of males, it was also possible to distinguish second-year animals (subadults) from mature individuals (Temple-Smith 1973).

To provide detailed information on the movements of animals living near the embankment culvert, radio-tags were fitted to two Platypus (an adult male and a juvenile female) captured within 0.3 kilometres of the culvert on the evening of 16 May 1997. Briefly, fast-setting epoxy resin was used to attach a miniature radio-tag (Biotrack TW-4 transmitter) to the outer guard fur of the rump (Serena 1994). Diurnal searches for radio-tags were undertaken each day, with burrow locations marked on the bank. Activity was monitored at night by standing near the bank and flagging an animal's position at 5-10 minute intervals, using a TRX-1000S receiver (manufactured by Wildlife Materials). Great care was taken not to alarm active animals, e.g. by ensuring that torch beams were shielded at all times and by remaining still when a Platypus was at the surface.

Results

From February 1996 to November 1998, 24 adult or subadult Platypus were captured on two or more occasions in the Monbulk Creek study area. Thirteen animals (five males and eight females) were recorded only at sites upstream of the flood retarding basin embankment, while six animals (five males and one female) were recorded only downstream of the embankment. The remaining five Platypus (all males) were encountered at sites located both upstream and downstream of the embankment culvert. The locations where these five animals were captured are described in Figure 2 and below:

Male A. Given that Platypus eggs are believed to hatch from September to November in Victoria (Griffiths 1978), A was estimated to be 15-17 months old when first captured as a subadult at Birds Land Reserve in Belgrave (about 2 km upstream of the culvert) in February 1996. He was subsequently encountered in Rowville (at Karoo Road, about 8.5 km downstream of the culvert) in June 1997, and then again in Belgrave (at Mount Morton Road, about 3 km upstream of the culvert) in February 1998.

Male B. B was first captured as a subadult at Birds Land Reserve in January 1997, at the age of 14-16 months. He was next recorded at Karoo Road in June 1997, followed by a site located along Corhanwarrabul Creek in Rowville/Scoresby (about 11 km downstream of the basin embankment) in November 1997, and at Blackwood Park Road (about 4.6 km downstream of the culvert) in September 1998.

Male C. C was first captured as a mature adult in March 1996, at a site located about 3 km downstream of the flood retarding basin. In May 1997, he was recaptured about 0.3 km upstream of the embankment culvert. After being radio-tagged and released, he travelled downstream through the culvert to occupy a burrow near Lysterfield Road (3.3 km downstream of the retarding basin) by early the following morning. C was located in burrows on 30 of the next 34 days and tracked for 7 hours while active in the water. Throughout this time he invariably was found downstream of the retarding basin, although on one occasion he moved to within 50 metres of the embankment before turning around and travelling back the way he had come. C was again captured at a trapping site located about 3 km

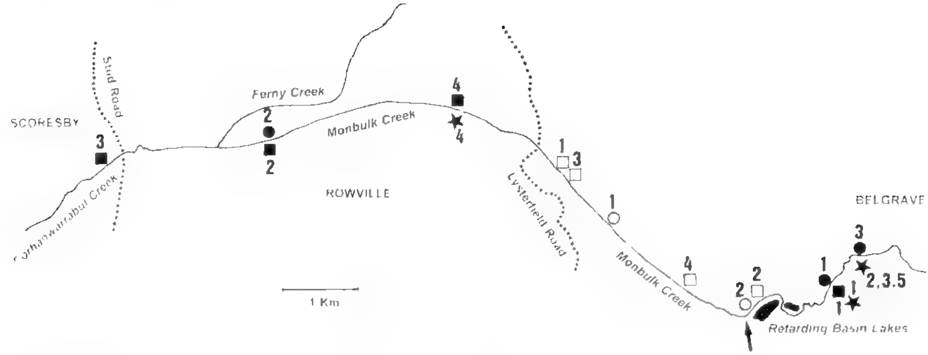

Fig. 2. Locations where male Platypus were captured in fyke nets upstream and downstream of the retarding basin culvert (Melway Map 83, J2). The dates when animals were captured are in brackets. Closed circles, male A (1=02/96, 2=06/97, 3=02/98); closed squares, male B (1=01/97, 2=06/97, 3=11/97, 4=09/98); open squares, male C (1=03/96, 2=05/97, 3=01/98, 4=09/98); open circles, male D (1=03/97, 2=02/98); stars, male E (1=01/97, 2=05/97, 3=09/97, 4=08/98, 5=11/98). The dark arrow marks the location of the upstream end of the culvert.

downstream of the retarding basin in January 1998, and at a site located about 1 km downstream of the retarding basin in September 1998.

Male D. D was first captured as an adult in March 1997, at a site located about 2 km downstream of the retarding basin. He was next encountered about 0.1 km upstream of the embankment culvert in February 1998.

Male E. E was first encountered as an adult in January 1997, upstream of the retarding basin in Birds Land Reserve. He was subsequently captured at Mount Morton Road in May 1997 and September 1997, at Blackwood Park Road in August 1998, and again at Mount Morton Road in November 1998.

While the observations summarised above clearly demonstrate that the culvert through the flood retarding basin embankment does not constitute a barrier to Platypus travelling along the length of the creek, there is some evidence to suggest that the animals may tend to avoid entering the culvert in the course of routine foraging:

(1) No Platypus were captured at a trapping site located 20 metres downstream of the culvert in five nights of surveys undertaken over a 17 month period. In contrast, at least one Platypus was trapped at each of the 16 other survey sites established along Monbulk Creek in the same period (sampled for 2-7 nights), with one or more animals captured on 46 of the 73 occasions that nets were set at these locations (63% trapping success rate). Based on this figure, and assuming that the animals use the area as frequently as other parts of the creek, the probability of not encountering Platypus at the culvert site in five nights of survey work is less than 0.7%.

(2) As described previously, there was no evidence that male C travelled through the embankment culvert in the five weeks following the night he was radio-tagged. Similarly, after being captured and released 0.2 km upstream of the embankment, female E was not found downstream of the culvert in the 50 days that her radio-tag was functional, although she spent 3.5 hours (of the 22 hours she was tracked while active) feeding within 0.1 km of the culvert entrance. As well, E occupied burrows located within 0.1 km of the culvert on 30 of the 49 days she was located diurnally, with her most downstream burrow (occupied on 7 days) located just 25 metres from the entrance.

Discussion

Despite its substantial length, the culvert through the Monbulk Creek flood retarding basin embankment clearly does not prevent Platypus from travelling in either the upstream or downstream direction. One-third (5/15) of the adult and subadult males in this study are known to have crossed the embankment on one or more occasions, in the course of travelling up to 11 kilometres from the retarding basin.

At the same time, evidence from this study suggests that Platypus may avoid using the culvert when engaged in routine foraging, presumably because there is little or no prospect of obtaining food along the tunnel in the form of aquatic invertebrates (Faragher *et al.* 1979, Grant 1982).

When Platypus are not in the water, they are generally found resting in underground burrows (Grant *et al.* 1992, Serena 1994, Gardner and Serena 1995, Gust and Handasyde 1995, Serena *et al.* 1998). It is therefore not surprising that the animals will enter man-made culverts and pipes, although more work is needed to identify specific conditions which may limit their use by Platypus. In particular, we believe that the following factors merit consideration:

Minimum diameter. Platypus have been known to enter pipes with a diameter of 10 centimetres, although some circumstantial evidence suggests that the animals may not be able to exit from (i.e. back up or turn around in) such a narrow space if it becomes blocked at one end (Taylor *et al.* 1991).

Maximum length. We are unaware of any accounts of Platypus utilising longer culverts than the one described in this report. (Additional information would be extremely welcome in this regard.)

Water flow rate. Platypus will walk across dry land to reach favoured feeding sites (Taylor *et al.* 1991, pers. obs.) and so presumably will travel through dry pipes connecting aquatic habitats. At the other extreme, very strong flows through relatively constricted pipes may well preclude (or at least discourage) travel by Platypus, particularly in the upstream direction (Tyson 1980).

Structural barriers. In Tasmania, Platypus have been killed by cars at stream crossings where a sharp vertical rise made it difficult for the animals to enter a culvert leading under the road (Tyson 1980). A vertical rise of as little as 20 centimetres from the water surface to a culvert lip can apparently preclude entry in the absence of materials (e.g. rocks or an adjoining gravel bank) which assist climbing into the culvert (Otley and le Mar 1998).

Disturbance (e.g. noise). Platypus have been observed to travel routinely under a dual-lane road carrying on average 2-7 vehicles per minute (Serena *et al.* 1998). The effect of more severe disturbance (e.g. from multi-lane freeways) on the animals' use of culverts remains to be assessed.

Acknowledgements

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Sperm Competition: a Marsupial Perspective

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Abstract

This paper examines the concept of sperm competition between males within a female oestrus period and the effects of this competition on male paternity success. The relationship between a species mating system and testes mass, epididymal sperm number and sperm length are discussed. The likelihood of sperm competition occurring in the marsupials is reviewed based upon available reproductive and behavioural data. The influence of copulatory behaviour, mate guarding, presence or absence of mating plugs and sperm transport and storage in the female tract, on the outcome of sperm competition events, are outlined for this group. (*The Victorian Naturalist* **116** (2), 1999, 58-64)

Introduction

The theory of resource competition and natural selection in vertebrates was originally proposed by Darwin in the 1800's and since that time has generated considerable interest among biologists. Much attention has been focussed on the significance of differential success in competition for resources (food, shelter and mates) and its effects on an animal's ability to contribute genes to the next generation. More recently, however, the debate has grown to include discussions of sperm competition and the factors that determine the amount of investment a male makes in sperm production and its relationship to mating strategies and siring success. Much of this theory was developed from studies of insects and birds with relatively few studies conducted in mammals (Birkhead 1995).

Sperm competition occurs when more than one male mates with a female within a single oestrus period (Parker 1970). This in turn leads to competition among the sperm of rival males to fertilise a female's eggs following ovulation, with Parker's theory predicting that the male inseminating the greatest number of spermatozoa will be most successful at fertilising a female's eggs and ultimately at siring progeny (Parker 1970). Morphological and behavioural correlates of sperm competition have been identified in both males and females which suggest that both sexes have evolved mechanisms which maximise their own reproductive fitness (Birkhead 1995).

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Morphological and Behavioural Correlates of Sperm Competition

In males, Parker (1970) suggests that the evolutionary result of such competition is that males have evolved larger testes relative to body mass, and produce greater numbers of spermatozoa. Evidence for this has been found in eutherian mammals and in many other vertebrate groups where there is a clear positive relationship between the testes mass of adults and body mass. For example, in primates, testes mass correlates with the number of sperm ejaculated both within and between species (Short 1979; Harcourt *et al.* 1981; Harvey and Harcourt 1984; Kenagy and Trombulak 1986). Over and above this relationship in primates, there are significant species differences in relative mass of the testes, with species that have relatively large testes generally occurring in multimale breeding groups. Within these groups a female is likely to mate with two or more males during a single oestrus period commonly resulting in sperm competition within the female reproductive tract. Conversely those species that occur in monogamous pairs or as single male breeding groups tend to have relatively smaller testes due to the unlikely occurrence of sperm competition and lower copulatory frequencies (Short 1979; Harcourt *et al.* 1981). In some species this has been taken a step further with animals having relatively large testes in relation to body mass found to produce ejaculates of high sperm counts, high sperm motility and a greater proportion of motile sperm (Møller 1988, 1989). Recently it has been claimed that not only relative numbers of sperm produced, but their relative size too, may relate to an animal's mating system (Gomendio and Roldan 1991).

Natural selection has also almost certainly favoured females that have some control over fertilisation (Birkhead and Moller 1993) and there is evidence of morphological correlates of sperm competition in the female. For instance, the length and complexity of the female reproductive tract has been associated with sperm colonisation rates and sperm competition (Birkhead and Møller 1993). Structures such as the cervix and utero-tubal junction in eutherian mammals act as selective barriers to sperm advancement up the reproductive tract (Hunter 1988). In addition, females of many invertebrate and a number of vertebrate species, store sperm in specialised structures before using them to fertilise their eggs (Birkhead and Møller 1992). In some species the number, design and size of these receptacles or the mode of sperm release from them have also been implicated in patterns of sperm precedence (Birkhead and Moller 1992).

A wide range of behavioural adaptations which help prevent competition by sperm from another male have also been identified (Birkhead 1995). These include the presence or absence of mating plugs, prolonged or frequent copulation and the instance and duration of mate guarding. In a similar manner females of some species have evolved lengthy periods of oestrus which increase the likelihood of multiple mating and would appear to actively promote sperm competition between males (Birkhead 1995).

The reproductive fitness of many species is therefore affected by the mechanisms which determine sperm competition success. Some of these will now be reviewed for the Marsupialia.

Studies In Marsupials

Testes Size, Sperm Number and Sperm Length

Until very recently, little information was available on sperm competition in any marsupial (Tyndale-Biscoe and Renfree 1987; Dickman 1993; Rose *et al.* 1997; Taggart *et al.* 1998). However, like eutherian mammals and other vertebrate groups, recent studies in marsupials have found that there is a positive relationship between body mass and testes mass (Rose *et al.* 1997; Taggart *et al.* 1998). Deviation from the expected testes mass relative to body mass can be used to predict the likelihood of sperm competition occurring. For example the Honey Possum *Tarsipes rostratus*, Feathertail Glider *Acrobates pygmaeus* and most macropods have large testes relative to body mass, thus suggesting that the likelihood of sperm competition occurring within these species is high. In contrast, the Mountain Pygmy Possum *Burramys parvus*, Sugar Glider *Petaurus breviceps*, wombats and Koala *Phascolarctos cinereus* have small testes relative to body mass. As might be expected, epididymal sperm counts for some of the representatives of the macropod lineage (e.g. the Western Grey Kangaroo *Macropus fuliginosus* and Red-necked Wallaby *Macropus rufogriseus*) with a large testes-body mass ratio are correspondingly high relative to body mass whilst epididymal sperm counts of the Southern Hairy-nosed Wombat *Lasiorhinus latifrons*, which has a low testes:body mass ratio, are likewise low relative to body mass (Taggart *et al.* 1998).

In contrast to the data for testes mass and sperm number, a negative relationship has been found between sperm tail length and body mass across all marsupial species. In species like the Honey Possum, which has the distinction of having the largest mammalian spermatozoa (Cummins and Woodall 1985), and the Dusky Antechinus *Antechinus swainsonii* for example, the value for sperm tail length relative to body mass is higher than would be expected for animals of that weight, thus supporting previous data which suggested that sperm competition may occur in these groups. In contrast the data for Petaurids indicates that sperm from this group are short relative to body mass, suggesting the existence of a monogamous type relationship in species within this group (Rose *et al.* 1997, Taggart *et al.* 1998).

As mentioned, a variety of behavioural and morphological factors also influence the outcome of sperm competition events. Comparisons of how testes mass, sperm number and sperm length compare with these other factors allows relatively accurate predictions to be made of the likelihood of sperm competition occurring within a particular species and the mating system employed. Some of these additional factors are considered below.

Copulatory Behaviour

With the exception of dasyurid and macropod marsupials few detailed observations have been made on copulatory behaviour in marsupials (Table 1). In dasyurids the length of copulation varies from 2-18 hrs depending upon the species (Table 1). In general, the semelparous dasyurid species, like the Agile Antechinus *Antechinus agilis* have the longest copulation (~7.7-18 hours). Lengthy copulations have also been reported in some didelphids (>6 hours). In contrast, the macropods mate for between 5-50 minutes, wombats for approximately 30 minutes, and other didelphids for 4-40 mins (Table 1). The shortest copulation (less than 30 seconds) has been reported for bandicoots (Table 1) (Taggart *et al.* 1998).

During detailed studies on copulatory behaviour in the Agile Antechinus (previously Brown Antechinus/Brown Marsupial Mouse *Antechinus stuartii*) (Shimmin 1996, 1998) it was found that the time at which males were given access to females within the oestrus period dramatically influenced the length of copulation. However, factors such as order of mating and delay between two rival males securing mating access had little effect on the duration of mating. Furthermore, mating behaviour varied significantly during the extended period of copulation. Males pursue females and tolerate high levels of female and subdominant male aggression whilst maintaining intromission and ensuring mating success. Females, however, can prevent male mating access in a similar manner to which they initiate the final dismount, through massive bouts of kicking and fighting. Subdominant males rarely force the dominant male to dismount (Shimmin 1998).

Amongst macropods the Tammar Wallaby *Macropus eugenii* has been the most extensively studied (Tyndale-Biscoe and Renfree 1987). Female tammars come into oestrus within hours of giving birth, whereas in the Swamp Wallaby *Wallabia bicolor* oestrus occurs 3 days before birth and in the Red Kangaroo *Macropus rufus* 2 days after birth. In some other macropod species it does not appear to be related to birth. In tammars, Whip-tailed Wallabies *Macropus parryi* and Red-necked Wallabies, females are vigorously pursued by the males within the group following birth and the initiation of oestrus. Intense inter-male aggression results from these mating chases and, in the tammar at least, results in delaying the time of the first successful ejaculation until 1-2 hrs post-partum (Rudd 1994). The first ejaculation is

Table 1. Maximum length of copulation in various marsupial species.

Marsupial Family	Species	Maximum Duration of Copulation
Dasyuridae (Semelparous)	Agile Antechinus *Antechinus agilis*	18.0 hrs
	Dusky Antechinus *Antechinus swainsonii*	9.5 hrs
	Yellow-footed Antechinus *Antechinus flavipes*	11.0 hrs
Dasyuridae (Iteroparous)	Fat-tailed Dunnart *Sminthopsis crassicaudata*	11 hrs
	Kowari *Dasyuroides byrnei*	3.0 hrs
	Stripe-faced Dunnart *Sminthopsis macroura*	2.5 hrs
	White-footed Dunnart *Sminthopsis leucopus*	1.8 hrs
Peramelidae	Long-nosed Bandicoot *Perameles nasuta*	<30 sec
Potoroidae	Long-nosed Potoroo *Potorous tridactylus*	2 min
Macropodidae	Eastern Grey Kangaroo *Macropus giganteus*	50 min
	Parma Wallaby *Macropus parma*	5 min
	Red Kangaroo *Macropus rufus*	15-20 min
	Red-necked Wallaby *Macropus rufogriseus*	8 min
	Tammar Wallaby *Macropus eugenii*	8 min
Vombatidae	Southern Hairy-nosed Wombat *Lasiorhinus latifrons*	30 min
Didelphidae	Grey Short-tailed Opossum *Monodelphis domestica*	4-40mins
	Mouse Opossum *Marmosa robinsoni*	>6hrs

Semelparous – all offspring produced at one time; Iteroparous – offspring produced in successive groups.

usually secured by the dominant (alpha) male, which is usually the largest male within the group. Bouts of thrusting activity are observed in the tammar throughout copulation with males ejaculating after each bout (although the components of each ejaculate are not known).

Mate Guarding

In antechinus, pelvic thrusting by the male during the extensive copulatory period is greatest early in the mount time and declines towards the end of copulation. This reduced activity in the later hours of copulation is consistent with contact mate guarding behaviour which has been reported for other vertebrate species. Mate guarding of this nature also assists in ensuring efficient sperm transport and storage, and therefore increases the likelihood of siring success (Shimmin *et al.* 1997).

In the Tammar Wallaby, the dominant male always copulates and ejaculates first (Jarman 1983), and subsequently guards the female from the advance of other males (by chasing, biting and kicking) for up to 8 hours. In macropods, subordinate male tammars, Red-necked Wallabies and Red Kangaroos that are not involved in mating, respond to the mating activity by the dominant male by biting and kicking the copulating male until he releases his hold on the female (Sharman and Calaby 1964; Johnson 1989; Rudd 1994). After the dominant male has finished guarding the female, some subordinate males may mate with her. In tammars and Red-necked Wallabies the dominant male has considerable mating advantages over subordinate males in terms of timing, and is probably the most reproductively successful. As ovulation does not occur until 40 hours after birth in the latter species, it is likely that the copulatory plug deposited by the dominant male plays a significant role in ensuring a high rate of paternity success (Tyndale-Biscoe and Rodger 1978).

In Long-nosed Bandicoots *Perameles nasuta*, males closely follow the females for several nights preceding copulation, and, although length of copulation is short (<30 seconds), the frequency is quite high with successive mounts occurring at intervals of several minutes. A peak in activity occurs ~2 hours later when about 13 mounts with intromission follow in quick succession. This is followed by a steady waning in attraction (Stoddart 1966, 1977). Whether multiple ejaculation occurs during this period has not been determined. A similar pattern of multiple, but brief, copulations has also been reported in members of the Potoroidae (Seebeck and Rose 1989) and is also thought to act as a type of mate guard.

For the Grey Short-tailed Opossum *Monodelphis domestica*, only a single intromission/ejaculation per male has been observed, whereas in the Woolly *Didelphis albiventris* and Virginia Opossums *Didelphis virginiana* there are multiple intromissions and/or ejaculations (Dewsbury 1972). Locking at the conclusion of mating immediately prior to dismount is also a feature of copulation in many didelphid opossums and has also been observed in the Yellow Footed Antechinus *Antechinus flavipes* and Agile Antechinus.

Prevalence of Mating Plugs

Copulatory plugs have been observed in the urogenital sinus and/or lateral vaginae following mating and ejaculation in opossums, macropods, phalangerids, vombatids, dasyurids and the Numbat *Myrmecobius fasciatus* (Hughes and Rodger 1971; Tyndale-Biscoe and Rodger 1978; Taggart *et al.* 1997; Taggart and Friend *unpubl. obs.*). The copulatory plug is thought to result from the mixing of semen and vaginal secretions, however coagulation can occur in the absence of female tract secretions in macropods. In Tammar Wallabies the mating plug is devoid of spermatozoa soon after ejaculation (Tyndale-Biscoe and Rodger 1978). It appears as a pale creamy coloured rubbery mass, and in macropods can often be seen protruding from the urogenital sinus for up to 24 hours after mating. Copulatory plugs in marsupials may prevent leakage of spermatozoa, act to retain spermatozoa in the vaginae close to the cervical canal thus ensuring maximal access for spermatozoa to the cervix, and/or perhaps act as a temporary physical barrier to subsequent matings by other males.

Sperm Transport in the Female Reproductive Tract

In marsupials, upon ejaculation, semen is deposited in the upper part of the urogenital sinus and sperm travel rapidly to the cervix, which may act as a reservoir for spermatozoa as well as a selective barrier to further sperm transport. In didelphid and dasyurid marsupials there appears to be extremely efficient transport of ejaculated spermatozoa from the urogenital sinus to the lower isthmus region of the oviduct (~1 in 7) suggesting little if any barrier to sperm transport up the female reproductive tract in species from these groups. This contrasts dramatically with the small percentage of ejaculated spermatozoa (~1 in 10,000) which reach the oviduct in most macropods studied (Bedford *et al.* 1984; Tyndale-Biscoe and Rodger 1978; Taggart and Temple-Smith 1991).

Sperm Storage and Release in the Female Reproductive Tract

Sperm storage in the female reproductive tract is a relatively common phenomenon in insects, lower vertebrates, reptiles and birds. In eutherian mammals, as fertilisation generally occurs within 24 hours of mating, spermatozoa only survive for short periods in the female tract. Long term sperm storage in this group is therefore extremely rare, with insectivorous bats being the most well-known exception (Racey 1979). In marsupials, extended periods of sperm storage in the female tract (up to 2-3 weeks) have been reported for three families. In the Dasyuridae (Bedford *et al.* 1984; Selwood and McCallum 1987; Breed *et al.* 1989; Taggart and Temple-Smith 1991) and the Didelphidae (Rodger and Bedford 1982; Bedford *et al.* 1984) sperm storage occurs in specialised crypts in the lower oviduct, whereas in peramelids (Lyne and Hollis 1977) it occurs in the vaginal caeca. Observations on the release of spermatozoa from the isthmic storage crypts have been studied in the Fat-tailed Dunnart *Sminthopsis crassicaudata* using transmitted light and suggest that those located closest to the ovary are the first to be released from the crypts following ovulation (Bedford and Breed 1994), and are perhaps therefore more likely to successfully fertilise any ovulated eggs.

Paternity Studies

The best evidence for sperm competition within marsupials has come from studies of captive colonies of two dasyurid species, the Agile Antechinus (Shimmin 1998; Shimmin *et al.* 1997) and the Brush-tailed Phascogale *Phascogale tapoatafa* (Millis *et al.* 1995). Both studies examined paternity within litters associated with competitive mating trials between two males. These studies indicate that spermatozoa from more than one male can concurrently occupy the sperm storage crypts in the lower oviduct prior to ovulation, and also that multiple paternity can occur within the one litter. Fertility studies undertaken in the Agile Antechinus suggested that spermatozoa from second and third inseminations can contribute spermatozoa for fertilisation. In studies on the Agile Antechinus, of the 61 young on which paternity was assigned 72% were sired by the second mating male when both matings occurred early in oestrus, 62% were sired by the second mating male when one mating occurred early and one in mid oestrus and 58% were sired by the second mating male when both matings occurred in mid oestrus. Overall, 64% of young were sired by the second mating male. Importantly, however, large numbers of the litters (7/11) were sired by both males given access to the female (Shimmin 1998; Shimmin *et al.* 1997). This result proves that effective storage of each male's sperm occurs and that males securing mating access early in oestrus are also gaining some siring success. Production of mixed paternity litters significantly increases the genetic diversity of the litter and, combined with the sex-biased dispersal of young, ensures that high levels of genetic heterozygosity are maintained in the population. Support for these findings also come from field studies of the Agile Antechinus in which radionuclide labels, individually recognisable by their spectral properties, were injected into males at the beginning of the breeding period. Labels passed to females during ejaculation were identified and counted following female capture to determine male mating success, and subsequently demonstrated that males and females did indeed exhibit a promiscuous mating strategy in the wild (Scott and Tan 1985).

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Birds

Book Reviews

Botany

The relationship between male dominance and paternity has been examined in captive colonies of Red-necked Wallabies and Tammar Wallabies using electrophoretic and DNA fingerprinting techniques. Within groups of Red-necked Wallabies the dominant male sired at least 70% of young surviving to the age of pouch emergence with 30% or less young surviving being sired by subordinate males (Watson *et al.* 1992).

Conclusion

Sperm competition is an important selective force which affects the reproductive fitness of many invertebrate and vertebrate species. Unfortunately the comprehensive testing of many of the predictions associated with sperm competition theory remains to be done. As the behavioural, morphological and quantitative correlates of sperm competition vary dramatically across the marsupial fauna, the study of this group of mammals offers a unique opportunity to test many of the predictions which remain unresolved in mammals and will help determine how the various factors that influence the outcome of sperm competition events affect male and female reproductive fitness.

Furthermore, when data on relative testes-body mass and sperm number-body mass are examined with other behavioural and morphological data for a particular species, this information can be used to help assess the likelihood of inter-male sperm competition occurring within a particular species and thus predict the likely mating system in operation (for example monogamy, promiscuity). In addition, a better understanding of paternity within mating systems and the natural strategies for enhancing intraspecific genetic diversity will assist conservation objectives and provide a new, useful and potentially rich area for further investigation.

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A Rare Sighting of the Common Dolphin *Delphinus delphis* in Port Phillip Bay, Victoria

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Troy A. Saville[3,4] and Dayanthi Nugegoda[1,2]

Abstract
This paper reports a sighting of two Common Dolphins *Delphinus delphis* off Blairgowrie in Port Phillip Bay, Victoria. Once the dolphins were sighted they were continously observed using an instanteous sampling technique to document focal group activity. The Common Dolphins were continously observed for a total of four hours. The preferred shore distance of these Common Dolphins was 150 m in a water depth of 10–15 m. The most common behaviour observed was feeding behaviour (87.5%) followed by social behaviour (10.4%) and travel behaviour (2.1%). Two whistles and one echolocation pulse were recorded during the observation period. (*The Victorian Naturalist* 116 (2), 1999, 65-67)

Introduction

On 15th November 1995, an opportunistic sighting of two adult Common Dolphins *Delphinus delphis* was made off Blairgowrie in Port Phillip Bay, Victoria (38°21.5'S, 144°46'E) (Fig. 1). The sighting occurred during a field study on Bottlenose Dolphins *Tursiops truncatus* (Scarpaci 1997) in the vicinity of the Blairgowrie Yacht Club, which is recognized by the local fishermen as a relatively good fishing spot. The Common Dolphins were observed continously between 1000 and 1400. All observations made in this paper are within the Australian Whale Watching Regulations. A minimum distance of 100 m was maintained by the research boat from the dolphins unless the dolphins approached the vessel of their own accord.

Identification

The dolphins were identified as the species *Delphinus delphis* (Fig. 2) on the basis of the following criteria: (i) a distinct, triple coloration was observed on their body (Aguayo 1975) and this consisted of a 'criss-cross' pattern as proposed by Baker (1983); (ii) the dorsal sector of the cross was dark grey, the ventral sector was white, the posterior sector was grey and the interior part was a creamish-tan color; (iii) the body size of each of the two Common Dolphins was considerably smaller than that of the Bottlenose Dolphin observed in the area, the rostrum was longer and the dorsal fins were relatively higher than those of the Bottlenose Dolphin. Data collected from a total of 10 strandings off the Victorian coast indicate body lengths of Common Dolphins range from 1.7–1.9 m (Warneke 1995) whereas the typical size of adult Bottlenose Dolphins in Australian waters ranges from

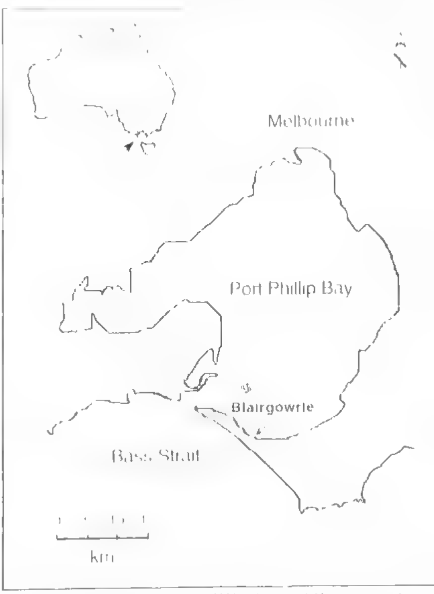

Fig. 1. Map of Port Phillip Bay, Victoria, showing the region where the Common Dolphins were observed.

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Fig. 2. Common Dolphin *Delphinus delphis*, showing the distinct 'triple colouration' of the body. **Note** these animals are not the individuals described in this paper. Photo kindly supplied by David Donnelly and sourced by the Dolphin Research Institute Inc., Frankston.

1.78–3.26 m (Ross and Cockcroft 1990), the largest of which are found in Tasmania, southern Victoria and South Australia. These distinct features were easily observed due to good water clarity and the frequent approaches made by the dolphins towards the research vessel. According to Jefferson *et al.* (1993) two types of Common Dolphin exist: a long-beaked (coastal) and a short-beaked (offshore) variety. Unfortunately, we were unable to distinguish if these dolphins were short-beaked or long-beaked.

Behaviour and Vocalisations

Once the Common Dolphins were observed an instantaneous sampling technique (Shane 1990) was used to document the focal group. The two Common Dolphins were defined as the focal group. Focal group activity was documented at five minute intervals. The behavioural activities of the dolphins were grouped into three categories: travel, social and feeding, as defined by Shane (1990). Data on their location, distance from shore and water temperature were also noted.

Vocalizations by the Common Dolphins were recorded using a hydrophone attached to a preamplifier. A standard tape recorder with a tape speed of 19 cm/sec was used. Recordings were later transformed into a frequency time wave (spectrograph) on a computer work station with the aid of specialized computer software (*Avisoft*®) co-ordinated to a printer.

The dolphins spent most of their time feeding (87.5%) in the area with little indication of social (10.4%) or travel behaviour (2.1%). This is unlike the behaviour of the Bottlenose Dolphins studied by Scarpaci (1997) in Port Phillip Bay. The dolphins remained an average distance from the shore of 150 m, in a water depth of 10–15 m; the water temperature was 19°C. A study conducted by Silber *et al.* (1994) showed that Common Dolphins normally inhabit relatively clear regions at a distance greater than 15 km from the shore where water depths are usually greater than 30 m. The typical group size of the Common Dolphin can range from several dozens to over 10 000 animals (Jefferson *et al.* 1993). However, on this occasion only two dolphins were sighted. Possible reasons for this may be: (i) the dolphins dispersed from their main group to forage; (ii) the dolphins dispersed from the main group for reproductive purposes; (iii) the dolphins may have formed a solitary group of their own; (iv) this was not a typical dolphin group, or (v) Common Dolphins may not always be in large groups.

Two whistles and one echolocation pulse were recorded during the observation session, with one whistle being clear enough to analyze. The duration of the whistle was 0.3 sec over a frequency range of 2.7 kHz to 4.0 kHz (Fig. 3). Generally, whistles of Common Dolphins start at 4 kHz and can sweep as high as 15 kHz, with harmonics to 30 kHz (Evans 1994). Echolocation pulses of Common Dolphins are extremely short in duration (20–50 µsec), with energy levels between 15 and 100 kHz (Evans 1994).

Comments

The Common Dolphin is widely distributed (Evans 1994) in all tropical and temperate seas (Warneke 1995). Common Dolphins are found both in shallow coastal environments and in deep oceanic water (Warneke 1995). Common Dolphins have been widely recorded in Australia, including Victoria, where it is the second most frequently stranded cetacean (Warneke 1995). However, unlike the Bottlenose Dolphins they do not appear to be resident in Port Phillip Bay but rather a casual visitor (Warneke 1995).

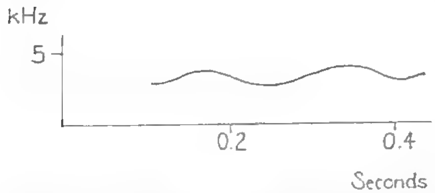

Fig. 3. Sound spectrogram of whistle emission by a Common Dolphin, *Delphinus delphis*, in Port Phillip Bay, Victoria.

The two Common Dolphins reported here were observed on only one occasion. No further sightings of these or any other Common Dolphins occurred in the period from September 1995 to March 1996 and January 1997 to November 1998 during which continuous field observations of Bottlenose Dolphins were recorded in Port Phillip Bay.

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Calomnion complanatum: an Endangered Moss found in Victoria

David Meagher[1]

A collection of bryophytes from wet forest on Wilsons Promontory has yielded specimens of the moss *Calomnion complanatum* (Wilson) Lindberg, one of only four mosses that are endangered in Australia (Scott *et al.* 1997). This species is apparently common in suitable habitat in New Zealand (Beever *et al.* 1992), but is known in Australia with certainty only from two previous collections: by W.W. Watts in New South Wales in 1903, and by Ilma Stone near Stanley, Tasmania, in 1980 (Stone 1990). An earlier record attributed to Tasmania (Whittier 1976, page 181) is thought to be an error (Stone 1990).

The habitat in Tasmania and Victoria is the trunks of Soft Tree-ferns *Dicksonia antarctica*, and in New Zealand also almost always on certain tree-fern species (Beever *et al.* 1992). Because the shoots grow almost horizontally out from the tree-fern trunk, they are easily mistaken at first glance for other tree-fern mosses of a similar size and habit, especially *Rhizogonium distichum*, *R. novaehollandiae*, *Hymenodon pilifer* and young shoots of *Lopidium concinnum*. *Calomnion*, though, is unique in having a row of almost circular leaves on the dorsal (upper) side of the stem (Fig. 1). Sainsbury (1955) mistakenly described this row as 'ventral'.

The yellow-green shoots are 10 to 15 mm long, erect, unbranched and very delicate, arising from creeping caulonema. The leaves are in three ranks, little altered when dry. Two rows (the lateral rows) are almost opposite on the stem. The ovate to obovate leaves of these lateral rows increase in size towards the stem apex, widely spaced on the lower stem but more closely arranged and rather oblong at the apex. The leaves of the third (dorsal) row are roughly circular all the way up the stem and are very variable in size, but tend to be larger towards the stem apex. The tips of these leaves are turned upwards.

All leaves are strongly nerved, the nerve reaching the apex in the lateral leaves and shortly excurrent in the dorsal leaves. The leaf margins are irregularly denticulate to entire. Cells in mid-leaf (similar in all leaves) are smooth and thin-walled, shortly rectangular to pentagonal but tending to be square or over-square near the leaf margins. I have not seen sporophytes, but they are described in detail in Sainsbury (1955). Scott *et al.* (1997) gave this species a '3E' conservation status. That is, it is considered to be in danger of extinction in Australia or is unlikely to survive if the factors that threaten its survival continue to operate, and it is highly localised but has a range of more than 100 km. As the Victorian population appears to be confined to small colonies on only five tree-ferns in an area where there is a considerable risk of natural or unnatural disturbance, this status is still appropriate.

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Acknowledgements

Thanks to Ilma Stone for an enlightening discussion on her collection of *Calomnion complanatum* from Tasmania; Phil Wierzbowski of the Arthur Rylah Institute for helping to find and map the population; Paddy Dalton of the University of Tasmania for advice on his own collection and that of Gunn; and the rangers at Wilsons Promontory National Park for their support and assistance.

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Addendum

Since I prepared this article for publication, Paddy Dalton has told me that Whittier's Tasmanian record is probably attributable to a collection by R.C. Gunn held by the New York Botanic Gardens (NY). Paddy has also recently found another population in Tasmania, near Strahan (see *Papers and Proceedings of the Royal Society of Tasmania* **132**: 41-5).

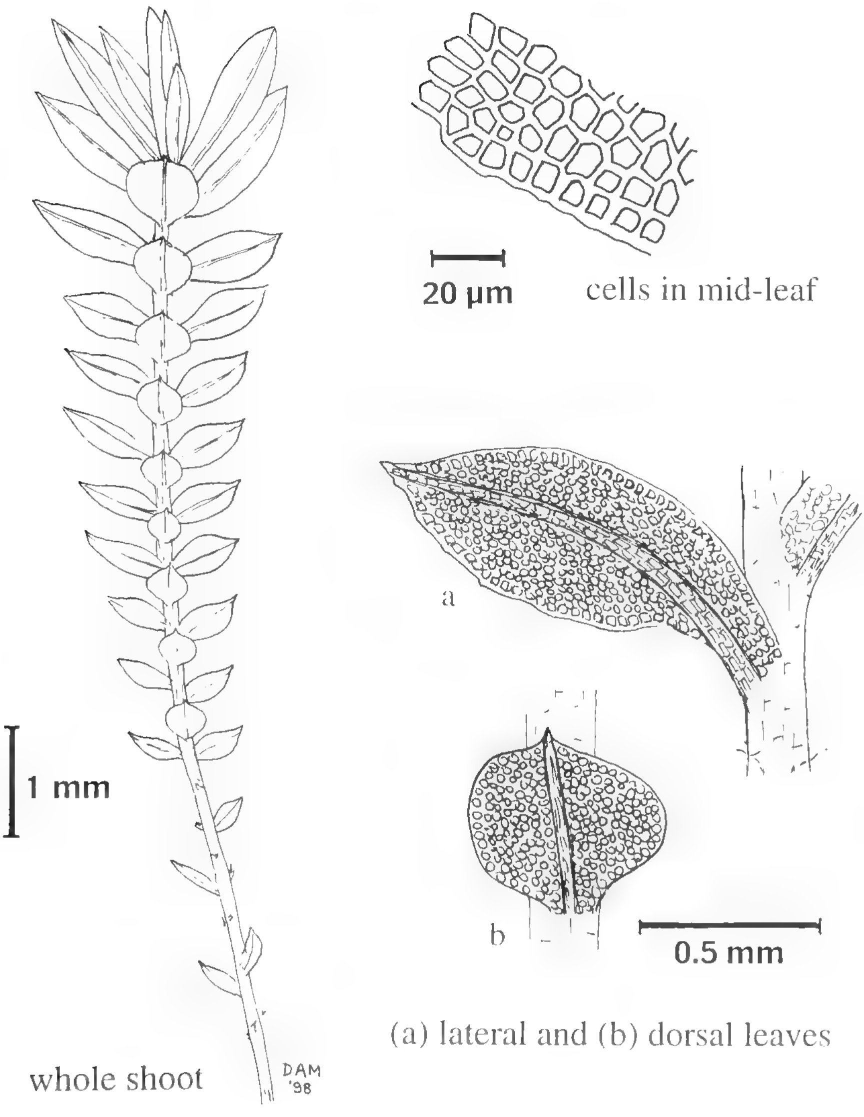

Fig. 1 *Calomnion complanatum* (Wilson) Lindberg: shoot (dorsal view), cells of lateral leaf in mid-leaf, lateral leaf (ventral view) and dorsal leaf (drawn from herb. D.A. Meagher 01636).

For assistance with the preparation of this issue, thanks to the computer team - Alistair Evans and Anne Morton. Thanks also to Felicity Garde (label printing) and Michael McBain (web page).

The Biography Behind the Bird: Grey Honeyeater *Conopophila whitei* (North 1910)

Tess Kloot[1]

Abstract
This paper describes the naming of the Grey Honeyeater *Conopophila whitei*, the part played in its naming by the Field Naturalists Club of Victoria and a brief biography of Alfred Henry Ebsworth White after whom the bird was named. (*The Victorian Naturalist* **116** (2), 1999, 70-72).

Introduction

Over ninety Australian birds commemorate individuals who have made a valuable contribution to our ornithology. Tracing the original publication that named and described a particular species is a fascinating aspect of bird lore. The scientific naming of a species is equally absorbing, as is the translation of the Latin and Greek names (see glossary).

Priority is paramount in the naming of a new species, hence publication of the find, description of the species and explanation of its name are all important. The Grey Honeyeater *Conopophila whitei*, with its stronghold in Western Australia, inhabits dense spinifex and thickets of mulga and other acacias. An inconspicuous little bird, occupying mainly inaccessible areas, it was discovered at Lake Way, East Murchison District, on 19 July 1909 by F. Lawson Whitlock. It was officially named by Alfred J. North, Ornithologist to the Australian Museum, Sydney, in *The Victorian Naturalist* in 1910.

This article is No.7 in a series reproducing the actual published note naming the bird and including a brief biography of the person after whom the bird was named. Previous biographies in this series cover George Arthur Keartland (Kloot 1997), Thomas Carter (Kloot 1997/1998), John Latham (Kloot 1998), Edwin Ashby and James Robert Beattie Love (Kloot 1998), Elizabeth Gould (Kloot 1998) and Keith Hindwood (Kloot 1999).

As the naming of the Grey Honeyeater is associated with the Field Naturalists Club of Victoria it might be of interest to members to learn something of its story.

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Naming the Bird

'Description of a new genus and species of honey-eater from Western Australia.'
(Read before the Field Naturalists' Club of Victoria, 13th December, 1909).
Remarks ... *Lacustroica inconspicua* would fittingly designate this modestly plumaged little Honey-eater inhabiting the vicinity of Lake Way, but in response to a request from the owner of the specimens [H.L.White], who has done so much recently to advance Australian ornithology, I have associated with it the name of his son, Mr Alfred Henry Ebsworth White, who, although yet young in years, I am informed is worthily following in his father's footsteps. Although generically allied to *Entomophila*, White's Honey-eater is an entirely new and distinct species, having no near ally, and may easily be distinguished from any other member of the family Meliphagidae inhabiting Australia.' (North 1910).
We now know it as the Grey Honeyeater *Conopophila whitei* (Christidis and Boles 1994) (Fig. 1).

Fig. 1. Grey Honeyeater *Conopophila whitei*. Reproduced from 'Atlas of Australian Birds' (1984), M. Blakers, S.J.J.F. Davies and P.N Reilly (Royal Australasian Ornithologists Union, MUP Melbourne). By Richard Weatherly, with permission from the artist and Birds Australia

The Biography.

ALFRED HENRY EBSWORTH WHITE (1901-1964)

Alfred Henry Ebsworth White (Fig. 2) slipped into the history of Australian ornithology on the crest of the wave of his father's fame. His father was Henry Luke White (1860-1927), the noted collector of birds' eggs and skins. The H.L.White Collection of eggs and skins, in their very fine cabinets made expressly for the purpose, were donated by him to the Victorian Museum where they remain today (Whittell 1954).

Alf, as he was known, was born at 'Belltrees', New South Wales, on 18 October 1901. After two daughters his father was so delighted at his birth that he decided to build a new homestead, the present day 'Belltrees'.

Wanting his son to follow in his own footsteps, H.L.White enrolled him in the [Royal] Australasian Ornithologists' Union at the age of eight, the youngest member ever. Alf attended Geelong Grammar School and although he did well scholastically his real love was cricket, a sport at which he excelled. He also acquired a rare knowledge of world geography. A religious lad, Alf was awarded a divinity prize. At school during the 1914-1918 war he wanted to enlist but his father refused to allow him to put up his age. He stayed on at Geelong Grammar School until 1921, then went on to attend Jesus College, Cambridge. By this time his prowess in the cricket world was well known. He played for Cambridge against South Africa, taking vital wickets and at the conclusion of the match was 53, not out. For his splendid efforts on behalf of the team he was awarded his cricket blue. Returning to 'Belltrees' in 1924, his father put him straight to work. The property was now a well established pastoral concern and with the increased work load H.L.White was very happy to have his son beside him.

Fig. 2. Master Alfred H.E. White of Belltrees Scone, September 1909. Reprinted from 'The White Family of Belltrees' (1981), by Judy White (The Seven Press, Sydney), with permission from the author. Photo by S.W. Jackson.

Alf married Judy Coombe on 20 September 1926, but by this time his father was too ill to attend the wedding (White 1981). Four children were born to the couple, one son and three daughters.

After the death of H.L.White in 1927 the full responsibility for 'Belltrees' fell on Alf's 26-year-old shoulders, and from then on he devoted his life to the property. A strict, but just man, he earned respect from both friends and employees. Despite the depression of the 1930s he drove his staff to maintain high standards. Dictatorial and impulsive he rejected criticism. However, this stern facade concealed his shyness and gentle manner.

A stickler for tidiness, Alf was constantly engaged in clearing away such things as unused workmen's cottages and sadly, valuable ornithological data from his father's library. On the other hand he realized the historic value of some of the early buildings, and employed one of the best bush workers, a fencer who understood round timber and was brilliant with a mortising axe and adze, to restore an old slab store.

Ultimately, 'Belltrees' carried sheep, cattle and horses. During the 1950s, seasonal prices were good and the family enjoyed great prosperity. Over the desk in his office Alf had pinned his motto, 'The best fertiliser of any country is the footsteps of the owner' (White 1981).

H.L.White had been strict with his children and Alf carried on this tradition with his own, although he mellowed in later years. When his eldest daughter asked her father's permission to announce her engagement he suddenly realized how 'Belltrees' had been his first concern to the neglect of family life. By about 1952 the 'despotic camouflage' (White 1981) started to disintergrate and revealed a much kinder and approachable person. A very proud grandfather, he fired a twenty-one gun salute from the top balcony of the homestead to announce the arrival of the first White grandson!

The last ten years of Alf's life were filled with contentment. 'Belltrees' had reached a very high standard of excellence; the stock, property, buildings and fences were in immaculate condition. He had attained his goal and felt that he could now delegate responsibilities to his only son, Michael. He and his wife travelled widely, both within Australia and overseas. Christmas, when the entire family gathered at 'Belltrees' were perhaps his happiest times.

Alfred died suddenly on 6 March 1964. Although he made no real contribution to ornithology and will be remembered as the son of the famous Henry Luke White, he deserves a place in our ornithological history, with his name perpetuated in the Grey Honeyeater *Conopophila whitei.*

Glossary:

Conopophila whitei - *conops*: gnat, *philos*: fond of, *whitei*: after Alfred H.E. White son of H.L. White.

Lacustroica - *lacus*: lake, *oicos*: house.

inconspicua - inconspicuous.

Entomophila - *entoma*: insects, *philos*: fond of.

Meliphagidae - *meli*: honey, *phagein*: to eat. (Wolstenholme 1926).

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One Hundred Years Ago

NOTES ON THE BIRDS OF THE BOX HILL DISTRICT

By Robert Hall

(Read before the Field Naturalists' Club of Victoria, 13th February, 1899)

'In this, the concluding paper of the series on the birds of the Box Hill district, I wish to bring under your notice the introduced birds of the district, which number in all seven species. Six of them, viz., the Thrush, Blackbird, Goldfinch, Greenfinch, Sparrow, and Starling, are imports from Western Europe, while the seventh is the Indian Myna. All are town birds, and pass their time in close proximity to the little townships of the district, especially Box Hill proper......

'I will conclude with a brief recapitulation of the birds dealt with in these notes. Altogether 113 species, including the introduced birds, have been referred to, besides which there are some 10 species which are only very casual visitors. Approximately, 43 of these reside with us all the year round, while 70 are migrants, arriving here with the advent of spring. Sixty species have been found breeding here. Grouping them according to their rarity, I would say that 42 are common, 43 less common, and 28 rare. Birds of prey are represented by 8 species; passerine birds, 88; parrots, 9; pigeons, 1; game birds, 2; hemipodes, 1; and waders, 5.'

The Victorian Naturalist ***XV****, pp 156-159. April 1899.*

Jean Galbraith
28 March 1906 – 2 January 1999
A Tribute

Helen I. Aston[1]

The death of Jean Galbraith, aged 92 years, marks the end of a lifetime of service to botany, naturalists, natural history organisations and gardeners, and the passing of a truly loveable and remarkable woman.

Jean was born at Tyers, near Traralgon, Victoria, on 28 March 1906 and lived there for most of her life. For 79 years she lived in her beloved home of 'Dunedin', only leaving it in July 1993 with great reluctance but with full acceptance of her need for care in advancing years. She moved first to a unit at 'Yallambee' village in Traralgon and then in 1996 to 'Olivet' nursing home at Ringwood, Melbourne, where she died peacefully on 2 January this year.

From early childhood Jean displayed a great love of the natural world and a sensitivity and wonderment at its beauty and diversity. Her enjoyment of natural things and of life in general was intense, her enthusiasm infectious, and her hospitality legendary. Friends and visitors alike were welcomed to her home and those in trouble or in sorrow turned to her. She held a deep Christian (Christadelphian) faith which sustained her at all times and shines through in her writings.

Although Jean had limited formal education, leaving school at the age of 14, she read avidly on wide-ranging topics from the classics to science. By the age of 19 she herself was already a published author, although her major works were still to come. Her enthusiasm for writing never waned, and besides the main gardening and botanical publications mentioned below she wrote poetry and several books and many articles for children.

Both of Jean's parents were keen gardeners, and gardens were also a major passion in Jean's life. It was Jean and her parents who designed and developed the garden at 'Dunedin', which Jean tended and maintained until prevented by age. She wrote about it, showed people through it, and treasured both its plants and the many birds which came to it. Although 'Dunedin' had to be sold out of the family in February 1997, it is a fitting tribute to Jean that it is now restored and maintained by the local purchasers, Max and Ollie Archbold, under the name 'Garden in a Valley', and opened to the public at weekends.

Jean's knowledge of botany and Australian native plants developed apace after she met the noted amateur botanist H.B. Williamson at the FNCV wildflower show in 1922, when she was only 16 years old. Struck by her keeness, Williamson offered to help and in *The Victorian Naturalist* 97: 116 (1980) Jean wrote how '... for the next ten years he identified plants for me almost every week and introduced me to Mueller's *Key*, which I slowly learned to use.'

Jean joined the Field Naturalists Club of Victoria as a country member in December 1923. She soon became a frequent contributor of articles to *The Victorian Naturalist*, contributing a total of 128 from 1925 onwards over a span of fifty-six years. Most of these have either birds or plants as their subject, but a smattering of titles encompassed other topics such as local areas, spiders, tree-frogs, and mammals. Particularly notable is a contribution of 43 articles on *Australian Wattles* which appeared during 1959 to 1964. Each article demonstrates Jean's 'plain English' ability in descriptions and her own enjoyment and capacity in enlivening text with the feeling she held for her subject. Short notes which help to bring each plant delightfully to the reader's eye follow each description. For example, for *Acacia alpina* she wrote (*Vic. Nat.* 79: 65; 1962) '...On the few high mountains where alone it grows ... it looks completely and cheerfully at home', and for *Acacia glandulicarpa* (*Vic. Nat.* 79: 166; 1962) 'the blossom is so abundant

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that whole bushes look golden, like gay clouds along the dry roadsides'. Her final contribution to *The Victorian Naturalist* was an important historical article titled *Botanists and the FNCV - the first 30 years*. (*Vic Nat* 97:114-120; 1980).

When field naturalist's clubs were formed in Sale, Bairnsdale and the Latrobe Valley, they increased the opportunities for participation with local naturalists. Jean played a key role in the establishment of the Latrobe Valley Field Naturalists Club (first known as the Gippsland F.N.C.) in 1960, and was a founding member of it. She became a valued speaker, excursion leader, and mentor, and her involvement with this Club from its inception onwards was greatly instrumental in its development and growth. She was also a sometime lecturer at the Mt Beauty summer schools run by the Council of Adult Education. Although she had no car, offers of transport were readily forthcoming and she travelled widely within Australia. She was a prolific correspondent with her many contacts, felt keenly the need for conservation of natural areas, and was active in the preparation of conservation submissions to government authorities. As a practical measure for conservation, she donated land at Tyers for the first wildflower sanctuary established, in 1936, by the Native Plants Preservation Society of Victoria.

Jean formed her own reference herbarium of plants collected both locally and on her travels in all States. She shared her knowledge with both amateurs and professionals alike and any plant which appeared unusual to her discerning eye was sent to the National Herbarium of Victoria for assessment. Many of her collections are lodged there permanently. She herself was a frequent visitor to the National Herbarium, working through the collections as she compiled information for her botanical writings, and never arriving without a boiled fruit cake or similar offering to add to the staff tea table.

Writing was essential to Jean, who revelled in it. Her many contributions to *The Victorian Naturalist* have already been mentioned. She wrote gardening articles for *The Australian Garden Lover* from 1926-1976 under the name of 'Correa', for *Your Garden* for some years from 1954 and more latterly, from 1985-1992, for *The Age* newspaper, Melbourne. Those which appeared in the *Garden Lover* between August 1943 and June 1946 were republished as the book *A Garden Lover's Journal* in 1989, each telling joyfully of garden happenings at 'Dunedin' and of the country life around. The full story of 'Dunedin' is beautifully told in Jean's book *Garden in a Valley*. First published in 1939, it was republished in 1985 to the delight of many.

Undoubtedly Jean's landmark botanical publication appeared in 1950, when her *Wildflowers of Victoria* first came off the press from Colorgravure Publications, Melbourne. With short, simple-language descriptions of approximately 1000 species and 175 close-up, black and white photographs, it filled a great void for naturalists. The earlier work of E.E. Pescott, *Native Flowers of Victoria* (1914), had become unobtainable and that of A.J. Ewart, *Flora of Victoria* (1931), was rare and expensive. In addition, neither of these works had the same easy-to-use text and illustrations of Jean's volume, which was published in two further editions in 1955 and 1967 before being supereceded by her greatly expanded and equally popular *Field Guide to the Wild Flowers of South-East Australia* (1977).

Jean Galbraith was elected a foundation life member of the Society for Growing Australian Plants at its formation in 1957 and was also honoured with life membership of the Victorian National Parks Association, the Native Plants Preservation Society, and the Latrobe Valley Field Naturalists Club. In April 1959 she was elected an honorary life member of the FNCV and in 1970 she was awarded the Australian Natural History Medallion for having conveyed 'interest in natural history and conservation to the general community, and stimulated people to a greater awareness of our natural heritage'. She was only the fourth woman to receive this award since its inception in 1939. Her alertness has been responsible for the discovery of new plant species and of extensions of the known range of rarer ones. Two species of plants have been named after her, namely *Dampiera galbraithiana* (*Telopea* 3: 204; 1988) and *Boronia gal-*

braithiae (*Muelleria* 8: 24; 1993). In describing the latter species the author acknowledged Jean with this tribute: '... doyenne of Victorian botanists, ... whose collections and writings have contributed much to our knowledge of flora of the Gippsland region'.

Much more could be written on Jean Galbraith the person, her life, and her contribution to others. I treasure the memories I have of her and feel very privileged to have known such a unique and selfless person. Warm and friendly, joyful in her Christian faith, generous, cheerful, compassionate and caring, yet ever-modest, she had a remarkable and endearing personality which will not be forgotten by all those who knew her.

Further Reading

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Jean Galbraith, surrounded by the flowers she loved so much, in her garden at 'Dunedin' (the *Garden in a Valley*). Photo kindly supplied by Ian Hyndman, Beechworth.

A Rich and Diverse Fauna: the History of the Australian National Insect Collection 1926 - 1991

Murray S. Upton

Publisher: *CSIRO Publishing, Collingwood, Victoria, 1997. xx + 385 pp. RRP $59.95*

From its inception, CSIRO's Division of Entomology has concentrated on agricultural problems and pest species; its first two projects involved cattle ticks and termites. It is a consequence of such applied research that a large collection of insects is accumulated, bringing with it a strong demand for taxonomic work. As it is now called, the Australian National Insect Collection (ANIC) is housed within the Division of Entomology and comprises about eight million specimens. This book tells the story of its first 65 years but, in spite of its subtitle, it imbeds the story of ANIC within the story of the Division, mirroring real life. It was not until 1962 that the name ANIC was gazetted and it took until 1980 before it moved into a dedicated building.

The first three chapters describe the inception of CSIR; its first Chief Entomologist, the brilliant but temperamental R.J. Tillyard; and the establishment of the entomological laboratory in Canberra. Thereafter the author arranges the chapters, not chronologically, but by topic and this can lead to some repetition. For review perhaps it is best to group the chapters into 'collecting', 'curating', 'taxonomy' and 'staff'.

Early 'collecting' is covered in chapter 6, with chapter 7 being devoted to Bill Brandt's heroic efforts in Papua New Guinea. Chapter 12 details the collecting expeditions since 1960. Each trip lists the staff involved, the route taken, the hardships encountered and, occasionally, some of the important specimens found. 'Curating' in a very general sense starts in chapter 8 when the laboratory was set up, a curator appointed, policies established and the detail of storage problems overcome. Chapter 9 emphasises the debt which the collection owes to gifts from both amateur and professional collectors over the years. Absolute numbers are astounding with donations of tens of thousands of specimens from individuals. Some were immaculately preserved while others were in poor array but containing valuable type specimens. This is the chapter that contains the stories of theft and mislaying of loans. Numerous departmental reviews, international pressures and interstate rivalries fill chapter 10, culminating in the recognition of ANIC and its place within CSIRO. Chapter 14 produces the new building and moves the collection into it.

Taxonomy is intimately connected with applied research and the housing and use of the collection. There are examples in this book of biological control programs which did not work, or were not necessary, because the target pest was incorrectly identified. Chapter 5 contains lots of early taxonomic research projects while those undertaken after about 1961 are detailed in chapter 13. Also included in this chapter are the publication of CSIRO journals and the monumental *Insects of Australia*. A lengthy discussion of the debate concerning the resting place for holotypes takes up all of chapter 15. In the context of the whole history of the Division and the Collection it probably takes too much space but the author's personal involvement is probably the reason for the bias. Finally, 'staffing' matters are covered in chapters 4 and 11, with the end of World War 2 marking the separation. Comings and goings of taxonomists and major events are faithfully recorded.

Between each chapter, throughout the book, are valuable archival photographs of personnel and places. Ten appendices detail staff, donated collections, standing orders, grants, publications and surveys. A comprehensive bibliography is included.

This is an important history to have been written and, as it was the author who gathered and systematised the ANIC Archives during his term as curator and manager of the collection, he was probably best suited to produce it. Nevertheless, some of his biases show. It is not difficult to see his contributions to ANIC and CSIRO were in the leading of field trips, manufacture of unusual equipment, and the minutiae of curation techniques. Close reading will reveal his subtle but political comment on the vicissitudes of both Collection and Division. Three last comments on style: the book does demonstrate a curator's mentality: a reluctance to throw out any item (e.g. the travel allowance for the use of a member's own bicycle was 2½d per mile in 1930). Secondly, the first time a new player is introduced a potted biography of qualifications and prior experience is included. Perhaps they would be better included as another appendix as it does break the flow of reading. Finally, inclusion of an item in the index seems to work by the rule that it must be a direct reference to the CSIRO. Peripheral people and institutions miss out.

If you have any interest in Australia's entomological history then you should read this book, all the famous names are there and their struggles (against bureaucracy and funding cuts) and triumphs are repeated periodically. It might be of some comfort to know that current difficulties are not unique, and the fit tend to survive. The book has received a Whitley Award in the history of Australian zoology category.

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Endangered Ecosystem Series

Publisher: *Victorian National Parks Association, 10 Parliament Place, East Melbourne, Victoria 3002*
RRP $10.00 each or $24.00 full set (postage included).

Looking after Native Grasslands and Grassy Woodlands

It is not often as a teacher you can pick up a kit and get all the information you would need to prepare a teaching unit. This kit satisfies that requirement. As a primary teacher I find that this kit would satisfy my learning needs to guide students through the investigative process of establishing a sound basis of grasslands education. The action section, 'What You Can Do' is a particularly valuable resource. Many documents suggest to take action but few give practical ideas of how to do this. The action activities in this document are reasonably simple to do and are readily available for most teaching situations. The Native Grassland Site Visit Sheet would be difficult for most younger students. A teacher could easily adapt the ideas however, and produce a sheet suitable for their students. The site visit information brochures included in the kit are an excellent excursion resource and relevant information could be rewritten to suit younger students.

The kit itself would be an excellent resource for levels 5-7 secondary school studies in SOSE and Science key learning areas. The plant lists are an excellent basis for classification activities and would lend themselves to excursion activities such as writing dichotomous keys. The action section could be used as a stimulus for the formation of an environmental club practising grassland conservation, or as a unit of work concentrating on grasslands.

VCE students would find this kit an excellent resource in the biology, environmental studies and geography areas. The information is excellent and the Contact and Resources list invaluable as a resource for further research.

As is, the kit could serve as an excellent resource document for student research and would be great addition to any school or home library. I recommend this kit to anyone who is involved in, or is considering grasslands as a teaching unit. It has excellent information, great action ideas and what's more doesn't take an eon to read.

Looking after Marine and Coastal Areas

This kit is one of the most concise documents I have read on the state of Marine Ecology in Victoria. At times it is rather depressing. As a resource document it would be excellent for teachers or older students studying the marine area. For VCE it would be a valuable starting point for research. The contacts and reference section is excellent.

As a teacher I would use this kit more as a resource for myself rather than using it as a kit for students. While the information is excellent and students need know the facts, I feel some parts of the document are all 'doom and gloom' and would be better interpreted by educators. Students need to be empowered to act, not to feel action is a lost cause. If not interpreted properly some students may only see the negatives of this document.

I found information sheets 1 and 2 particularly informative. The concise descriptions of the terms and the types of habitats were simply written and easily understood. These would be an excellent starting point for any marine study.

Unfortunately, unlike the other kits in this series, the Marine kit did not include a site visit sheet. These sheets may not always be suitable for all levels of students but serve as a guide for educators to produce their own sheet. The information in the document and the site visit brochures are sufficient for teachers to produce their own sheets however.

I would recommend this kit as a valuable resource for all teachers and VCE students and it would be a suitable resource to have in the teachers' resource section in any library.

Looking after Box and Ironbark Forests and Woodlands

Did you know that if there are enough trees to form a canopy that shades 30% or more of the ground it is a forest. If the area is less than 30% shade, the plant community is called a woodland? This fact and many more you will read in the Box and Ironbark Information Kit. Written in a similar manner to the Grasslands and the Marine and Coastal Kits, this I feel is an essential resource to any school library. Teachers from Prep to VCE would find this kit useful. A particularly interesting section I feel for older students was Information Sheet 9. This section covered some of the government legislation involved in the Box and Ironbark Forests. While the information was minimal, it gives a good overview of some of the legislation involved in conservation processes in Victoria.

I found that I read this document with bird and flora identification books beside me. This made Sections 3 and 5 far more meaningful. Even though there is a reference list in the document I would suggest a list of readily available guides to flora and fauna in Victoria would be beneficial and should be used along with the kit.

The Box-Ironbark Site Visit Sheet is extremely helpful and could be used as an excursion guide for any teacher. The information sheets for the four park areas are excellent resources and could be utilised by teachers in many ways.

My immediate reaction to this kit was one of I don't know enough about these areas and need to do some more research, visiting and teaching about these limited and threatened areas of Victoria. For this reason, plus the fact that this, like the other kits in this series is excellent, I would recommend that it be purchased as an important resource in any teachers and school library.

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Flora and Fauna Guarantee Act 1988

The following Flora and Fauna Guarantee Scientific Advisory Committee Recommendation Reports have been received. The number following each listing is the nomination number.

Final Recommendations Reports

Supported for listing on Schedule 2:

Flora

Daisy, Yellow-tongue *Brachyscome chrysoglossa* – No. 449

Fauna

Bittern, Black *Ixobrychus flavicollis australis* – No. 450

Bittern, Little *Ixobrychus minutus* – No. 439

Crake, Baillon's *Porzana pusilla* – No. 447

Kite, Square-tailed *Lophoictinia isura* – No. 444

Rail, Lewin's *Dryolimnas pectoralis* – No. 446

Shark, Great White *Carcharodon carcharias* – No. 419

Tern, Caspian *Sterna caspia* – No. 443

Tern, Gull-billed *Sterna nilotica* – No. 438

Communities

Devonian Limestone Pomaderris Shrubland Community – No. 429

Grey Box - Buloke Grassy Woodland Community – No. 434

Limestone Grassy Woodland Community – No. 428

Semi-arid Herbaceous Pine Woodland Community – No. 432

Semi-arid Herbaceous Pine-Buloke Woodland Community – No. 433

Semi-arid Northwest Plains Buloke Grassy Woodland Community – No. 431

Semi-arid Shrubby Pine - Buloke Woodland – No. 430

Not supported for listing:

Gum, Yellow *Eucalyptus leucoxylon* subsp *connata* – No. 448 (significance of threats to the survival of the species not sufficiently demonstrated)

Preliminary Recommendations Reports

Supported for listing on Schedule 2:

Flora

Daisy, Dookie *Brachyscome gracilis* subsp. *gracilis* – No. 418

Donkey-orchid *Diuris tricolor* – No. 457

Duck-orchid, Grampians *Caleana* sp. aff. *nigrita* – No. 456

Greenhood, Robust *Pterostylis valida* – No. 458

Leek-orchid, Fragrant *Prasophyllum suaveolens* – No. 451

Liverwort *Pseudocephalozia paludicola* – No. 462

Spider-orchid, Dwarf *Caladenia pumila* – No. 455

Spider-orchid, Short *Caladenia brachyscapa* – No. 454

Sun-orchid, Basalt *Thelymitra gregaria* No. 463

Sun-orchid, Winter *Thelymitra hiemalis* – No. 464

Swainson-pea, Downy *Swainsona swainsonioides* – No. 452

Water-shield *Brasenia schreberi* – No. 437

Fauna

Albatross, Sooty *Phoebetria fusca* – No. 442

Shark, Grey Nurse *Carcharias taurus* – No. 420

Communities

Coastal Moonah (*Melaleuca lanceolata* subsp. *lanceolata*) Woodland Community – No. 460

Lowland Riverine Fish Community of the southern Murray-Darling Basin – No. 459

Not supported for listing:

Fauna

Albatross, Black-browed *Diomedea melanophrys* – No. 441 (Threatening process occurs in oceanic waters beyond Victorian jurisdiction)

Albatross, Shy *Diomedea cauta* – No. 440 (Threatening process occurs in oceanic waters beyond Victorian jurisdiction)

Albatross, Wandering *Diomedea exulans* – No. 423 (Threatening process occurs in oceanic waters beyond Victorian jurisdiction)

Items considered invalid for listing:

Flora

Swainson-pea, Red *Swainsona plagiotropis* – No. 139 (Already listed on Schedule 2, No. 109)

Fauna

Frog, Giant Burrowing *Heleioporus*

australiacus – No. 241 (Already listed on Schedule 2, No. 114)

Invalid Nomination

Promotion and protection of environmental weeds – No. 445 (Subject considered to be covered by The Invasion of Native Vegetation by Environmental Weeds Schedule 3, No. 360)

Preliminary Recommendation Reports
Supported for listing on Schedule 3:
Potentially Threatening Processes

Human activity which results in artificially elevated or epidemic levels of Myrtle Wilt within *Nothofagus*-dominated Cool Temperate Rainforest – No. 453

Incidental catch (or by-catch) of seabirds during longline fishing operations – No. 424

Other Documents

A list of flora (including communities) protected under the *Flora and Fauna Guarantee Act* 1988.

Schedule 2 – list of taxa and communities of flora or fauna which are threatened.

Schedule 3 – list of potentially threatening processes.

An index of items nominated for listing that have been considered by the Scientific Advisory Committee and the status of the nomination.

Items added to schedules of the *Flora and Fauna Guarantee Act* 1988.

Copies of all FFG documents are held in the FNCV library.

The Field Naturalists Club of Victoria Inc.

Reg No A0033611X

Established 1880

In which is incorporated the Microscopical Society of Victoria

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

Membership is open to any person interested in natural history and includes beginners as well as experienced naturalists.

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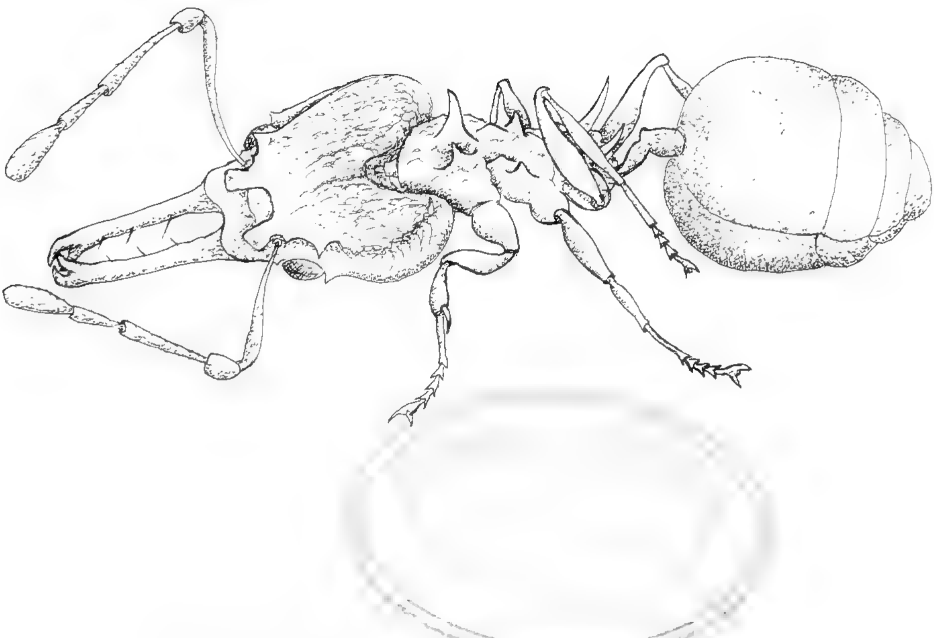

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A Bizarre Ant

A most unusual-looking ant was collected at Wilsons Promontory during the research weekend in October 1998. It was found in one of the traps set in the burnt heath site (38°54'21" S, 146°21'06" E). The distinctive features of this moderately-sized (c 5 mm), rust-coloured ant include: the form of the mandibles (parallel sided and very elongate), the spines and other protuberances on the trunk, and the heart-shaped head with strongly developed occipital lobes. The antennae are also unusual in that they only have five segments instead of the usual 11 or 12. Erich Sacco has drawn the specimen (front cover of this issue) which illustrates these characteristics.

The ant keyed out to the genus *Orectognathus* in the sub-family Myrmicinae. Additional information indicated that only one species of this genus was known from Victoria – *O. clarki* (Andersen 1991).

While the appearance of this ant is bizarre, its feeding habits are remarkable. The species feeds on Springtails (Collembola) which it hunts with its mandibles wide open. Sensory hairs on the inner part of the mandibles are triggered when they touch the prey and the jaws close on the Collembola (Brown 1953). The strike is, of necessity, extremely rapid since the escape response of a Springtail species has been measured at 4 milliseconds (four thousandths of a second) (Hölldobler and Wilson 1994). If the Springtails preyed on by *O. clarki* behave in a similar way, then this ant has to sense its prey and close its jaws within this time – speed indeed!

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Corrigendum

The editor has received correspondence pointing out the following misdetermination which should be corrected.

The determination of the liverwort referred to in 'The Biogeography of *Pseudocephalozia paludicola* R.M. Schuster; an Endemic Australian Liverwort' by Jon Sago, (*The Victorian Naturalist* **115** (3), 1998, 84-86) is incorrect. The liverwort has now been assigned as *Lepidozia laevifolia*. Also, please correct the perianth measurement in Para. 1, p. 84 of the article to 2 x 0.25 mm.

The drawing on p. 85 is of *Pseudocephalozia paludicola* R.M. Schuster, but the magnifications are incorrect. The correct magnifications for the drawing of the leaf and underleaf are x100.

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Cover: A bizarre ant, *Orectognathus clarki*. This ant is about 5 mm long. (See Naturalist Note on p. 82.) Drawing by Erich Sacco.

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Effect of Fire Frequency on Plant Composition at the Laverton North Grassland Reserve, Victoria

Ian D. Lunt[1] and John W. Morgan[2]

Abstract

The plant composition of two adjacent zones with different fire histories was documented at the Laverton North Grassland Reserve, in western Melbourne. One area remained unburnt for 17 years, from 1978 until 1995. The other zone was burnt six times during this period. Both zones were burnt 20 months before sampling in November 1996. The two zones were superficially similar in 1978, but differed substantially in 1996. In 1996, the rarely burnt zone was dominated by exotic species (49% cover c.f. 40% native cover), whereas the frequently burnt zone was dominated by native species (72% cover) with just 7% exotic cover.

Nearly half of the species recorded (22 species) differed significantly in cover between the two fire zones. The largest differences were for the exotic Cat's Ear *Hypochoeris radicata* (33% mean cover in the rarely burnt zone c.f. 1% in the frequently burnt zone) and Kangaroo Grass *Themeda triandra* (22% in the rarely burnt zone c.f. 63% in the frequently burnt zone). The density of live Kangaroo Grass tussocks in the rarely burnt area was only 30% of that in the frequently burnt zone. These differences are assumed to reflect different fire histories rather than underlying environmental patterns. The long-term absence of burning has caused the death of many Kangaroo Grass tussocks and promoted many perennial exotic weeds. The need for frequent biomass removal in productive Kangaroo Grass grasslands is emphasised. (*The Victorian Naturalist* **116** (3), 1999, pp. 84-90).

Introduction

It has long been known that extended intervals without grass removal (by burning, light grazing or slashing) can lead to substantial losses of native plant diversity in many grasslands dominated by Kangaroo Grass *Themeda triandra* in south-eastern Australia (Stuwe and Parsons 1977; Scarlett and Parsons 1982, 1990). For this reason, most grassland management plans incorporate the need for frequent biomass reduction (e.g. Craigie and Stuwe 1992; DCE 1992). However, despite the widespread acceptance of this recommendation, few studies have documented the long-term outcomes of failing to regularly remove grass biomass.

The Laverton North Grassland Reserve, 20 km southwest of Melbourne (37°51'S, 144°48'E) has been managed for grassland conservation since 1978. Grazing stock have been excluded during this period and the reserve has been intermittently burnt. From 1978 to 1995, all disturbances (including fire) were intentionally excluded from one small, triangular area of about 2.5 ha, which acted as a 'control' plot against which the effects of burning could be assessed. There were no obvious differences between the control and adjacent areas initially (Bob Parsons, *pers. comm.*, July 1998). The control area remained unburnt for 17 years, until it and surrounding areas were burnt in March 1995.

Despite its small size and the lack of replicate controls, the long-unburnt area at Laverton provides a valuable opportunity to document the impacts of the prolonged exclusion of burning and grazing, especially given the existence of detailed knowledge about the management history of the plot and surrounding areas. In this paper, we describe and contrast the plant composition of the long-unburnt area and an adjacent area which was burnt six times during the past 17 years, and we discuss the relevance of these results for grassland conservation.

Methods

Two adjacent areas within the Laverton North reserve were examined. The 'frequently burnt' zone was burnt six times after 1978: in March 1980, March 1983, March 1985, February 1987, 1990 (month unknown) and March 1995 (McDougall 1989; J. Morgan *unpubl. data*). By contrast, the rarely burnt zone was burnt only once during this period, in March 1995, 17

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years after reservation. Both zones were sampled in November 1996, 20 months after the most recent fire.

Five, parallel, 50 m long transects were located 40-50 m apart in the frequently burnt zone, and five in the infrequently burnt zone. Transects in the two zones were approximately 150 m apart. A 1 m quadrat was sampled every 5 m along each 50 m transect, giving 100 quadrats in all (50 in the frequently burnt zone and 50 in the rarely burnt zone). In each quadrat, all vascular plant species were identified and the cover of each species was visually estimated to the nearest 5%. For data analysis, species with less than 1% cover were assigned a cover value of 0.5%.

To assess whether the vegetation composition of the two zones was markedly different, the quadrat data were classified using the PATN analysis package (Belbin 1994). In this program, quadrats with the same species are grouped together, whilst those with different species are grouped separately. Cover data were first range standardised, and the Bray-Curtis association index was calculated. The flexible unweighted paired group arithmetic average (UPGMA) procedure was used to classify data, with default $\beta = -0.1$ (Belbin 1994). To identify species and species groups which occurred more frequently in either zone, mean percentage cover was compared for each species and group between the two zones using the non-parametric Mann-Whitney U-test (Sokal and Rohlf 1981).

To determine how fire management affected tussock attributes of the dominant grass, the number of live tussocks, live tillers and inflorescences of Kangaroo Grass (scientific names are given in Appendix 1) were counted in five 0.25 m^2 plots randomly placed in each zone on 23 November 1996. Total plant biomass was recorded by harvesting all plant matter to ground level in six 0.25 m^2 quadrats, and drying for 72 hrs at 80°C. Significant differences between these attributes were investigated using the Mann-Whitney U-test. All plant names follow Ross (1996), and asterisks before the scientific name indicate exotic species.

Results

The classification analysis clearly separated all frequently burnt quadrats from all rarely burnt quadrats, indicating that the vegetation of both zones was substantially different. The percentage cover of native and exotic species differed between the two zones (Table 1). The frequently burnt zone was dominated by native species (72% cover) with relatively little cover of exotics (7%), whereas the rarely burnt zone was dominated by exotic species (49% cover) with just 40% cover of native species (Table 1).

Almost half of the species recorded (46%, 22 species) occurred at significantly greater cover in one of the two zones (at $P < 0.01$; Appendix 1). Only one species, Kangaroo Grass, exceeded 5% mean cover in the frequently burnt zone, where it averaged 63% cover. By contrast, five species exceeded 5% mean cover in the rarely burnt zone: Cat's Ear **Hypochoeris radicata*, Kangaroo Grass, Rigid Panic *Homopholis proluta*, Squirrel-tail Fescue **Vulpia bromoides* and Spear-grasses *Stipa* species. The exotic Cat's Ear dominated the rarely burnt area with a mean cover of 33%, but reached only 1% mean cover in the frequently burnt zone. Despite dramatic differences between the two fire zones in the mean *cover* of different species, the mean *number* of species in each quadrat (i.e. species richness) was similar in both zones (Table 1). On average, 10.5 species occurred in each quadrat in the rarely burnt area, compared to 9.6 in the frequently burnt area; although small, this difference was statistically significant ($P < 0.05$; Table 1).

Surprisingly, given the substantial differences in management history, there was no significant difference ($P > 0.05$) between the two zones in the species richness or cover of all annual species when pooled together. Furthermore, when assessed individually, most annual species occurred at similar frequencies in both zones. Only four species – Mediterranean Brome **Bromus hordeaceus*, Oats **Avena* sp., Lesser Quaking-grass **Briza minor* and Subterraneum Clover **Trifolium subterraneum* – had a significantly greater cover in either zone in 1996, and all were more

Table 1. Mean species richness and cover of native and exotic species in frequently burnt and rarely burnt zones at Laverton North in November 1996. Significance levels using the Mann-Whitney U-test: NS = not significant ($P > 0.05$); * = $P < 0.05$; *** = $P < 0.001$.

Attribute	Frequently burnt	Rarely burnt	Significance (*P* value)
		Mean % cover	
Native species	72.0	40.5	***
Exotic species	6.6	49.0	***
		Mean species richness	
Number of species	9.6	10.5	*
Native species	3.3	3.9	*
Exotic species	6.3	6.6	NS

abundant in the rarely burnt zone (Appendix 1).

Only one geophyte was recorded, Common Onion-grass **Romulea rosea*. This species occurred in all frequently burnt quadrats (mean cover 0.5%), but none of the unburnt plots. Whilst significantly more forb species were recorded from each quadrat in the frequently burnt zone (5.4 c.f. 4.0, $P < 0.0001$), forb cover was significantly greater in the rarely burnt zone (37% c.f. 6%, $P < 0.0001$), owing to the abundance of Cat's Ear.

Quadrats in the rarely burnt zone had significantly fewer Kangaroo Grass tussocks and tillers than those in the frequently burnt zone (Table 2). However, there was no significant difference between the zones in the number of inflorescences or tillers produced per tussock ($P > 0.05$). Mean biomass 20 months after burning was substantially greater in the frequently burnt zone, but this difference was not significant ($P = 0.0549$); however the P value is close to 0.05 and suggests that a Type I error might be likely, and that significant difference may have been reported had more samples been collected. Many dead Kangaroo Grass tussocks and tillers occurred in the rarely burnt area, indicating substantial Kangaroo Grass mortality in the past.

Discussion

The frequently burnt and rarely burnt areas at Laverton North Grassland Reserve now have very different plant compositions, despite their superficial similarity at the time of reservation in 1978. The most obvious differences are the abundance of exotic species and the decline of Kangaroo Grass in the area which remained unburnt for 17 years.

Statistically, this sampling design is termed 'pseudoreplicated' (Hurlbert 1984); whilst the samples (quadrats) were replicated, the two treatments (fire zones) were unreplicated (i.e. there was only one zone for each fire type, rather than replicates of both treatments). This problem plagues many observational and experimental studies in ecology (e.g. Wahren *et al.* 1994). This means that, whilst significant differences in plant composition between the zones can be formally demonstrated, the reasons for these differences cannot be formally identified from the data gathered. Since only one unburnt area exists, it is possible that the differences between the burnt and unburnt zones were not necessarily due to burning history, but could perhaps be due to underlying differences in soil type or initial plant composition. Such a problem highlights the value of including more than one 'control' site in a reserve, to increase the confidence that any differences between the control and other areas were due to different management treatments, rather than to intrinsic site factors.

Notwithstanding this statistical caveat, we are confident that the differences observed are primarily due to different burning histories rather than to underlying site factors. Firstly, there are no obvious differences in topography or soils between the two areas. Secondly, when the 'control' area was first established in the 1970s, there were no obvious differences between the control and adjacent areas (Bob Parsons and Dale Tonkinson, *pers. comms*, July 1998). Thirdly, the boundary between the two zones is obvious, sharp,

Table 2. Comparison of mean tussock attributes of the dominant grass, *Themeda triandra*, between the two fire zones in November 1996, 20 months after burning. Significance levels using the Mann-Whitney U-test: NS = not significant ($P > 0.05$); * = $P < 0.05$; ** = $P < 0.01$.

Attribute	Frequently burnt	Rarely burnt	Significance (P value)
Biomass (kg/ha)	4640	3490	NS
No. tussocks / 0.25m²	11.8	3.6	**
No. live tillers / 0.25m²	406	170	*
No. inflorescences / 0.25m	46	28	NS

triangular, and clearly marks the fire boundary between the two zones. The long-unburnt vegetation is now distinctively different from grassland vegetation throughout the rest of the Laverton North Reserve, even though soil and drainage conditions vary considerably in other areas of the reserve. Furthermore, the decline in Kangaroo Grass in the long-unburnt area follows a similar trend to that observed at the nearby Derrimut Reserve, where the poor Kangaroo Grass health was directly related to fire history (Lunt and Morgan 1999a; Morgan and Lunt 1999). Finally, the long-unburnt area at Laverton North has been observed by many grassland botanists during the past 20 years. All those we contacted had no doubt that fire management was likely to be the principal reason for the substantial differences in plant composition between the two zones (Keith McDougall, Bob Parsons, Steve Platt, Neville Scarlett, Dale Tonkinson, *pers. comms*, July 1998). For these reasons we are confident that, whatever minor differences in soils and initial plant composition might exist between the two areas, long-term differences in fire management are most likely to account for the patterns observed.

Kangaroo Grass mortality

The long-term absence of fire (and other disturbances) led to a substantial decline in the dominant Kangaroo Grass in the rarely burnt zone. There were many dead tussocks in this zone, and the density of live tussocks was only 30% of that in the frequently burnt zone. A similar decline of Kangaroo Grass in the absence of fire has also been found at the nearby Derrimut Grassland Reserve (Morgan and Lunt 1999). At Derrimut, dead grass from previous years' growth steadily accumulated until tussocks started to senesce after about 5 years and eventually died after about 10 years. The cause of death was assumed to be self-shading by old, dead leaves. Areas which had not been burnt for 11 years supported extensive swards of dead Kangaroo Grass, only 25% of which survived when tussocks were belatedly burnt (Morgan and Lunt 1999).

McDougall (1989) studied the long-unburnt zone at Laverton North in 1986 (8 years after the reserve was proclaimed), and documented the poor health of unburnt Kangaroo Grass tussocks at that time. Whilst McDougall (1989) described the small basal area and poor root development of unburnt plants, which were easily killed after trampling, he did not record any substantial mortality of Kangaroo Grass and this appears to have occurred since 1986. This mortality has major implications for future weed invasions, since areas where Kangaroo Grass has died are likely to be prone to invasion by exotic species such as Chilean Needle-grass **Nassella neesiana* (Lunt and Morgan 1999b). Elsewhere, we have suggested a simple method of assessing Kangaroo Grass health to help prevent such mortality occurring in other areas (Lunt and Morgan 1998).

Exotic species

A number of perennial exotic species – including Cat's Ear, Yorkshire Fog **Holcus lanatus*, Paspalum **Paspalum dilatatum*, Buck's-horn Plantain **Plantago coronopus* and Ribwort **Plantago lanceolata* – were abundant in the long-unburnt area in 1996, but were rare or absent in the frequently burnt zone (Appendix 1). All of these species have expanded considerably since McDougall's 1986 survey (McDougall 1989). For instance, Cat's Ear was recorded from just

1% of quadrats in the rarely burnt zone in 1986, compared to 100% in 1996. Similarly, Ribwort, Yorkshire Fog and Buck's-horn Plantain were not recorded from either zone in 1986, but occurred in 92%, 66% and 18% respectively of rarely burnt quadrats in 1996. These perennial weeds grow vigorously in rank, undisturbed vegetation, and their expansion is disturbing, since all are likely to be difficult to control.

By contrast, another group of exotic species (including the wind-blown daisies, Aster-weed **Aster subulatus*, Spear Thistle **Cirsium vulgare* and Ox-tongue **Helminthotheca echioides*) was more abundant in the frequently burnt zone than the rarely burnt area. These three species have increased in abundance since 1986 (McDougall 1989). The reason for this expansion is unknown but worthy of further investigation. Thus, whilst frequent burning did not prevent invasion of all exotic species, it did result in significantly less cover of exotic species than did fire exclusion.

Many species of exotic annual grasses and forbs are abundant at Laverton North (and in many other grassland remnants). Consequently, the impact of different fire regimes on this group of species is of some interest. Perhaps surprisingly, given the magnitude of the differences between the two zones, there was no significant difference between the two zones for most exotic annuals. The abundance of exotic annual species in both zones in 1996 (20 months after burning) demonstrates their potential to rapidly re-establish large populations from a persistent soil seed bank. Thus, long-term fire exclusion did not provide a suitable method for depleting these exotic species.

By contrast, long-term fire exclusion proved an extremely successful method of controlling the exotic geophyte, Common Onion-grass **Romulea rosea*. This species is abundant in many grassland remnants in south-eastern Australia (McDougall and Kirkpatrick 1994) and resprouts vigorously after fire (Lunt 1990). In 1996, Common Onion-grass was not recorded from a single quadrat in the rarely burnt zone, but was found in every quadrat in the frequently burnt zone. This decline has occurred since 1986, as McDougall (1989) recorded the species from 98% of frequently burnt quadrats and 89% of unburnt quadrats in 1986. Unfortunately, however, this small beneficial outcome was more than compensated for by the negative impacts of Kangaroo Grass death and the promotion of other perennial exotic weeds in the long-unburnt area.

Generality of results

This study has documented a number of adverse outcomes from long-term fire exclusion in a native grassland, including the decline of Kangaroo Grass and the promotion of vigorous, perennial exotic weeds. These findings support much of the grassland conservation literature (e.g. Stuwe and Parsons 1977; McDougall 1989; Lunt 1991) which has stressed the need for frequent biomass reduction (i.e. grass removal) to maintain grassland values. However, whilst earlier recommendations have focussed on potential losses of native plant diversity, these results show little change in native plant diversity, but instead show an expansion of perennial weeds and decline of the dominant Kangaroo Grass.

The failure to document major changes in native plant diversity probably reflects the landuse history of the Laverton North reserve. When the reserve was established in 1978, native plant diversity was low as a result of past stock grazing (many species occurred in the reserve, but few forbs were abundant). By contrast, studies which have recorded substantial losses of native plant diversity beneath dense grass have focussed on intact, diverse remnants (e.g. rail and road reserves) or more sensitive species (e.g. Scarlett and Parsons 1990; Morgan 1997). Presumably such losses may also have occurred at Laverton North had the area been diverse in the 1970s.

How relevant are these findings to other grasslands dominated by Kangaroo Grass? Since this study was conducted at one site only, it is difficult to generalise to other areas. However, we have observed similar processes in other Kangaroo Grass grasslands in western Victoria (e.g. Derrimut and Lake Goldsmith Wildlife Reserve), Gippsland (e.g. West Sale) and the ACT.

Conversely, grasslands exist in these and other regions with a diverse native flora and healthy swards of Kangaroo Grass, despite not being grazed or burnt for extended periods (e.g. McDougall and Kirkpatrick 1994, p. 61). Clearly, further work is required to better predict where such problems are likely to occur in the future. We would suspect however that Kangaroo Grass decline can potentially occur in many productive sites (of moderate rainfall and/or soil fertility) where Kangaroo Grass can grow vigorously to form a closed sward. Elsewhere, we would simply encourage managers to remain alert to the possibility of future grass mortality, and to assess grass health regularly (Lunt and Morgan 1998).

Whilst the lessons learnt from the long unburnt zone at Laverton North are negative ones, we do not wish to imply that the unburnt 'control' plot should never have been managed in this way. On the contrary. The long-unburnt zone has provided valuable lessons in a relatively small area. Hopefully these lessons will not have to be re-learnt elsewhere.

Acknowledgements

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Appendix 1. Percentage frequency and mean percentage cover of all plant species in the frequently burnt (freq. burnt) and rarely burnt zones of the Laverton North Grassland Reserve in November 1996. Asterisks before the scientific name denote exotic species. Differences in mean % cover were determined using Mann-Whitney U-tests. Values are highlighted where $P < 0.01$. Significance levels: NS = not significant ($P > 0.05$); * = $P < 0.05$; ** = $P < 0.01$; *** = $P < 0.001$.

Species	Common name	% frequency		Mean % cover		
		Freq. burnt	Rarely burnt	Freq. burnt	Rarely burnt	Signif. (P value)
Acaena echinata	Sheep's Burr	0	2	0.00	0.01	NS
Agrostis aemula	Purplish Blown Grass	16	0	**1.84**	0.00	**
Agrostis avenacea	Common Blown Grass	60	66	4.92	1.29	NS
*_Anagallis minima_	Chaffweed	4	2	0.02	0.01	NS
Asperula scoparia	Prickly Woodruff	2	0	0.01	0.00	NS
*_Aster subulatus_	Aster-weed	94	36	**0.47**	0.18	***
*_Avena_ species	Oat	4	66	0.02	**0.33**	***
*_Briza maxima_	Large Quaking-grass	6	0	0.04	0.00	NS
*_Briza minor_	Lesser Quaking-grass	70	34	0.35	**0.46**	***
*_Bromus hordeaceus_	Soft Brome	20	60	0.10	**0.31**	***
Carex breviculmis	Short-stem Sedge	4	52	0.02	**0.26**	***
*_Centaurium tenuiflorum_	Branched Centaury	0	4	0.00	0.02	NS
*_Cirsium vulgare_	Spear Thistle	86	40	**1.04**	0.02	***
Convolvulus erubescens	Pink Bindweed	4	44	0.11	**0.23**	***
*_Conyza bonariensis_	Tall Fleabane	22	6	0.11	0.03	*
*_Cynodon dactylon_	Couch	0	4	0.00	0.02	NS
*_Cyperus tenellus_	Tiny Flat-sedge	2	4	0.01	0.51	NS
Danthonia species	Wallaby-grasses	8	10	0.04	0.07	NS
Deyeuxia quadriseta	Reed Bent-grass	4	10	0.02	0.14	NS
Dichelachne crinita	Long-hair Plume-grass	16	0	**0.08**	0.00	**
Elymus scabrus	Common Wheat-grass	2	0	0.01	0.00	NS
Epilobium billardierianum	Robust Willow-herb	38	0	**0.19**	0.00	***
Eryngium ovinum	Blue Devil	6	12	0.04	0.06	NS
*_Euchiton_ species	Cudweed	0	2	0.00	0.01	NS
*_Gamochaeta purpurea_	Cudweed	2	0	0.01	0.00	NS
*_Helminthotheca echioides_	Ox-tongue	48	2	**0.64**	0.01	***
*_Holcus lanatus_	Yorkshire Fog	0	66	0.00	**3.10**	***
Homopholis proluta	Rigid Panic	0	20	0.00	**10.82**	***
*_Hypochoeris radicata_	Cat's Ear	54	100	1.24	**33.41**	**
*_Juncus capitatus_	Dwarf Rush	0	4	0.00	0.02	NS
*_Leontodon taraxacoides_	Hairy Hawkbit	20	16	0.20	0.12	NS
*_Lolium rigidum_	Wimmera Rye-grass	2	4	0.02	0.02	NS
Oxalis perennans	Grassland Wood-sorrel	4	6	0.02	0.03	NS
*_Paspalum dilatatum_	Paspalum	0	8	0.00	1.32	*
Pimelea spinescens	Plains Rice-flower	2	2	0.01	0.01	NS
*_Plantago coronopus_	Buck's-horn Plantain	0	18	0.00	**1.50**	**
*_Plantago lanceolata_	Ribwort	0	92	0.00	**0.46**	***
*_Romulea rosea_	Common Onion-grass	100	0	**0.50**	0.00	***
Schoenus apogon	Common Bog-sedge	4	0	0.02	0.00	NS
Senecio glomeratus	Annual Fireweed	2	4	0.01	0.02	NS
Senecio quadridentatus	Cotton Fireweed	54	10	**1.24**	0.05	***
*_Sonchus asper_	Rough Sow-thistle	2	6	0.01	0.32	NS
Stipa species	Spear-grasses	2	48	0.01	**5.49**	***
Themeda triandra	Kangaroo Grass	98	100	**63.40**	22.07	***
*_Tragopogon porrifolius_	Salsify	0	20	0.00	**0.10**	***
*_Trifolium subterraneum_	Subterraneum Clover	0	14	0.00	**0.07**	**
*_Vulpia bromoides_	Squirrel-tail Fescue	96	82	1.78	6.65	NS
*_Vulpia myuros_	Rat's-tail Fescue	0	4	0.00	0.02	NS

The Beetle *Gondwanennebous minutissimus* Kaszab (Coleoptera: Archeocrypticidae) – a First Record for Victoria

A number of small beetles (<3 mm) that had been collected from pit lines in the Red Box *Eucalyptus polyanthemos* woodland at Glynns Reserve, Warrandyte, during the FNCV survey of the invertebrate fauna, could not be identified. The key used (Moore 1980) only works satisfactorily with beetles greater than 3 mm in length.

In some cases, there were large numbers of these small beetles, for example 143 were collected in January 1997, 114 in July 1997 and 47 in September 1997. Since non-identification would have made the overall results of the survey less meaningful, help was sought from Dr John F Lawrence (CSIRO Canberra, Division of Entomology) in identifying two particular groups that made up most of the unidentified specimens.

Dr Lawrence was very helpful, and named the two species of beetles which comprised most of the unidentified specimens as *Thalycrodes pulchrum* (Coleoptera: Nitidulidae) and a *Nargomorphus* sp. (Coleoptera: Leiodidae). Furthermore, he enthusiastically selected another minute beetle (brown, ca 2 mm), unidentified from the July sampling, which he identified as *Gondwanennebous minutissimus*. Dr Lawrence said that this beetle had been previously known only from New South Wales, ACT, South Australia and Western Australia (Lawrence 1994). Our specimen (Fig. 1) was, therefore, the first record from Victoria.

Details of the Glynns record: Date, 12–19 July 1997; Location, Warrandyte, Victoria 37°44'12" S, 145°11'42" E; Habitat, Red Box *Eucalyptus polyanthemos* woodland; Collecting method, pitfall traps; Collector, The Field Naturalists Club of Victoria.

The specimen has been lodged with the Museum of Victoria who also advise this is the first and only specimen from this family in their collections (A. Yen *pers. comm.*).

This note reinforces two important lessons – the need to retain and label all unidentified species within an order, and how easy it is to overlook important material through lack of knowledge and skill.

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Yallambie, Victoria 3085.

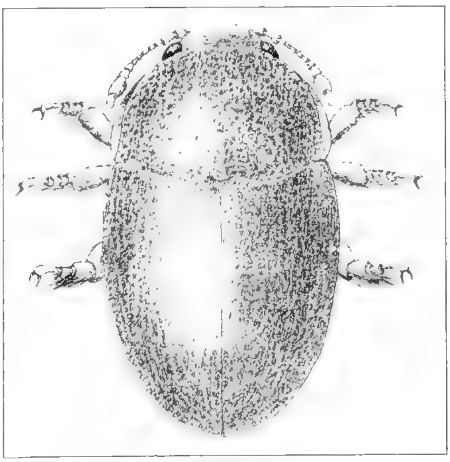

Fig. 1. *Gondwanennebous minutissimus* (about 2 mm). Drawing by Erich Sacco.

Thin-skinned Tectonics: its Application in Western Victoria

D.H. Taylor[1]

Abstract
Thin-skinned tectonics has become the standard framework for interpreting the crustal structure of Victoria. Steeply dipping structures visible at the surface are no longer viewed as extending downwards to great depths. Instead such structures are interpreted to have 'grown' or 'peeled off' from discrete levels in a crust composed of several stacked layers, the topmost being a 'thin-skin'. (*The Victorian Naturalist* **116** (3), 1999, pp. 92-96).

Introduction

This paper was written on invitation to explain the much used term thin-skinned tectonics, with examples from Victoria being used to illustrate the concept. Tectonics is the study of the structures in rocks and the broader geometrical architecture of the earth's crust which develops in response to imposed pressures. Geology is a young science and many of the accepted ideas about how structures develop when imposed pressures deform rocks are relatively recent. For example, theories explaining how rocks fold and develop cleavages weren't well documented until the 1960-70s, and compressional (stacking) and extensional (segmenting) faults were poorly understood until the late 1970s and early 1980s. The recent widespread acceptance and application of the concept of thin-skinned tectonics has grown out of these basic understandings of how rocks and the crust deform.

The new array of concepts has allowed a much more dynamic interpretation than previously - a paradigm shift. It is now accepted that large pieces of the crust may be transported around on accommodating structures such as weak or 'slippery' layers and stacked or emplaced upon other crustal pieces to form a composite crust of which the upper levels may be considered a 'thin-skin': hence the term 'thin-skinned tectonics'. The process being somewhat analogous to a carpet being pushed across and rucking up over a smooth floor.

The view that the deformed crust we see at a site today always represents the remains of strata once deposited close to that original site may also no longer hold true. The process of continental drift is now recognised as the mechanism by which masses of rock formed in one place on the earth's surface may be transported and amalgmated into another region which was previously far away, thus giving rise to 'exotic terranes' (e.g. Jones *et al.* 1983).

This burgeoning knowledge has revolutionised how we interpret the architecture of the earth's crust from the mapping of the 2-dimensional surface exposure. In the past, surface structures were extended to great depths into the underlying crust which was considered to be static and essentially deformed in place. This is the view expressed in the first comprehensive synthesis of the Geology of Victoria (Douglas and Ferguson 1976). Since then the concept of thin-skinned tectonics has been applied to Victoria (e.g. Fergusson *et al.* 1986) and incorporated into the revised synthesis of the Geology of Victoria (Douglas and Ferguson 1988). Since the revised geological synthesis was presented, widespread detailed and ongoing geological mapping of the state by the Geological Survey of Victoria (e.g. VandenBerg *et al.* 1992; Cayley and McDonald 1995; Taylor *et al.* 1996) and university investigations (e.g. Cox *et al.* 1991) has filled in much of the detail only addressed in principle in the revised synthesis (Fig. 1).

Western Victoria: an example of thin-skinned tectonics

In the first synthesis of the Geology of Victoria (Douglas and Ferguson 1976) the deformed piles of deep marine sediments that comprise most of western Victoria were viewed as different sedimentary basins (depositional troughs) separated by highs of volcanic rock (Fig. 2). The troughs contain many kilometres of sediments, thickened by folding, and cut by numerous faults. Across the goldfields of western Victoria much of the structure was

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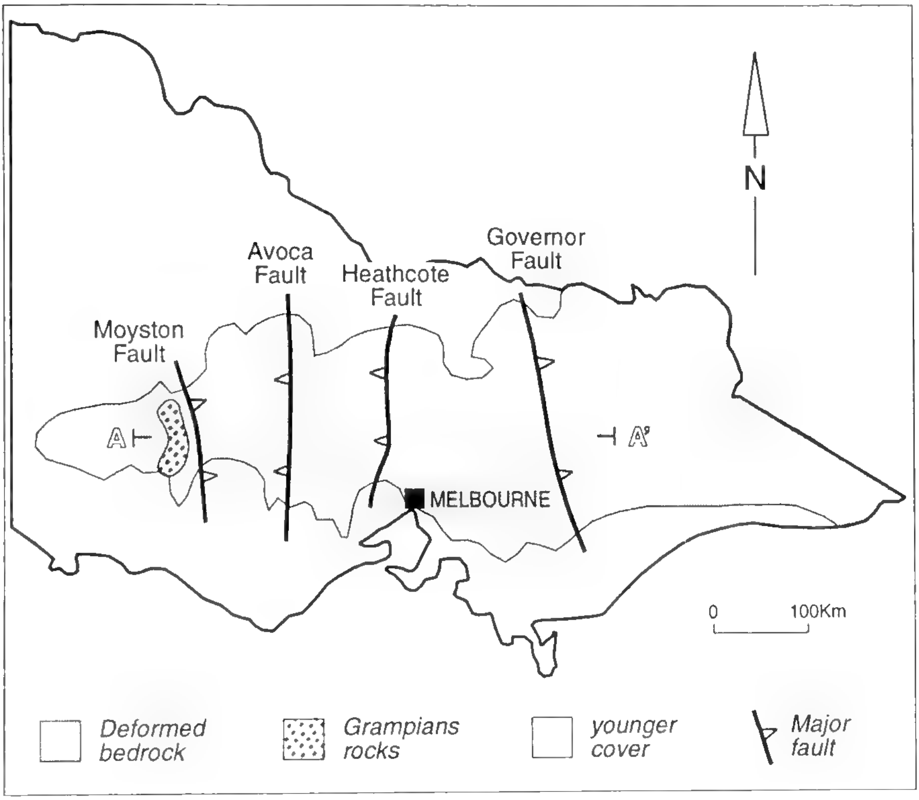

Fig. 1. Map of Victoria showing the position of the major faults across the west-central region and the position (A-A') of the section lines presented in Figs. 2, 3 and 4.

inferred from the distribution of graptolite fossils (small planktonic marine organisms whose diversification over time makes them useful for determining rock ages) which also provided an estimate of the offset across large faults (e.g. Harris and Thomas 1948). The extent and geometry of the faults below the surface were unknown but were viewed as extending sub-vertically to as deep as any cross-section could show. A synthesis of how the surficial rocks were deformed and what lay beneath them was beyond the scope of the geological knowledge of the time.

By the second edition of the Geology of Victoria (Douglas and Ferguson 1988) the ideas and mechanisms of thin-skinned tectonics had been applied to Victoria. Rather than being in-situ, separate sedimentary basins the deformed sediments were now interpreted as being parts of the same large ocean basin amalgamated along major faults (Fig. 3). Movement along these major faults transported the volcanic rocks, fragments of the original ocean floor underlying the sediments, to the surface. Thus the volcanic rocks are no longer viewed as ancient topographic highs separating many depositional troughs but as the deepest parts of one great big trough brought to the surface by faults!

The major faults continually expose the volcanic rocks, or the oldest sediments lying just above them. In the deformed rock pile these rocks generally now reside at mid-crustal levels of about 15 km. Since the faults are steep at the surface and keep bringing rocks to the surface from roughly the same crustal level they must flatten out and tap into this mid-crustal level which is called a detachment (Fig. 3). The flattening geometry of the faults is called a listric geometry and is supported by seismic imaging of the subsurface geometry of the

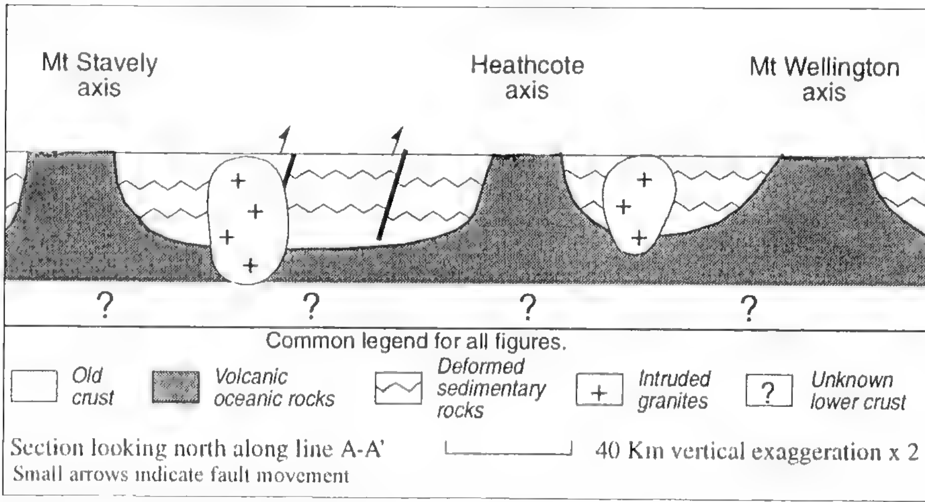

Fig. 2. Schematic cross-section of the crustal structure of western Victoria constructed from the first synthesis of Victorian geology. Note the unconstrained extension of surface structures to depth and the implication of in-situ deformation of all the exposed rocks. Note that the legend for Fig. 2 is a common legend for all Figures.

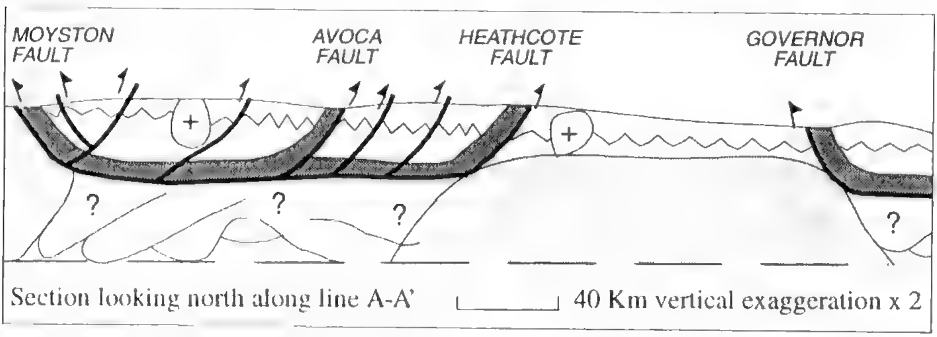

Fig. 3. Schematic cross-section of the thin-skinned tectonic interpretation of the crustal structure of western Victoria as presented in the second synthesis of Victorian geology and updated by more recent mapping. Note a top layer of folded and faulted sedimentary rocks above mid-crustal detachment faults in the underlying volcanics which are occasionally brought to the surface. The nature of the deeper crust is unknown.

Heathcote Fault Zone in which the major fault was shown to flatten at depth (Gray *et al.* 1991). Such major faults stack the stratigraphy and thus effectively shorten it, helping to accommodate the deformation imposed upon the rocks. In the sediments above the level of the mid-crustal detachment faults, the deformation is largely accommodated by the tight folds and cleavage visible in outcrops. How the shortening is accommodated below the level of the mid-crustal detachment faults is unknown but it was possibly thickened by a separate system of fault stacking.

Geological mapping in areas not complicated by strong deformation shows that the original ocean basin of western Victoria probably consisted of 3-5 km of sand-rich sediment deposited upon an ocean floor of volcanic crust that is known from modern settings to be about 6 km thick. Fossils and dating of radioactive isotopes show that this ocean basin existed from about 510 to 420 million years ago. Mapping of more deformed areas suggests significant thickening of these rocks during deformation by folds and fault stacking to form a crust about 30-40 km thick (e.g. Gray and Willman 1991). All this deformation was driven by plate tectonic forces which forced the ocean basin of western Victoria to be pushed onto the edge of the older

Australian rocks to the west. The age of this deformation is constrained between the depositional age of the rocks and the intrusion age of later granites to about 450-420 million years ago (VandenBerg 1976), a timing broadly confirmed by recent dating of minerals that grew during the deformation (Foster *et al.* 1998).

The Moyston Fault is the big fault which emplaced the oceanic basin of western Victoria against older rocks to the west (Cayley and Taylor 1998). This fault trends northwesterly through Moyston in western Victoria. West of the fault is the flat surface of the Dundas Tableland from which the Grampians Ranges protrude. To the east is the hilly country of the Western Victorian Uplands with the well developed Great Divide. Within this belt of rocks numerous faults splay up through the 'thin-skin' of folded sediments, with the biggest bringing the volcanic rocks from mid-crustal levels of about 15 km to the surface. These include the Avoca Fault which trends northerly between Maryborough and Avoca and the Heathcote Fault Zone trending northerly through Heathcote. Smaller faults which bring up sediments from just above the volcanics also occur in Victoria, with many being recognised by associated zones of more intense deformation caused by the fault movement, or by disruption to the distribution pattern of graptolite fossils. Goldfields such as Stawell often lie directly on such faults while other goldfields such as Bendigo and Ballarat occur in close proximity. It is generally accepted that the faults acted as conduits for gold-rich fluids generated at depth to rise towards the surface and be deposited in favourable sites during their upwards passage (e.g. Willman and Wilkinson 1992).

The structure of the rocks which form the Grampians has also recently been interpreted as being thin-skinned (Cayley and Taylor 1997). The tilted sedimentary strata are no longer viewed as a 7000 m thick gently deformed in-situ depositional trough. Instead, a sedimentary package originally only half this thickness was stacked by a complex fault system, probably forming a high mountain range which was then partially segmented and pulled apart by a different, later set of extensional faults. These extensional faults again flatten out into a crustal level where a detachment fault separates the younger Grampians rocks as a thin skin over older, unrelated rocks below (Fig. 4). This deformation style in the Grampians is a different type of thin-skinned tectonics to the rest of western Victoria – one driven by extension rather than shortening of the crust.

Conclusions

Thin-skinned tectonics has revolutionised the way the deformation history and crustal architecture of Victoria is viewed. Whilst the surface distribution of rocks on the map face is little altered, the cross-sec-

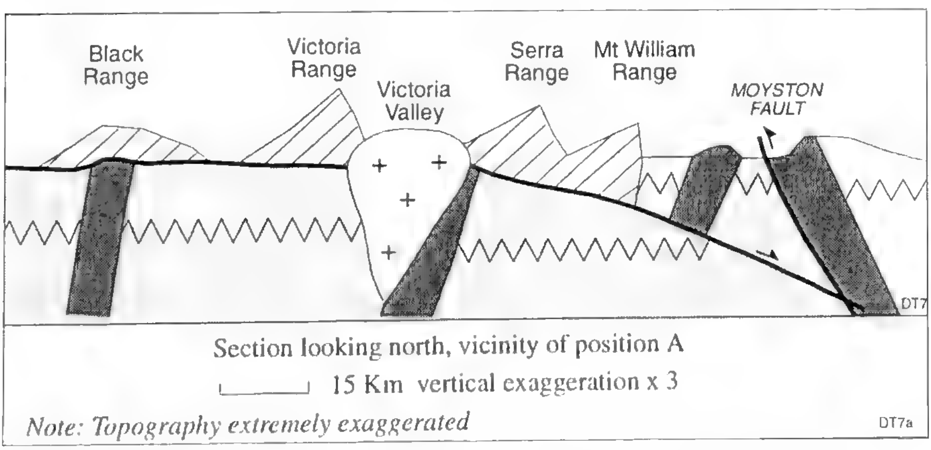

Fig. 4. Schematic cross-section of the thin-skinned tectonic interpretation of the Grampians region. Note the thin layer of deformed Grampians rocks separated from older underlying rocks by a flat detachment fault.

tional slice representing the layered crust with respect to depth is profoundly different. These ideas have been successfully applied to much of western Victoria where new map coverage is nearly complete. Thin-skinned tectonics is also applicable to eastern Victoria and an overall synthesis of this still ongoing mapping in this more rugged country will shortly be available.

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Letter to the Editor

SIR,—I was greatly pleased, when present at your conversazione last week, to hear Professor Spencer say that at last there was some reasonable chance of an early extension of the buildings at the National Museum. Having waited so long it may seem rather injudicious to propose any opposition on account of which the matter may be indefinitely postponed, but at the risk of so doing I would venture to suggest that the Field Naturalists' Club should exert its influence in favour of the removal of the National Museum to a more central and accessible site, say at the Public Library, where there is room for an annexe, similar to the picture galleries, along the Latrobe-street frontage. Here a museum would be in close proximity to the existing literature, and thus permit of greater facilities to study. It may be said that the Musuem is required at the University for teaching purposes, but I think on inquiry it will be found that biological and other schools possess nearly enough typical specimens, and that if more are required they can easily be spared from the National collection. The so-called assistants' rooms at the Museum are a disgrace to Victoria, and the whole of the accommodation is far behind that of the Australian Museum, Sydney, as I remember it some years ago.

Along with others I deeply deplore the death of the late director, Sir F. McCoy, but think that now, as there is a vacancy in the management, is the time to bring the Museum more within reach of the average citizen and student. —I am, &c.,

KANGAROO.

Melbourne, 27th May, 1899

["Kangaroo," and doubtless other readers, will be pleased to know that the desirability of removing the Museum as suggested above was affirmed at a meeting of the trustees on the 1st inst., and at the same time Professor Spencer was appointed honorary director.—ED. *Vict. Nat.*]

From *The Victorian Naturalist*, one hundred years ago, Vol. **XVI**. No. 3, 1899.

A Forester's Log: the Story of John La Gerche and the Ballarat-Creswick State Forest 1882-1897

by Angela Taylor

Publisher: *Melbourne University Press, 1998, 224 pp., maps and photographs (black & white). RRP $29.95.*

The physical appearance of a forest, or any other type of vegetation, does not reveal the complete story of its past. Certainly there are visible clues such as the diversity of species, the density and age of trees and the presence of axed stumps. Other clues exist elsewhere–in the soil profile and in the memories and records of Aboriginal and European Australians.

Angela Taylor has used the records of an early forester to provide some late nineteenth century glimpses of a Victorian forest. The forester is John La Gerche and the forest is the 'open forest of mixed species of eucalyptus [which] merges with serried ranks of plantation pines' near Creswick, where Australia's first forestry school was established in 1910. La Gerche's work in the 1880s and 1890s significantly shaped Creswick's eucalypt forest and pine plantations.

The forest between the goldfields of Creswick and Ballarat was one of many areas which, in the second half of the nineteenth century, were reserved as Victorian State forests. In 1882 La Gerche was appointed Crown Lands Bailiff and Forester 'to supervise the Ballarat & Creswick State Forest and to take legal proceedings under the 1869 Land Act against all persons found cutting or removing timber in the forest'. Using the comments he recorded in his official Letter Books (into which he copied all his official correspondence - inwards and outwards) and his Pocket Books (in which he pencilled field notes while out in the forest) Angela Taylor has re-presented La Gerche's perceptions of the forest. Executing his dual role as bailiff and forester was difficult but essential. By 1882 the forest had endured three decades of exploitation to satisfy the needs of goldmining and other European activities. Its regeneration and survival required the protection of seedlings from marauding rabbits and goats, and saplings from men seeking mine props and fuel. As well as attempting to protect the forest to allow its regeneration, La Gerche attempted to reclothe hillsides stripped bare by miners and tested a wide range of tree seedlings. He established a nursery at Sawpit Gully, where he germinated thousands of seedlings including Blue Gum, Black Wattle, Golden Wattle and Radiata Pine, and established plantations nearby.

John La Gerche was not a Club member. However, since Angela Taylor writes so engagingly about his work in the forest, this book may interest current FNCV members and other readers of *The Victorian Naturalist* who share my interest in forest history. I thank Angela Taylor for applying her historical intellect to La Gerche's Letter Books and Pocket Books and I thank those who ensured that these unique archival records were not lost.

La Gerche's plantations in Sawpit Gully are now on the Register of the National Estate. By the time you read this review, the La Gerche Walking Track* through them should be completed. My daughter, who is beginning university forest science studies this year, returned from a preliminary visit to Creswick with the hot-off-the-press track leaflet from the Creswick Landcare Centre. Now you can enjoy reading La Gerche's nineteenth century forest perceptions in *A Forester's Log* and walk through the landscape which has been shaped by his efforts over a century ago.

*Postscript. The Track has just won a Victorian Community and Local History Award.

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An Australian Sea Lion on Phillip Island, Victoria

Roger Kirkwood[1], Jenny Hibble[2] and Ian Jerret[3]

Abstract
A weak, adult, male Australian Sea Lion *Neophoca cinerea* came ashore on Phillip Island, Victoria in June 1998, the first reported sighting of this species in eastern Victoria for over 100 years. The sea lion was suffering from a severe lung infection and was euthanased to reduce the possible spread of disease. Based on growth rings in its teeth, the animal was 12 years old. (*The Victorian Naturalist* **116** (3), 1999, pp. 98-101).

Introduction

Australian Sea Lions *Neophoca cinerea* breed at colonies in South and Western Australia and have an estimated total population of 9900 to 12 400 animals (Gales *et al.* 1994; Dennis and Shaughnessy 1996). Although they were distributed more widely prior to sealing activities in the 1800s (Warneke 1982), their currently known foraging range is restricted to the coastal waters of South Australia and southern Western Australia. Occasionally, though, individuals are sighted in Victoria (Menkhorst 1995), Tasmania (Kirkwood *et al.* 1992), and New South Wales (Fulton 1990, P. Shaughnessy *pers. comm.*) (Fig. 1a). Here we report on the first such sighting of an Australian Sea Lion in eastern Victoria, as well as the death of the animal and its subsequent autopsy, which aimed to determine why it could have arrived in this area.

Description of sighting

During the afternoon of 6 June 1998, a 'large seal' came ashore at Sunderland Bay, Phillip Island (Fig. 1b). Local residents saw the seal move up a steep track, across a road and into a residential area, and reported the sighting to the Phillip Island Nature Park (PINP). One of us (RK) identified the animal as an adult male Australian Sea Lion and estimated it to be 1.9 m long and 150 kg in body mass. It appeared thin and weak, but was able to return to the sea during the night, as evidenced by its tracks across the beach the next morning.

During the afternoon of 16 June, a '2 m-long dead seal' at Shelly Beach, Phillip Island (Fig. 1b) was observed and reported to the PINP. The animal was not present when searched for by us one hour after the sighting. It may have been the underweight sea lion that actually was alive and capable of returning to the sea.

In the evening of 17 June, the same sea lion that had come ashore at Sunderland Bay (identified by patterns of scars on its neck and shoulders) was found in a backyard in Ventnor (Fig. 1b). It probably came ashore on Ventnor Beach, entered a creek behind the beach, swam inland about 1 km, then crossed 400 m of open farmland to arrive at the residential block. The sea lion did not change its position during the night and the next morning it appeared to be close to death, in the opinion of a veterinarian (JH). It was thin, could only snarl (without raising its head) when approached to within 2 m, and its breathing was laboured. We suspected the animal could have had a tuberculosis infection, which is known to occur in Australian Sea Lions (Cousins *et al.* 1993). Under the supervision of Department of Natural Resources and Environment Officers (David Cass and Grant Griffin) the sea lion was euthanased using a shot-gun fired at the head from a distance of less than 5 cm.

We took precautions to ensure non-transferral of the potential infection; the ground where the sea lion had lain was doused in petrol and burnt, the sea lion and its body fluids were contained in a plastic sheet and transported directly to a 3 m deep burial pit. Also, all handlers wore disposable gloves and breathing masks. Prior to being buried, the sea lion was autopsied (by JH and RK), its stomach contents were examined and

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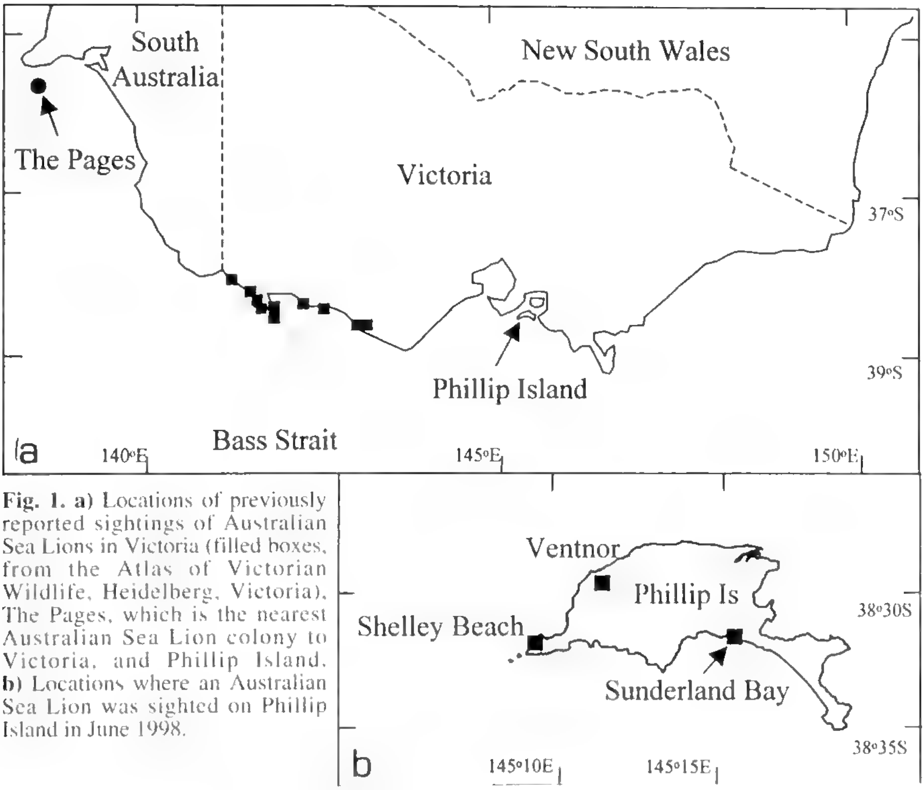

Fig. 1. a) Locations of previously reported sightings of Australian Sea Lions in Victoria (filled boxes, from the Atlas of Victorian Wildlife, Heidelberg, Victoria). The Pages, which is the nearest Australian Sea Lion colony to Victoria, and Phillip Island. **b)** Locations where an Australian Sea Lion was sighted on Phillip Island in June 1998.

several teeth were removed from its jaw for ageing.

Results and Discussion

Autopsy

The sea lion had no obvious external wounds. Several teeth were missing and those present were worn, but there was no sign of a major infection to the jaw, which sometimes is apparent in beachwashed fur seals (RK *pers. obs.*). From our experience at autopsying a range of beachwashed marine mammals, the internal tissues appeared to be normal for an otariid, in all organs except the lungs. Three-quarters of each lung exhibited generalised lesions, with only the lower sections being intact. The lesions did not have the appearance of a tuberculosis infection, which causes hard, white granulomas in fur seal lungs (RK *pers. obs.*). Samples of lung tissue were sent to Ian Jerret at the Gippsland Pathology Service, Bairnsdale, for histopathological and bacteriological examination.

The sea lion's stomach contained three, egg-shaped stones (700 g total mass, each 70–100 mm long), 16 cephalopod beaks and approximately 50 cartilaginous vertebrae from an elasmobranch. Cephalopod beaks were sent to Robyn Ickeringill (Museum of Victoria) for identification. No flesh was present in the sea lion's stomach to indicate that it had fed in the few days prior to death. Several ascarid parasites were removed from the intestinal walls and sent to the Gippsland Pathology Service for identification.

Laboratory analysis

Macroscopic examination of the sea lion's lung tissue suggested a probable bronchopneumonia. The tissue contained numerous pale areas, 2–4 mm in diameter. Microscopic examination revealed a diffuse neutrophil and macrophage infiltration of the bronchioles and alveoli. There were multiple peribronchial and interstitial areas of plasma cell and lymphocyte accumulation as well as widespread atelectasis and multifocal intra-alveolar haemorrhages. The diagnosis was chronic suppurative bronchopneumonia; the tissue

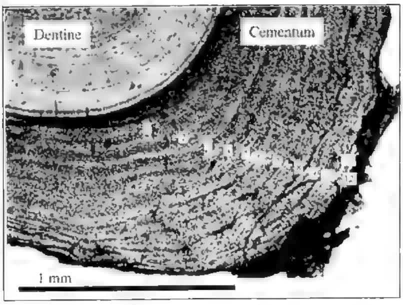

Fig. 2. A cross-section of a canine from the Australian Sea Lion that came ashore on Phillip Island. Numbers indicate growth rings in the cementum of the canine.

changes were suggestive of a non-specific bacterial infection but with no evidence of tuberculosis.

Stomach contents

The occurrence of stones in the stomach of the sea lion was normal (Walker and Ling 1981). Australian Sea Lions deliberately swallow stones that remain in their stomachs and presumably assist with digestion (Needham 1997).

The cephalopod beaks included three lower *Sepia* beaks (cuttlefish), six upper and two lower Ommastrephid beaks (squid) and five unidentified beaks. Descriptions of Australian Sea Lion diet (Walker and Ling 1981, Gales and Cheal 1992) suggest that these cephalopods, as well as elasmobranchs which were represented by the vertebrae, are normal prey for this species.

The ascarid parasites removed from the intestinal walls of the sea lion were identified as *Contracaecum ogmorhinis*, a common parasite in Australian Sea Lions (Johnston and Mawson 1941). These parasites may cause gastric ulcers in sea lions, but generally are considered to be of low pathogenicity.

Ageing

Teeth from the sea lion were sectioned and stained (hematoxylin and eosin) following the procedures outlined in Johnston and Watt (1980). A total of 12 growth rings were evident in the cementum of the canines (Fig. 2). Assuming the rings represented annual growth (as has been demonstrated for other otariids such as the Antarctic Fur Seal *Arctocephalus gazella*, Arnbom *et al.* 1992), the sea lion was 12 years of age. This is old for male sea lions, which rarely live more than 12 years (Stirling 1972).

There appeared to be a change in the growth pattern of the canine's cementum after the laying-down of the fifth growth ring (see Fig. 2). Australian Sea Lions mature at about five years of age and the changed growth pattern in the cementum may reflect a behavioural or physiological modification in response to maturation.

Conclusions

This paper describes the rare sighting of an Australian Sea Lion outside South and Western Australian waters, and the first record, since sealers' accounts, of this species in eastern Victoria. In the 1800s, Australian Sea Lions bred at several locations in Bass Strait, but sealers eliminated their colonies (Warneke 1982). Since 1973, 13 Australian Sea Lions have been recorded in western Victoria, one in southern Tasmania and three on the New South Wales south coast (Menkhorst 1995 and unpublished reports to the Atlas of Victorian Wildlife, Kirkwood *et al.* 1992, Fulton 1990 and P. Shaughnessy *pers. comm.*). Like the Phillip Island sea lion, most sightings have been of large males, although some females also have been noted. The apparently rare visits to Bass Strait waters may be occasional wanderings by individuals away from the species' normal foraging range. Alternatively, Australian Sea Lions may forage regularly in Bass Strait waters, but rarely come ashore on coasts where they can be sighted.

Australian Sea Lions are known to occasionally travel inland. Individuals have been found up to 10 km from the coast (Wood-Jones 1925), so it was not exceptional for the sea lion on Phillip Island to travel 1 km inland. The animal's poor condition (bronchopneumonia and starvation), however, probably impared its judgement, which may have influenced its movement away from the sea.

The frequency of occurrence of bronchopneumonia in sea lions is unknown, but it has been a common infection in other otariids that have come ashore in poor condition on Victorian beaches (Beasley 1998). In the present instance, old age may have reduced the sea lion's ability to tolerate infection making it susceptible to the broncho-pneumonia.

This sea lion was euthanased because we suspected that it had a tuberculosis infection. We recommend, however, that pinnipeds that come ashore on beaches in southern Australia normally should be left alone. If the animal appears to be suffering or diseased, a veterinarian should inspect it. Euthanasia is a last resort to end undue suffering by an individual and/or prevent the spread of disease.

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Albury-Wodonga Field Naturalists Club	$10	Dr Elizabeth N. Marks	$100
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The fund relies almost entirely on donations, and the annual administrative costs are about $100. Expenses in 1998 were high, because we had four new medallions struck, which together with the presentation boxes cost $1280. Anyone wishing to make a donation to this fund should make cheques payable to the Field Naturalists Club of Victoria, and send to the Treasurer, FNCV, Locked Bag 3, Blackburn 3130.

The Australian Natural History Medallion, which was instituted in 1939, is awarded annually to a person who, in the preceding ten years, has made a significant contribution to the understanding of natural history in Australia.

Hydroids from Ricketts Point and Black Rock, Victoria

Jeanette E Watson[1] and the late Daniel E. McInnes[2]

Abstract
Daniel McInnes, naturalist and microbiologist (3/10/1906 24/9/98) left many notes but published few results of his observations over many years on the Hydrozoa from Port Phillip Bay. In this paper his research notes on hydroids collected during the 1980s are collated and edited. The paper describes six species of athecate hydroids, two of which are first records for their respective genera in Australia, two are Australian species not reported since their first description and four thecate species including one probably new species. (*The Victorian Naturalist* **116** (3), 1999, pp. 102-111).

Introduction

Daniel McInnes, naturalist and microbiologist (3/10/1906 – 24/9/98) left many notes but published few results of his observations over many years on the Hydrozoa of Port Phillip Bay. During the 1980s he regularly collected intertidal and shallow water hydroids from the Melbourne seaside suburbs of Black Rock (37° 58' S, 145° 01' E) and Ricketts Point (38° 00' S, 145°02' E) in Beaumaris. He found many hydroids growing on common seaweeds near shore and in tide pools on the rock platform. Species on which he found hydroid epiphytes were the green alga *Ulva*, holdfasts and thalli of the brown kelps *Ecklonia radiata* and *Cystophora* sp. and the red coralline alga *Corallina officinalis*.

He examined his collections in the small laboratory and seawater aquarium at his home in the suburb of Malvern. The aquarium system consisted essentially of aerated glass tanks and an array of plastic containers. Interesting specimens selected under the microscope were isolated in glass petrie dishes in the containers. Hydroids that particularly caught his attention were the small, cryptic species which have received little study in Australia. A detailed account of his collection methods and aquarium maintenance are given in McInnes (1982).

He kept a behavioural diary of his aquarium specimens, including copious weekly, daily and sometimes hourly notes and diagrams of interesting specimens. (One such note plaintively asks 'Oh! where has my medusa gone?' An hour later according to his diary, the errant medusa was found hidden under algae.) Although his measurements and drawings are accurate, unfortunately he left no preserved or mounted voucher or type specimens, presumably because he continued observations until the specimens died.

A difficulty I encountered in reviewing his data is that in many instances, he did not name the specimens under observation, providing only a reference such as 'hydroid in red container 3'. Those specimens which he was able to name were usually correct to genus and generally to species; often, however, these were old names now synonymised in the modern literature.

I suspect that his lack of rigorous scientific publication was a matter of diffidence and that he (quite wrongly) considered himself to be an amateur whose efforts in taxonomy would be unworthy of scientific recognition. As a tribute to his work I now try to set the record straight. I have been able to extract and summarise from his notes the following information: two species are first records of their respective genera from Australia; two species have not been reported in Australia since their first description and gaps in life histories of some others have now been filled. Because of insufficient information and unfinished sketches I regretfully exclude several other unusual athecate species. Three thecate species including one almost certainly new to science are reported and other common athecate and thecate hydroids he found on algae are listed. For clarity in publication it has been necessary to redraw many of his sketches from the microscope. In keeping with what I am sure would have been his wish, in this paper he is referred to simply as 'Dan'.

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Subclass Anthoathecata
Family Clavidae McCrady, 1859
***Clava* Gmelin, 1791**
***Clava* sp.**
Fig. 1A

Material

Colony collected 7/3/85 from underside of *Ecklonia radiata* holdfast; colony survived until 18/4/85. Another colony of many dozens of hydranths collected 8/4/87.

Description

Hydranths arising directly from a creeping stolon; stolon and hydranth pedicel covered by thin perisarc. Hydranth cylindrical, young hydranth with four oral tentacles, probably moniliform, 0.3-0.4 mm long but tentacles not in a whorl; hypostome clavate. Tentacles increasing in number to 18, scattered over hydranth body, older (distal) tentacles up to 0.8 mm in length, proximal ones shorter. Hydranth up to 2 mm high at

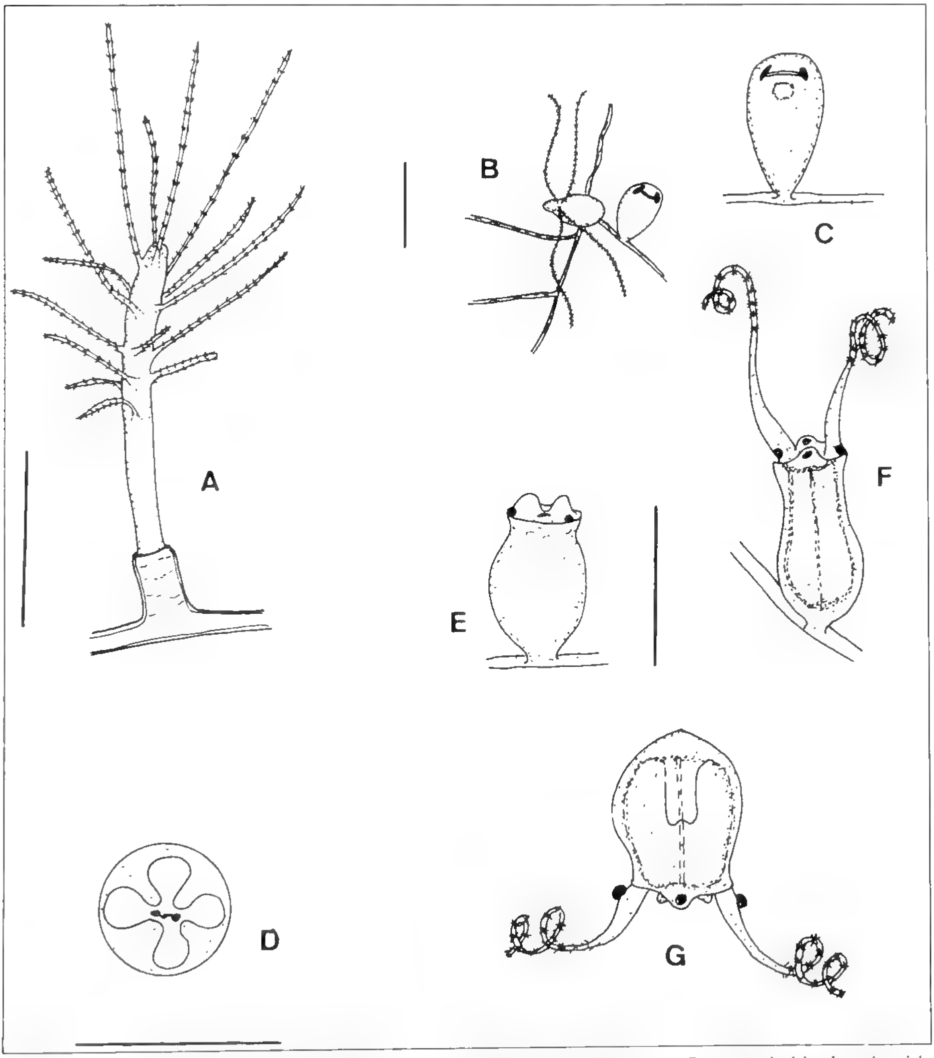

Fig. 1A-G. A, *Clava* sp., extended hydranth. B-G, *Rathkea octopunctata*. B, extended hydranth with four tentacles and medusa bud, C, medusa bud, enlarged, showing spots, D, apical view of medusa bud, E, more advanced medusa with tentacle bulbs, F, medusa with newly extended tentacles, G, liberated medusa. Scale bar: 0.5 mm.

maturity, pedicel about 1.2 mm long.

Colour Hydranths colourless to grey.

Remarks

One stolon grew to a length of 8.5 mm. The number of tentacles on the hydranth increased from four to 10 over a period of nine days. During this time one of the hydranths was observed feeding on an amphipod.

One of the problems encountered in rearing very small hydroid colonies detached from their substrate is inducing re-attachment to new substrata in the aquarium. Dan apparently successfully solved this with *Clava* by embedding the stolons in a blob of petroleum jelly on the bottom of a petrie dish.

This may be the species listed by Dan as *Turris neglecta* Lesson (McInnes 1982). In the absence of reproductive structures and without information on the cnidome the species cannot be identified. There are no previous records of the genus *Clava* from Australia.

Family Rathkeidae Russell, 1953

***Rathkea* Brandt, 1838**

***Rathkea octopunctata* (M. Sars, 1835)**

Fig. 1B-G

Cytaeis octopunctata M. Sars, 1835: 38, pl. 6, figs 14a-g.
Rathkea octopunctata- Russell, 1953: 137, pl. 7, figs 3-4, text-figs 65A-E, 66, 67A-B.- Southcott, 1982: 130, fig. 4.20a, b.- Schuchert, 1996: 49, fig. 34a-c.- Watson, 1998.

Material

Colonies first found in 1982. Colonies collected in April 1986 were maintained in aquaria until November 1986, during which period the hydranths multiplied on glass to 30 - 40 individuals and at least two medusae were released.

Description

Colonies stolonal, hydranths arising from a ramified, creeping hydrorhiza. Hydranths pyriform to spindle-shaped, capable of extension to 0.3 mm, with four thread-like filiform oral tentacles up to 2 mm in length.

Juvenile gonophores ovoid, 0.5 mm high and 0.3 mm wide, borne erect from stolon on a very short pedicel. Viewed from above, the young medusa within the gonophore has four thick internal lobes, probably radial canals, and two central red spots connected by a thin red line (Fig. 1D). After four days the gonophore became vase-shaped with two opposite, protruding, thick tentacle bulbs; base of bulbs with red spots. At this stage the medusa commenced pulsing inside the gonophore.

Over several hours the gonophore extended to 0.6 mm in length and the two tentacle bulbs became elongated into two long, filiform tentacles armed with nematocysts in the distal third; two more thick tentacle bulbs appeared opposite the original tentacles. The red spots, present at the base of each bulb, now enlarged into perradial vesicles.

Several hours later, the medusa was released. At this stage the umbrella was balloon-shaped, 0.6 mm high and 0.4 mm wide, slightly thickened apically, with faint radial canals passing down the umbrella to the tentacle bases. A quadrangular manubrium extended more than halfway through the bell; mouth a simple broad disk. The gonophore remained as a transparent deflated sheath. The observations ended with death of the medusa.

Remarks

There are five known species of *Rathkea* medusae (O'Sullivan 1984), of which *Rathkea formosissima* and *Rathkea octopunctata* have been reported from New Zealand (Schuchert 1996) and *R. octopunctata* from Port Phillip Bay, Australia (Southcott 1982). Of these species, only the hydroid stage of *R. octopunctata* has been conclusively associated with its medusa (Russell 1953). Watson (1998) recorded an infertile hydroid growing on a muddy bottom in the Geelong Arm of Port Phillip Bay and doubtfully referred it to that species. Dan's sketch of the hydroid exactly matches the description and figure of *Rathkea octopunctata* given by Watson (1998).

The newly liberated medusa of *R. octopunctata* from the parent hydroid has never previously been described, the smallest specimens taken from the plankton of the British Isles being about 1 mm in height (Russell 1953). Only adult specimens 2.5–4 mm high have been reported from the plankton of New Zealand (Schuchert

1996) and Australia (Southcott 1982).

A puzzling aspect is the red spots, developing into prominent pustules near the base of the tentacles. As they occur on the tentacle and not the circular canal, these are not ocelli which, in any case, are excluded from the family definition of the Rathkeidae. No such structures are mentioned in descriptions of more advanced medusae: it is possible that these are lost as the medusa matures.

The family definition of Rathkeidae also includes short oral arms on the manubrium and multiple sets of tentacles on the adult medusa. Increase in the number of tentacles is a common event in maturation of hydrozoan medusae so it is equally possible that in this species the oral tentacles may also grow at a later stage of development.

Until the report by Watson (1998) and the present account, the hydroid of *R. octopunctata* was known only from some cultured specimens reared in overseas laboratories (Russell 1953, Werner 1958). This account fills a gap in the natural life history of the species.

Family Corynidae Johnston, 1836
***Coryne* Gaertner, 1774**
Coryne sp.
Fig. 2A

Material

Collected from holdfast of *Ecklonia radiata*, 24/4/85; no other information.

Description

Part of a small colony, simple and sparsely branched, diameter of branch 0.25 mm, perisarc almost smooth, reaching to base of hydranth. Hydranth 1.5 mm long, with an oral whorl of four capitate tentacles and (probably) 16–18 capitate tentacles scattered over body. Gonophores are fixed sporosacs scattered among tentacles; gonophore balloon-shaped, about 0.5 mm long with a short peduncle and thick clear pellicle; sex probably male.

Colour Sporosac orange.

Remarks

The specimen bears some similarities to *Coryne* sp.1 of Schuchert (1996), small colonies of which were found on stones and other cryptic habitats in New Zealand. Unfortunately, without information on the cnidome of Dan's specimen, no further identification is possible. This is the first record of the genus *Coryne* from Australia.

Dicoryne Allman, 1859
***Dicoryne annulata* von Lendenfeld, 1884**
Fig. 2B

Dicoryne annulata von Lendenfeld, 1884: 490, pl. 17, fig. 30.

Material

Colonies collected 17/5/82, 10/9/82, 5/11/82. Another colony collected from red coralline alga 22/1/82.

Description

Colonies infertile. No information on hydrorhiza. Hydranth pedicel cylindrical, 0.6 mm long, 0.18 mm wide, perisarc moderately thick, deeply annulated. Extended hydranth 1.3–1.5 mm long, spindle-shaped, with 16-18 distal filiform tentacles to 0.8 mm long, hypostome an open annulus.

Remarks

This is undoubtedly *Dicoryne annulata* described by von Lendenfeld from Port Phillip Bay.

Dan left no information on the species other than the scale drawing of the hydranth and hydranth bud. The species has not been recorded since its first description.

Sarsia Lesson, 1843
***Sarsia radiata* von Lendenfeld, 1884**
Fig. 2C

Sarsia radiata von Lendenfeld, 1884: 583, pl. 20, figs 31, 32.- Watson, 1978: 305, fig. 2A-D.

Material

Collected 25/4/82; no other information.

Description

Hydranth 1 mm high, arising from a stolon (not sketched). Hydranth with four oral tentacles and nine to 10 tentacles scattered over body; all tentacles long, capitate, capitulum armed with nematocysts. Medusa 0.7 mm long and 0.6 mm wide, on a short pedicel below proximal tentacles, umbrella balloon-shaped, with four radial canals and four long tentacles armed with nematocysts; velum broad, almost quadrate in shape, opening small, circular. Manubrium cylindrical narrowing to a simple mouth.

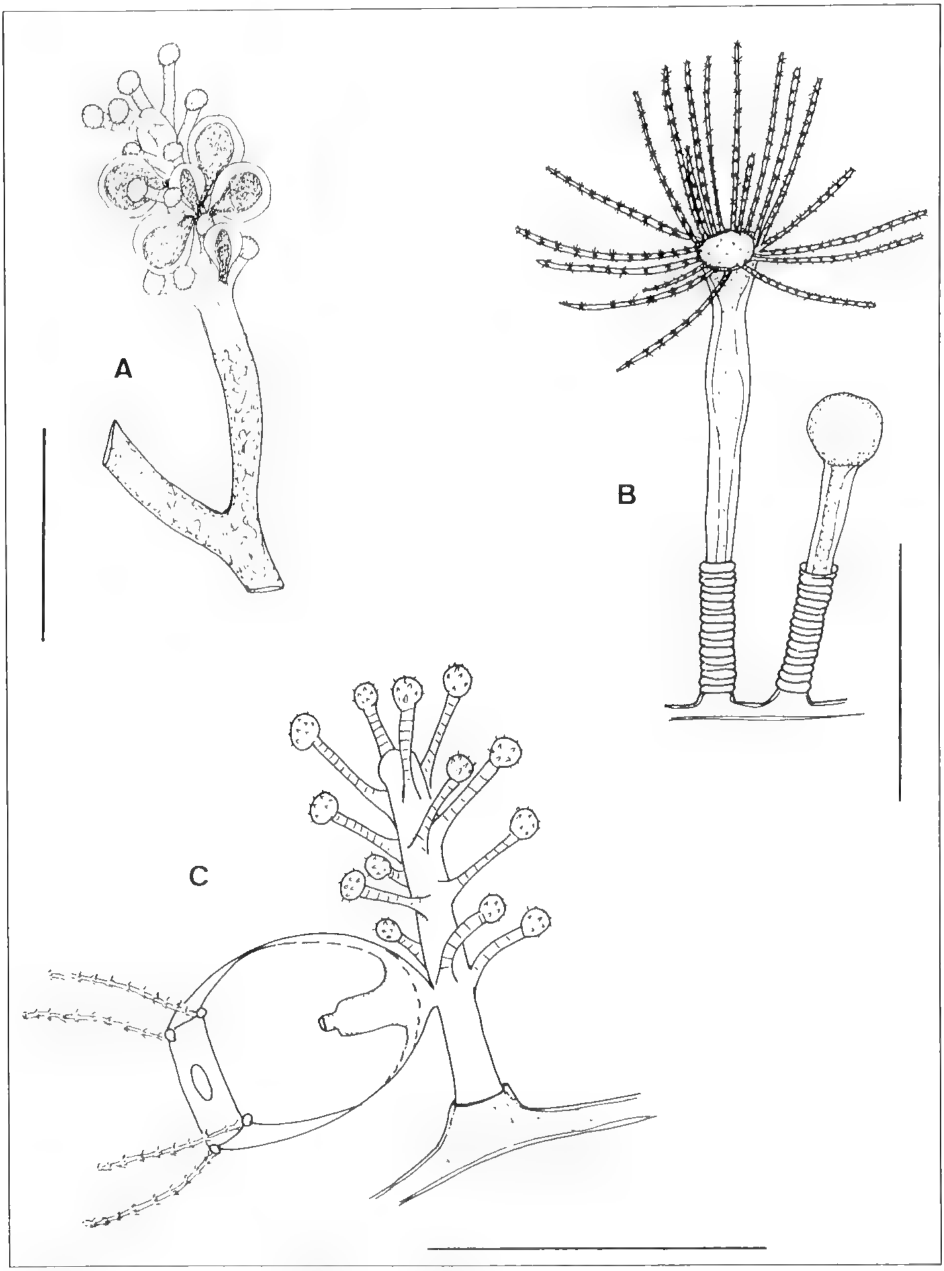

Fig. 2A-C. A, *Coryne* sp., simple branch with hydranth and sporosacs. B, *Dicoryne annulata*, extended hydranth and hydranth bud. C, *Sarsia radiata*, extended hydranth and medusa about to be released. Scale bar: A, 0.5 mm, B, C, 1 mm.

Remarks

This is probably the species referred by Dan to *Stauridiosarsia producta* (Wright), (see McInnes 1982: 163). Although he provided no notes and his sketch lacks detail, especially in relation to the basal perisarc of the hydroid, the species is clearly *Sarsia radiata*, previously reported from Port Phillip Bay by Watson (1978). The medusa was released in the aquarium.

Family Aequoreidae Eschscholtz, 1829
***Aequorea* Péron & Lesueur, 1810**
***Aequorea* sp.**
Fig. 3A-C

Material

Hydroid colony with medusa bud collected 25/4/82; medusa released in laboratory from colony. Medusa collected 5/11/82. Dan noted (26/9/86), that the colonies had been 'in the (petrie) dishes for years, giving birth to medusae, and are the toughest of all hydroids, despite very cold to very hot weather and "crook" seawater'.

Description

Colony stolonal, hydrorhiza tubular, creeping. Hydranth and medusa buds arising on short annulated pedicels from hydrorhiza; pedicel expanding distally from base. Hydranth 2.5 mm long, spindle-shaped, body slightly swollen below tentacle ring. Hydranth with 12 probably moniliform tentacles 2 mm long, a large basal tentacle web 0.25 mm wide; hypostome circular.

Cnidome of hydroid consisting of two size classes of nematocysts, probably isorhizas:

1) capsule bean-shaped, 7.5 × 3.5 μm tubule 350 μm long.

2) capsule bean-shaped, 15 × 7.5 μm, tubule 100 μm long.

Medusa buds borne on hydrorhiza and hydranth pedicel, the more advanced bud 0.5 mm high and 0.4 mm wide, showing a well developed manubrium and radial canals. Medusa at release balloon-shaped, bell 0.6 mm high and 0.6 mm wide, with four radial canals and a cylindrical

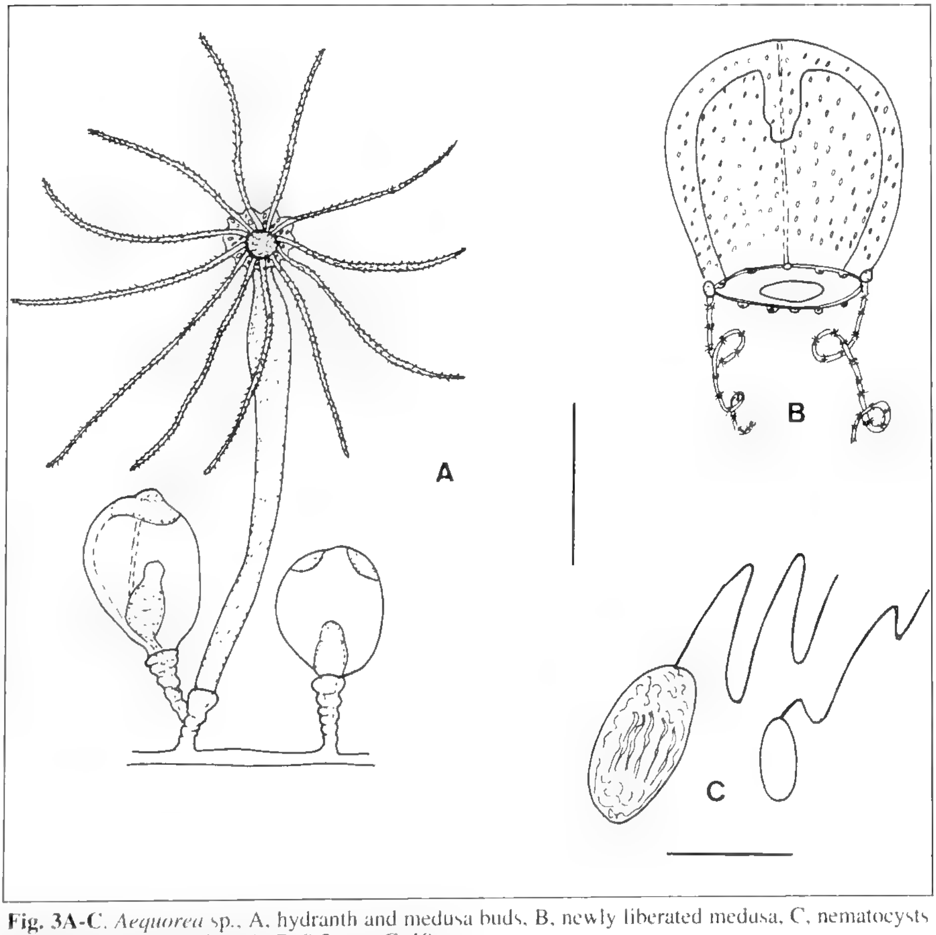

Fig. 3A-C. *Aequorea* sp., A, hydranth and medusa buds, B, newly liberated medusa, C, nematocysts from hydranth. Scale bar: A, B, 0.5 mm, C, 10 μm.

manubrium narrowing to simple tubular lips; exumbrella covered by numerous scattered large nematocysts, base of bell with two opposite long moniliform tentacles with swollen bulbs and two opposite perradial tentacle bulbs at base of radial canals, ring canal narrow, eight interradial marginal vesicles with concretions, velum broad.

Remarks

There is indication in his laboratory notes (see McInnes 1982: 163) that Dan assumed this hydroid to be a species of *Perigonimus* Sars. However, the medusa has features described for juveniles of *Aequorea forskalea* (Péron and Lesueur 1809) in the concretionary vesicles of the ring canal, and of *Aequorea vitrina* Gosse, 1853, in the almost complete cover of the exumbrella by large nematocysts.

The figured cnidome is from the tentacle web of the hydroid and it is possible that these, and the tentacular nematocysts, are different from those of the medusa. The nematocysts cannot be further identified as there is no information on the armature of the tubule.

The problem with precise identification of species of *Aequorea* is that the hydroid and early life histories of most common *Aequorea* medusae in the world plankton are virtually unknown. A further complicating factor is that the relatively large adult medusae bearing many tentacles bear little resemblance to juvenile forms. It is likely that the hydroid *Aequorea phillipensis* Watson 1998 from Port Phillip Bay is the same as that found by Dan; however, this can only be ascertained with collection of more material and further laboratory study.

Family Cladonematidae Gegenbauer, 1857
***Staurocladia haswelli* (Briggs, 1920)**
Fig. 4A, B

Cnidonema haswelli Briggs, 1920: 93 - 104, pls 17, 18.

Material

Several colonies collected from coralline alga, 14/1/82; colony attached to glass of aquarium; observations proceeded until 9/3/82.

Description

New hydranths spindle-shaped, arising about 1 mm apart from a reptant stolon about 0.15 mm diameter; juvenile hydranth with three capitate tentacles increasing to four or five after seven to 10 days, mature hydranth at that stage about 1.5 mm long with a clavate hypostome; medusa buds appear as bulges on lower body and stolons. Medusa small, with four groups of bifurcate tentacles, each with an ocellum at base. Buds grew over four days, in which time the tentacles lengthened with one bifurcation longer than the other. Medusae were released after four to five days, creeping on floor of aquarium. At this stage the aboral tentacles were shorter, each bearing five nematocyst pads - a large terminal pad, two closely adjacent pads a short distance down the tentacle, a smaller pad, almost opposite, and one small pad opposite the bifurcation. The lower, longer (oral) tentacles without nematocysts, but with a bluntly pointed end.

The medusae lived for four days after release during which time 18 tentacles developed and several new medusa buds commenced growth around the manubrium of the parent.

Remarks

Although Briggs (1920) collected many medusae and wrote a detailed account of *Staurocladia haswelli* from the Sydney region, he never discovered the parent hydroid. From Dan's description and sketches there is no doubt that this is the first record of the hydroid of *S. haswelli*. Except for the absence of a ring of aboral tentacles the hydroid resembles other known polyps of *Staurocladia*; the absence of these tentacles may be a normal character of *S. haswelli* or possibly a consequence of the specimens being reared in an aquarium.

Dan mentions that the medusae were fed on amphipods and the hydranths on tubifex worm cut into very small pieces.

Subclass Leptothecata
Family Syntheciidae Marktanner-Turneretscher, 1890
***Hincksella* Billard, 1918**
***Hincksella cylindrica* (Bale, 1888)**
Fig. 4C

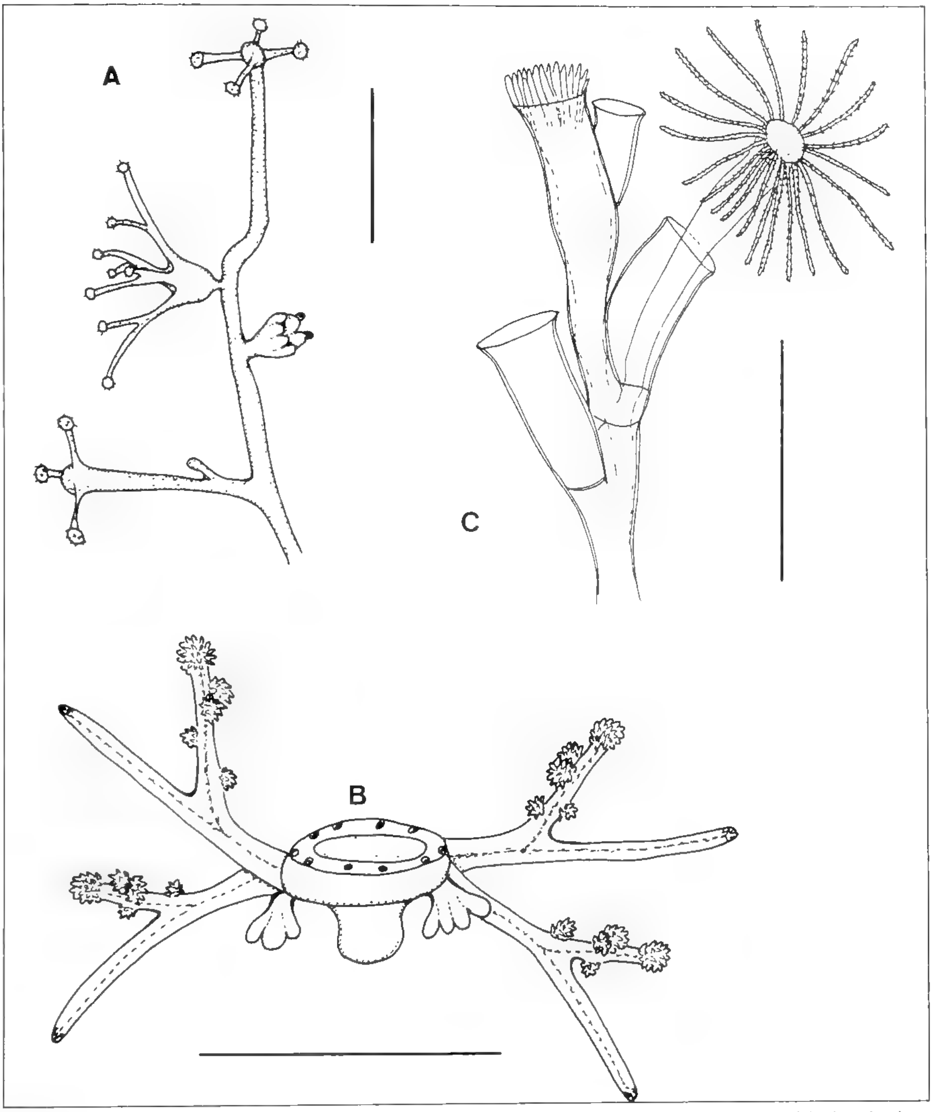

Fig. 4A-C. A, B, *Staurocladia haswelli*, A, colony with hydranths and medusa bud with developing medusae, B, medusa, showing two sets of tentacles only, and medusa buds. C, *Hincksella cylindrica*, hydrothecae and extended hydranth. Scale bar: 1 mm.

Sertularella cylindrica Bale, 1888: 765, pl. 16, fig. 7.- Ralph, 1966: 163.

Material

Colony collected on *Ecklonia* holdfast, February 1985, maintained for approximately eight weeks in aquarium to May, 1985.

Remarks

Dan was uncertain whether the colony with faintly undulated hydrothecae was *Hincksella corrugatum* Millard, 1958 with corrugated hydrothecae or *Hincksella cylindrica* (Bale 1888) with smooth hydrothecae. Ralph (1966) was also uncertain to which species her faintly corrugated specimens from Port Phillip Bay should be referred. As the hydrothecae of Dan's specimens are smooth the species is here assigned to *H. cylindrica*. Probably detailed studies will eventually show the two to be conspecific.

Thecate hydroids are well known to be

intractable aquarium subjects so it is a remarkable achievement to have maintained a thecate colony over this period of time in relatively primitive laboratory conditions.

Family Haleciidae Hincks, 1868
***Halecium* Oken, 1815**
***Halecium fragile* Hodgson, 1950**
Fig. 5A

Halecium fragile Hodgson, 1950: 15, fig. 11a-d.

Material
Colony collected 16/10/82; no other information.

Remarks
This collection date is the first record of the species from Port Phillip Bay.

***Halecium* sp.**
Fig. 5B

Material
Colonies collected twice, the first on

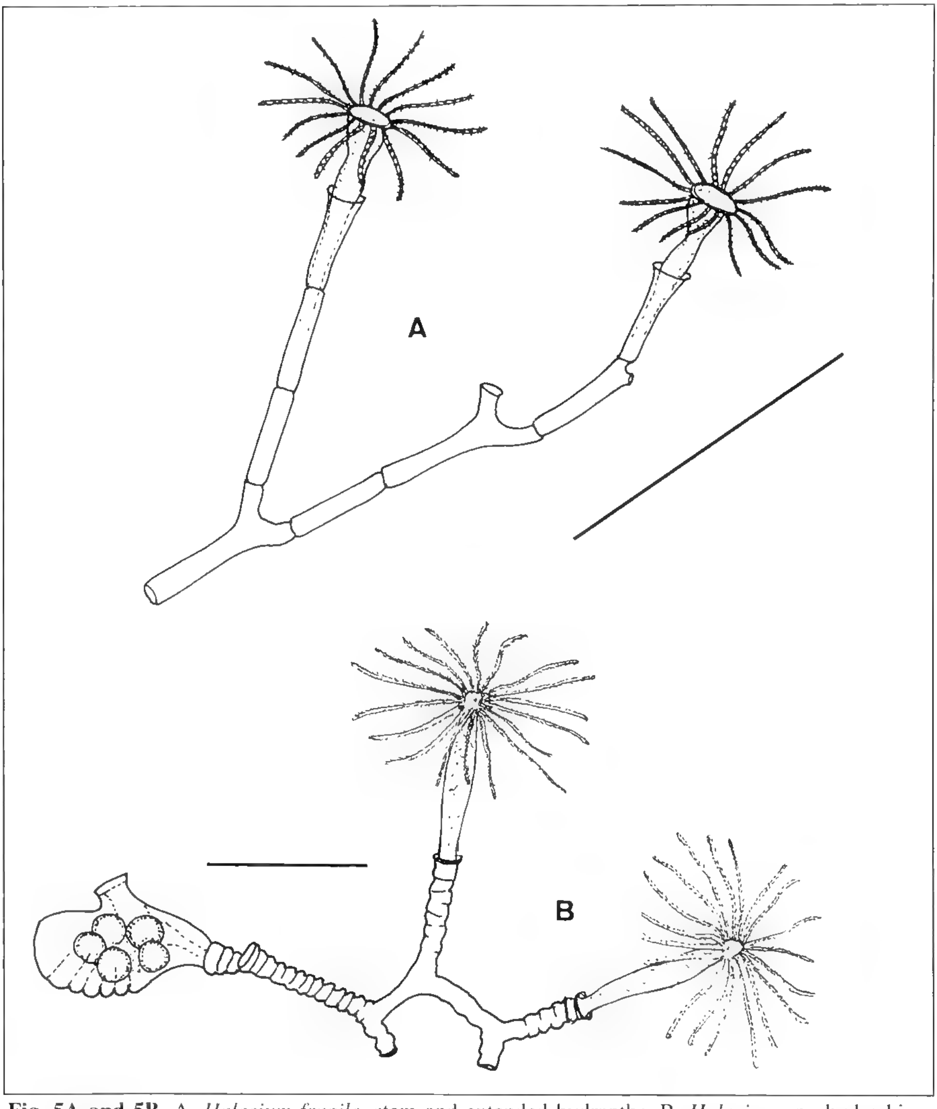

Fig. 5A and 5B. A, *Halecium fragile*, stem and extended hydranths. B, *Halecium* sp., hydrorhiza, hydranths and gonotheca. Scale bar: 1 mm.

2/4/82, the second collection a fertile colony from weed, 25/10/82; this colony maintained in aquarium until 27/12/82.

Description

Hydrorhiza a creeping undulated stolon; hydrothecal pedicels 0.25–0.35 mm high, 0.12–0.13 mm diameter, arising singly at intervals from hydrorhiza; pedicels deeply annulated. Hydrophore shallow dish-shaped (but not clearly figured), hydranth tall, spindle-shaped, with 18–20 tentacles. Gonotheca borne on a short annulated pedicel from hydrorhiza or from side of hydrothecal pedicel, mitten-shaped, aboral side deeply ridged, 0.6 mm long and 0.5 mm wide, orifice (probably) cylindrical, 0.13 mm in diameter, possibly with slightly everted rim. One gonotheca containing several spherical ova.

Remarks

Dan figured the species but left no notes, assuming it to be *Halecium corrugatissimum* Trebilcock, 1928. However, *H. corrugatissimum* is a tall, arborescently branched hydroid, not stolonal as is this species. As there is no other known *Halecium* similar to Dan's figure it is almost certainly an undescribed species. Verification must, however, await the finding of more material.

Supplementary Species List

At various times Dan found other common hydroid species on algae. The list (Table 1) is extracted from his notes (1982-1985) and from McInnes (1982: 163).

Acknowledgements

I thank Mrs C. McInnes for providing me with Dan's notes and permission to publish this resume of his researches on the Hydrozoa

Table 1. Common Hydroids on Algae from Ricketts Point and Black Rock.

Species	Habitat
Eleutheria dichotoma Quatrefages, 1842	corallines
Eudendrium capillare Alder, 1856	brown alga
Silicularia rosea Meyen, 1834	*Ecklonia* thalli
Orthopyxis caliculata (Hincks, 1853)	brown alga
Clytia hemisphaerica (Linnaeus, 1767)	filamentous red alga
Phialella quadrata (Forbes, 1848)	brown alga
Amphisbetia minima (Thompson, 1879)	*Ecklonia* hold fast
Plumularia ?obliqua (Johnston, 1847)	*Ecklonia* hold fast
Plumularia setaceoides Bale, 1882	*Ecklonia* thalli
Monotheca pulchella (Bale, 1882)	?*Cystophora* thalli
Sertularella robusta Coughtrey, 1876	not given
Monotheca spinulosa (Bale, 1882)	not given
Aglaophenia plumosa Bale, 1882	*Ecklonia* hold fast

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The Booroolong Frog *Litoria booroolongensis* Moore (Anura: Hylidae): an Addition to the Frog Fauna of Victoria.

Graeme R. Gillespie[1] and David Hunter[2]

Abstract
The Booroolong Frog *Litoria booroolongensis* is a lotic species formerly restricted to streams in New South Wales. We report confirmation of the species in north-east Victoria, north of Burrowa Pine Mountain. This species has declined throughout much of its range in New South Wales and is currently listed as Endangered in that State. These records are therefore a significant extension to the known occurrence of the species. (*The Victorian Naturalist* **116** (3), 1999, pp. 112-114).

Introduction

The Booroolong Frog *Litoria booroolongensis* is a riverine species morphologically similar to Lesueur's Frog *L. lesueuri* (Moore 1961, Anstis *et al.* 1998) (Fig. 1). It occurs predominantly along western-flowing streams of the Great Dividing Range in New South Wales, from catchments draining the Northern Tablelands, to the Tumut River in the Southern Highlands, and other tributaries of the Murrumbidgee River (Caughley and Gall 1985; Heatwole *et al.* 1995; Anstis *et al.* 1998; Hunter and Gillespie *in press*). *Litoria booroolongensis* has been recorded close to the north-eastern Victorian border (Caughley and Gall 1985), but previous fauna surveys have not located it in Victoria. This may be because accurate identification of *L. booroolongensis* is difficult, especially in the south of its range where the species is superficially very similar to *L. lesueuri* (G. Gillespie *pers. obs.*). The Australian Museum holds several juvenile *L. booroolongensis* specimens collected in 1961 from the King River, near Wangaratta in Victoria (Australian Museum record nos R90917–R90930). However, examination of these specimens by one of the authors (GG) indicates that they are *L. lesueuri*.

Litoria booroolongensis was formerly abundant along streams draining the Northern Tablelands of New South Wales (Heatwole *et al.* 1995). There have been very few sightings of this species in the past ten years (New South Wales Wildlife Atlas), and concerns have been raised about its current conservation status (Anstis *et al.* 1998). Further south, there are relatively few historical records (Australian Museum records; New South Wales Wildlife Atlas). A recent survey conducted for riverine frogs along west-flowing streams in Kosciuszko National Park failed to find the species at two historic collection sites, and only located it in one stream in the region (Hunter and Gillespie *in press*). The species has recently been listed as endangered in New South Wales (NSW Threatened Species Conservation Act 1995).

Observations

During the summer of 1998/99 we conducted a survey commissioned by the New South Wales National Parks and Wildlife Service, to assess the current distribution of *L. booroolongensis* along the south-western slopes of the Great Dividing Range in New South Wales. During this survey we located the species along three small creeks, several kilometres north of the Murray River, near Jingellic, New South Wales. This led us to suspect that *L. booroolongensis* may also occur along similar small creeks feeding the Murray River from Victoria, north of Burrowa Pine Mountain. We subsequently surveyed four creeks (Burrowye, Walwa, Sandy and Cudgewa Creeks) and the Murray River in this area. *Litoria booroolongensis* was located on Burrowye Creek at Burrowye (36° 2' E; 147° 33' S), and on the banks of the Murray River near Jingellic (35° 56' E; 147° 42' S), confirming the occurrence of the species in Victoria (Fig. 2). Specimens were collected from each of these localities and lodged with the Victorian Museum

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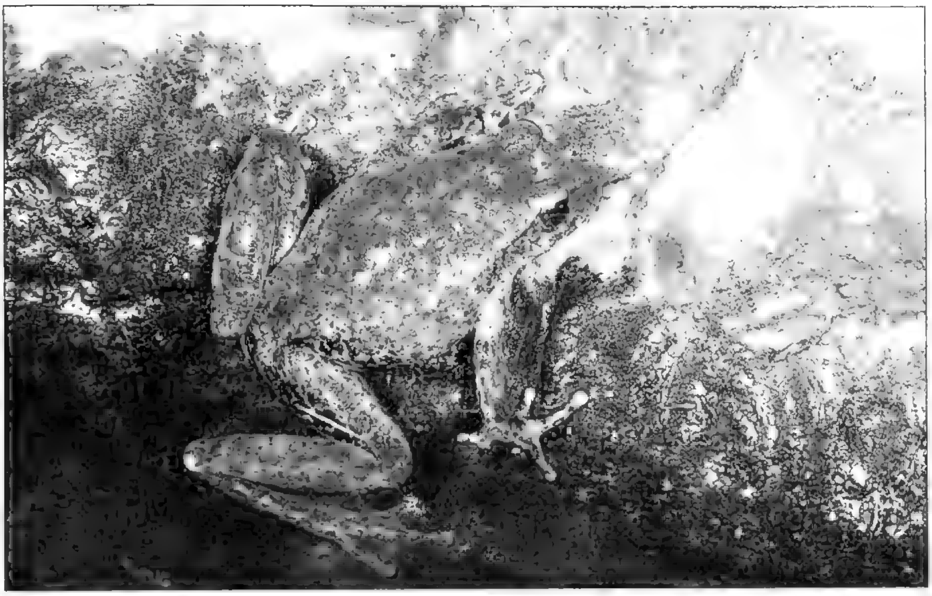

Fig. 1. The Booroolong Frog *Litoria booroolongensis*, from Bombowlie Creek, southern New South Wales. Photo: G. Gillespie.

(Victorian Museum record nos D69973 and D69974).

Our observations in southern New South Wales suggest that *L. booroolongensis* and *L. lesueuri* have allopatric distributions in this region. We found *L. lesueuri* along Cudgewa Creek, and previous surveys in the region have located *L. lesueuri* on most other streams in this region of Victoria (Watson *et al.* 1991; Gillepsie and Hollis 1996; Hunter and Gillespie *in press*; Victorian Wildlife Atlas). *Litoria booroolongensis* is therefore likely to be restricted in Victoria to this region north of Burrowa Pine Mountain.

Fig. 2. Localities of *Litoria booroolongensis* (indicated by closed circles) in north-eastern Victoria. (Scale 1 cm = 20 km.)

Litoria booroolongensis inhabits rocky permanent streams, ranging from small slow-flowing creeks to large rivers (Anstis *et al.* 1998; authors' *pers. obs.*). Adults are typically found sheltering under boulders or cobbles near riffles along the stream bank (Anstis *et al.* 1998; authors' *pers. obs.*). The species occurs along streams in both forested areas and open pasture. Sites where we observed the species in Victoria and southern New South Wales were highly modified streams flowing through pasture, and were heavily disturbed and polluted by cattle. In the southern parts of its range, breeding occurs in spring. Eggs are deposited in rock crevices in the stream or in isolated stream-side pools (authors' *pers. obs.*). Tadpoles metamorphose in January and February (Anstis *et al.* 1998).

Identification

Litoria booroolongensis is morphologically very similar to *L. lesueuri*, which is a common and widespread riverine species in south-eastern Australia (Barker *et al.* 1995). The species can be reliably distinguished from *L. lesueuri* by the extension of webbing to the base of the first inner toe pad on the hind foot. The webbing on *L. lesueuri* extends only to the base of the penultimate phalange of the first inner toe (authors' *pers. obs.*). *Litoria booroolongensis* typically has a highly mottled dorsum with a scattering of salmon-coloured flecks. *Litoria lesueuri* typically has a distinct black stripe passing through the eye and over the tympanum to the shoulder, whereas this is less distinct in *L. booroolongensis* (Barker *et al.* 1995).

Significance

Litoria booroolongensis is one of a number of riverine species in eastern Australia which have suffered severe population declines over the past two decades (Tyler 1997). Its discovery in Victoria is a significant addition to the frog fauna of the State, taking the total number of species recorded to 35 (Atlas of Victorian Wildlife). Further information is required to determine the current distribution of this species and the causes of its apparent decline, and how best to manage and protect these remaining populations.

Acknowledgements

This work was funded by the New South Wales National Parks and Wildlife Service and the Arthur Rylah Institute, Department of Natural Resources and Environment, Victoria. Ross Saddler (Australian Museum) and John Coventry (Museum of Victoria) kindly provided access to museum specimens. R. Loyn and G. Brown provided comments on the manuscript.

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Erratum

Re 'Emperor: the Magnificent Penguin', review by Peter Dann, in *The Victorian Naturalist* **116** (2), 46. Pauline Reilly was not the first female President of the R.A.O.U. A Mrs. Perrine Moncrieff, of New Zealand, had that honour. She was President during 1932-33. Thanks to Mrs Tess Kloot for pointing this out.

For assistance with the preparation of this issue, thanks to the computer team – Alistair Evans and Anne Morton. Thanks also to Felicity Garde (label printing) and Michael McBain (web page).

Dawn Till Dusk: In the Stirling and Porongurup Ranges

by Rob Olver and Stuart Olver

Publisher: *Tuart House, 1998. 176 pp. RRP $45 hard cover, $34 paper cover.*

'Dawn Till Dusk is both a practical guide to, and a visual celebration of, the Stirling and Porongurup Ranges of South-western Australia.' This quote from the press release is an accurate description of this wonderful book. The photography, mostly done by Rob Olver, is enough to make you want to pack your bags and catch the first flight to W.A. Des Olver also supplies a stunning shot of a Western Grey Kangaroo in the Stirling Range heathland.

The book covers such topics as: detailed information of natural history, bushwalks, climbs, special attractions, gliding, flying, wineries, scenic drives, facilities and accommodation.

Chapter one gives a little of the known Aboriginal history. Chapter two gives a more detailed and well-researched record of early European history. Then follow chapters on: geology, climate, flora and fauna and some very useful maps for the future travellers of this magnificent area.

I was pleased to read in Chapter five, on the subject of mammals, that control of feral cat and fox populations need to be addressed before the re-introduction of some of the diminishing mammal species.

The topic of environmental weeds is touched upon; this and the feral animal problems faced by most land managers is often omitted from books of this nature. Also, the authors highlight the serious effects of *Phytothphora cinnamomi*, the fungus which has devastated many W.A. forests. A Management Plan has been prepared for the Stirling Range and at present twenty-five percent of the park is closed to all users on a seasonal basis. C.A.L.M. is also carrying out research on threatened and priority listed flora in the Stirling Ranges.

There are 123 species of the Orchidaceae family found in the Stirling Range, 38% of all known orchids in Western Australia. As all the flowers in previous chapters give common and scientific names, I wondered why the authors did not do the same for the orchids that were mentioned in the text. I realise many are undergoing revision, but would have still liked the current name included.

Bridal Creeper is also mentioned as a problem weed in the Stirlings. This is a common name for a highly invasive weed and once again I would have liked the scientific name to clarify what plant the authors were referring to. Was the plant *Myrsiphyllum asparagoides*? Bridal Veil and Bridal Creeper are common names used by the nursery trade and sold to the unwary.

The authors state that in the Porongurup Range, 300 varieties of fungi grow. I would suggest that there are many more, but was interested that a count of species has taken place as like the non-vascular plants (mosses, lichens and liverworts) they are sometimes overlooked when Flora and Flora are being compiled.

The chapter on scenic drives will be useful for visitors planning a trip to the two parks, but it is the bushwalking chapters that are exceptional, their enthusiasm for these two magnificent areas is apparent. Rob and Stuart have gone to great detail to explain the way to really see these two areas on foot. Maps are excellent throughout the whole book including this chapter. The rock-climbing information is given in the same detail with stunning photos of some challenging climbs.

I highly recommend this very well researched and beautifully photographed book and congratulate the authors for sharing their vast knowledge on the Stirling and Porongurup Ranges. The book is an absolute must for any traveller planning to explore these two ranges in the future.

Cecily Falkingham
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Mitcham, Victoria 3132.

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Intertidal Sighting of *Stiliger smaragdinus* Baba 1949 – an Uncommon Mollusc

During the late morning of 23 February 1999, at Kitty Miller Bay, Phillip Island, a single *Stiliger smaragdinus* was sighted in the lowermost intertidal zone during the spring low tide. This is an opisthobranch mollusc in the Order Sacoglossa (see Burn 1998). It was exposed to air on a flat rock that was situated between two rockpools rich in the seaweeds *Caulerpa cactoides* and *Amphibolis antarctica*. The day was warm but overcast.

The mollusc was placed in a plastic container of seawater; it then expanded and began to move about. The estimated length was 5 cm. The specimen was a beautiful lime green with delicate yellow and bluish-white colouration at the bases of the cerata and across the bodies of some of them. The numerous cerata waved about like algal fronds when the water column was disturbed. The photograph below shows the elevated pericardium on the dorsum of the mollusc, with the anal opening as a raised white papilla just anterior to it (see Burn 1998). After photography, the specimen was left in the adjacent rockpool on a frond of *C. cactoides*. When the spot was revisited half an hour later, the mollusc had not moved from its position.

Stiliger smaragdinus is found in Japan, the western Pacific, around Australia and also in New Zealand (Burn 1998), to depths of 22 m (Edgar 1997). It feeds on green algae and, when sighted, is often associated with *C. cactoides* (Edgar 1997). The species attains lengths of up to 75 mm (Burn 1998; Edgar 1997).

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I thank the Marine Research Group for their eager support, particularly Clarrie Handreck for his enthusiam, Robert Burn for identifying the mollusc, and both of these and Ken Bell for valuable comments on an earlier draft of this note.

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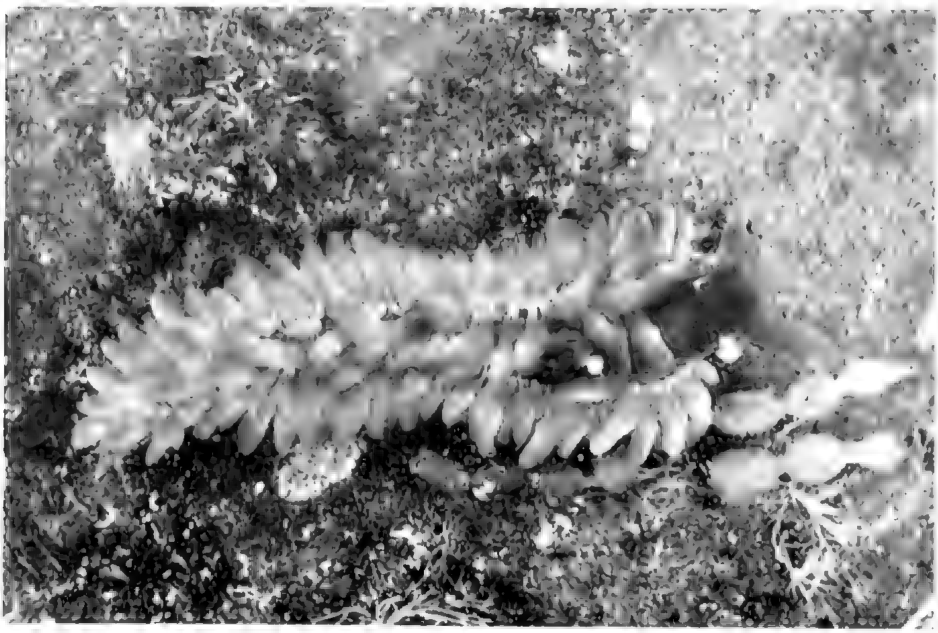

Stiliger smaragdinus at Kitty Miller Bay, 23 February 1999. Photo by Platon Vafiadis.

The Victorian Naturalist

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Cover: The Common Brushtail Possum *Trichosurus vulpecula* in the Fitzroy Gardens, Melbourne, eating bread left by tourists. (See Research Report, p. 120.) Photo by Kelly Miller.

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Attitudes Towards Possums: a Need for Education?

Kelly K. Miller[1], Peter R. Brown[1] and Ian Temby[2]

Abstract

When dealing with wildlife-human conflict issues, social considerations are as important as biological and ecological considerations to the successful implementation of management strategies. This study investigated the human dimensions of the human-possum conflict, by asking people in an urban area of Melbourne for their views and knowledge of possums. The survey found that although factual knowledge of possums within the community is generally low, residents are keen to learn more about possums. It also found that respondents with a high knowledge of possum biology had a more positive attitude towards possums than respondents with a comparatively low level of knowledge. These findings suggest that further community education on this issue is warranted. (*The Victorian Naturalist* **116** (4), 1999, 120-126).

Introduction

Although research into the human dimensions of wildlife management is well advanced in North America, it is still in its infancy in Australia (Jones 1993). North American studies over the last two to three decades suggest that an understanding of the human component of wildlife management issues is crucial to the effective implementation of management strategies. As Pomerantz *et al.* (1987: 357) explain, 'understanding the public's needs and concerns and communicating the rationale for agency programs back to the public are necessary steps to achieving management objectives'. This understanding is particularly important for wildlife-human conflicts such as those arising from the cohabitation of people and possums in urban areas.

Two species of possum commonly cohabit with humans in the urban, suburban and rural areas of Australia: the Common Ringtail Possum *Pseudocheirus peregrinus* and the Common Brushtail Possum *Trichosurus vulpecula*. Both species are protected in the State of Victoria under the *Wildlife Act* 1975.

While the Common Ringtail Possum can create problems for residents, such as damage to garden plants (McKay and Ong 1995; Temby 1992) and aesthetic problems (e.g. droppings on driveways), it is the Common Brushtail Possum that causes most concerns. The Common Brushtail Possum is nocturnal and spends the day in a den in a hollow branch, tree trunk, fallen log or, with increasing urbanisation, in the roof cavity of a house (How and Kerle 1995). The occupation of house roof cavities by members of this species is common in many urban areas of Australia and is the primary cause of conflict between humans and possums (How 1992).

Problems associated with the Common Brushtail Possum include noise, damage to the house, damage to garden plants, aesthetic problems, and potential health risks.

1. Noise from possum movement (in the ceiling and on the roof) and possum calls can present problems for residents. Indirect noise problems can also occur when domestic dogs bark at possums during the night.
2. Damage to the house can include urine stains and holes in the ceiling and walls.
3. Damage to garden plants can result when possums defoliate native and ornamental trees and shrubs and eat vegetables, fruit and flowers.
4. Aesthetic problems can occur when there is possum odour, droppings on driveways or urine stains on cars.
5. Potential health risks can cause concern for residents (e.g. loss of sleep due to noise).

In order to better understand the dynamics of the urban possum issue, the aim of this study was to investigate what people in an urban area feel (attitudes) and know (knowledge) about possums and explore the link between the two.

Methods

The City of Knox, a group of suburbs located approximately 25 km east of the Melbourne Central Business District, was chosen as the study site. This site contains

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highly vegetated areas (particularly in those areas abutting the Dandenong Ranges National Park) through to residential areas with little vegetative cover. It was therefore considered to be representative of a range of different types of urban areas.

A nine-page questionnaire was mailed, in 1995, to 500 adult residents (randomly selected using publicly available ratepayers books) throughout the City of Knox, of whom 142 residents responded (28%). A limited time-frame did not allow follow-up of non-respondents, and the sample (referred to as the Resident Sample) was considered to be an adequate size for the exploratory nature of the study. Twenty-one percent of respondents were 18-30 years of age, 42% were 31-45 years of age, 23% were 46-60 years of age, 14% were over the age of 60 years; and 70% of the sample was female.

Accompanying the questionnaire was a covering letter and reply-paid envelope. The covering letter introduced the study to potential respondents and emphasized anonymity and confidentiality of responses. Respondents were given the option of including their name and contact details on the questionnaire for any future studies but were not required to do so. Respondents indicating interest in the survey results were mailed a summary of the research at the conclusion of the study.

The questionnaire included 44 questions on a number of topics including attitudes towards possums, human-possum conflicts, knowledge of possums, management issues and demographic characteristics of respondents.

In addition to the Resident Sample, 50 members of local special interest groups and other stakeholders were interviewed by telephone. These groups included the Knox Environment Society, Ferntree Gully Residents' Action Group, Ferntree Gully Horticultural Society, residents who had recently hired possum traps from the Knox City Council, Wildlife Shelters/Wildlife Foster-carers, and Veterinary Surgeons. The telephone interviews focussed on the same topics as the questionnaire, but allowed for further discussion on certain points.

Both quantitative and qualitative data analysis techniques were used. For quantitative data, descriptive and inferential statistics (two-sample z test (Moore and McCabe 1993)) were used with comparative data statistically significant at $p \leq 0.05$. For qualitative data, open-ended questions were analysed for key themes and important comments. These components of the data are illustrated using direct quotes from respondents.

Results and Discussion

Respondent attitudes towards possums were assigned to three main categories based on answers to several questions including 'how would you describe your overall view of possums?' and 'why do you hold this view?' The attitude categories were:

1. Positive attitude, where the respondent indicated that possums were welcome at the house or property;
2. Negative attitude, where the respondent indicated that possums were a nuisance or pest; and
3. Neutral attitude, where the respondent indicated an undecided opinion.

From the Resident Sample (n = 142), 25.4% of respondents expressed a positive attitude towards possums, 33.1% expressed a negative attitude towards possums, 37.3% expressed a neutral attitude towards possums, and 4.2% of respondents did not complete the attitude questions.

Five questions were used to test the knowledge level of the resident in terms of possum biology. Fifteen percent of the respondents from the Resident Sample who completed the knowledge questions (n = 137) answered all five questions correctly, and 10% displayed a low knowledge level answering either no questions correctly or one question correctly. The proportion of the Resident Sample that answered each of the five knowledge questions correctly is shown in Table 1.

The poor knowledge of possum biology in the Resident Sample was also apparent in the special interest group samples, with small proportions completing all knowledge questions correctly. Five of the 10 Knox Environment Society respondents answered all five knowledge questions correctly, compared with three of the seven responding Veterinary Surgeons,

Table 1. Proportion of Resident Sample that answered knowledge questions correctly.

Knowledge question	**Response categories**	**Proportion that answered correctly (%) (n = 137)***
A full-grown Brushtail Possum is smaller than a full-grown Ringtail Possum	true/false/unsure	26.1
Ringtail Possums usually have a white tip on their tail.	true/false/unsure	34.1
Possums are nocturnal.	true/false/unsure	92.8
A marsupial is:	a nocturnal animal/a mammal with a pouch/a mammal without a pouch	91.3
Tick those of the following that are marsupials:	dog/fox/possum/dolphin/kangaroo	73.2

* Five questionnaire respondents did not answer the knowledge questions and were excluded from this analysis.

three of the 10 Ferntree Gully Residents' Action Group respondents, three of the 10 Ferntree Gully Horticultural Society respondents, one of the 10 trap-hirers, and all three Wildlife Shelters/Wildlife Foster-carers. Of particular interest was the poor knowledge shown by the responding Veterinary Surgeons, which was surprising given the relative simplicity of the knowledge questions.

Another indication of poor knowledge can be seen in the responses to the question that asked what species of possum was present around respondents' homes. Of the 55 respondents from the Resident Sample who believed they had possums around the house or property, 65% were unsure of the species.

There was a clear correlation between attitudes towards possums and knowledge levels of possum biology. Sixty percent of those respondents with a high level of possum knowledge (n = 20), defined as answering all knowledge questions correctly, held a positive attitude towards possums. In comparison, only 7% of those respondents with a low level of possum knowledge (n = 14), defined as no knowledge questions answered correctly or one knowledge question answered correctly, held a positive attitude towards possums (two-sample z test: $z = 3.13$, $p = 0.001$).

This trend was also observed in the Special Interest Group samples. Respondents from the Knox Environment Society and Wildlife Shelters/Wildlife Foster-carers held mainly positive attitudes towards possums and had predominantly high knowledge levels, when compared with respondents from the trap-hirers group (residents who had recently hired possum traps from the Knox City Council) and the Ferntree Gully Horticultural Society. The latter two groups held mainly negative attitudes towards possums and had comparatively low knowledge levels (Fig. 1).

A similar correlation was noted by Schulz (1987) in a study of adult students' attitudes towards wildlife in West Germany. Schulz found that knowledge level was the best variable to explain different scores on the attitude scale. Schulz's study, based on the value framework developed by Kellert (1976), showed that respondents with a very high knowledge level also had high values on the moralistic, naturalistic, ecologistic, and scientistic attitude scales. Conversely, respondents with a very low knowledge level had high values on the humanistic, negativistic, and utilitarian attitude scales.

Although Schulz's study (1987) had more detailed attitude categories than our study, the results are similar. Respondents to our questionnaire who had a high knowledge of possums displayed characteristics consistent with the moralistic, naturalistic, ecologistic and scientistic attitudes as described by Kellert and Berry (1987). These respondents typically held positive attitudes towards possums, with sentiments such as:

I appreciate wildlife.
Possums are a natural part of the

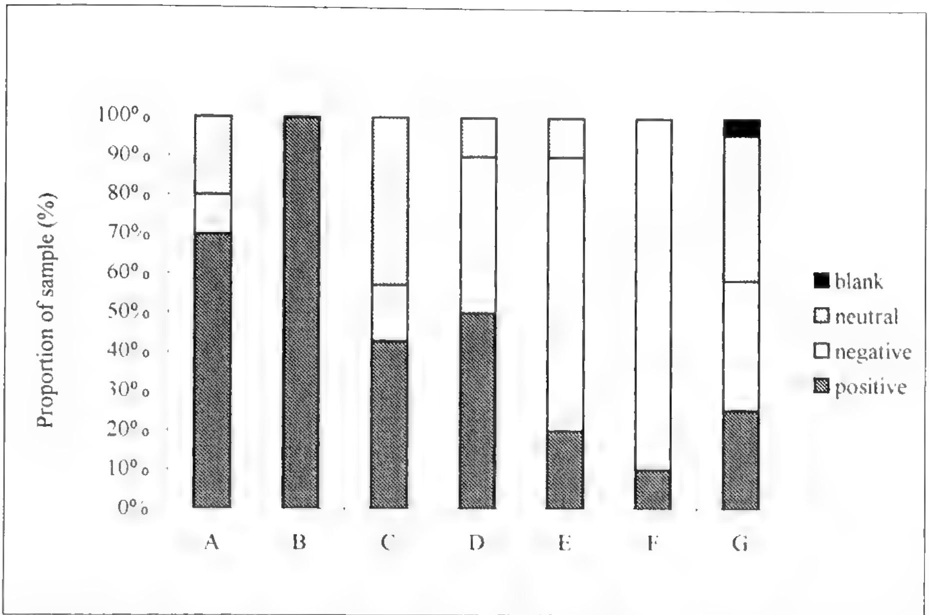

Fig. 1. Attitudes towards possums in Special Interest Group and Resident samples (statistical analysis could not be conducted due to small sample sizes).
A = Knox Environment Society (n = 10), B = Wildlife Shelters/Wildlife Foster-carers (n = 3), C = Veterinary Surgeons (n = 7), D = Ferntree Gully Residents' Action Group (n = 10), E = Ferntree Gully Horticultural Society (n = 10), F = Trap-hirers (n = 10), G = Resident Sample (n = 142)

Australian environment and we should learn to live with them.

I am an animal lover and enjoy seeing possums in my garden.

I love animals and wildlife.

We like a bush environment and enjoy all native animals.

It is good for the kids to experience animals and learn to live with them.

They were here long before us and I believe all native fauna should be preserved.

In comparison, typical answers from respondents with a low knowledge level included:

[my view is] based on friends' experiences with possums doing damage to their houses.

... we had possums... noisy, vermin, destroyers, and their dropping mess everywhere.

People live in houses with family and pets. The bush is provided (and there is plenty of it in Victoria) that possums can live in without causing problems in roof, fireplace etc.

This correlation between knowledge of possums and attitudes towards possums raises an important question that could be explored by future research – which comes first, the positive attitude or the high knowledge level? That is, does a person with a positive attitude towards possums have more interest and therefore seek out information, or does the increased information or factual knowledge result in the positive attitude? To investigate this question, attitudes could be assessed before and after an education program (focusing only on factual knowledge and not information that could directly influence attitudes) specifically relating to urban possums.

Other studies have indeed shown that public values either change or can be changed with better information (Stucky *et al.* 1987). A preliminary study by Caro *et al.* (1994) found that in a short period of time, education in conservation biology (via an undergraduate university course) made students more biocentric. Although this indicates that education may be an effective management tool in modifying attitudes towards nature, it may be that students seeking out an environmental course already have positive attitudes towards the environment. The education they choose may simply strengthen the attitudes that they already have and encourage them to clearly express those attitudes. In order to explore this further, education could be targeted at those people within the community with negative attitudes towards possums in order to determine if education is effective in modifying their attitudes.

Implementing education programs also requires an understanding of what people wish to learn about. From our survey, 30.4% of respondents (n = 138) said they would like to learn about 'possum ecology/biology', 40.6% said they would like to learn about 'how to live with possums', 26.1% said they would like to learn 'how to remove possums' and 26.8% said they would like to learn about 'what happens to translocated possums'. Table 2 divides these findings further into those respondents with a positive attitude towards possums and those respondents with a negative attitude towards possums.

Respondents with a positive attitude towards possums were significantly more interested in learning about possum ecology and biology and how to live with possums, than those respondents with a negative attitude towards possums (Table 2). In contrast, those respondents with a negative attitude towards possums were significantly more interested in learning about how to remove possums, than those respondents with a positive attitude (Table 2).

As respondents with negative attitudes towards possums were shown to be less interested in learning about possums, it may prove more difficult to change their attitudes (through education) into positive attitudes. Thus, education of children (rather than adults) may be more effective in modifying and/or shaping attitudes, because the attitudes of children are still forming. Similarly, Caro *et al.* (1994) speculated that conservation education may be more effective in changing attitudes when people are exposed to it at an early age. Other studies have also shown that a person's childhood experiences with animals are important factors in the development of adult attitudes towards wildlife (Hair and Pomerantz 1987).

Although a change in attitudes towards wildlife can be achieved (Temby 1995), it has been suggested by Baldwin (1995) that a change in attitude is not enough. Baldwin (1995) said 'while basic classroom education can be effective at changing values and attitudes toward nature, direct experience has the powerful effect of changing behaviour' (p. 241). In our study, the most common factor contributing to the respondents' knowledge of possums in the Resident Sample was 'personal experience' (49%). One current possum education program in our study area incorporates 'basic classroom education' with 'personal experience' by showing the class a possum and allowing interaction (Y. Cowling *pers.com.*). Although this program focuses on childhood education, the experience of actually seeing a native animal will undoubtedly have an impact on many children and possibly instil a positive value of wildlife within them. However, further research would be required to confirm whether or not a change in attitude would lead to a change in behaviour on this issue.

While childhood education is important, information must also be available to adults. The fact that 40.6% of respondents from the Resident Sample indicated they would like to learn how to live with possums, clearly indicates the need to educate the general public – to inform residents of urban areas how to cohabit successfully with possums, or at least inform them that 'harmonious' cohabitation is possible and has many advantages.

As Temby (1995: 178) has suggested for the management of kangaroos, 'acceptance and use of alternative approaches that do not rely on destruction will only come about through appropriate extension programmes that demonstrate their effectiveness and economic benefits'. Similarly, residents with possum problems must be informed of appropriate and effective management techniques. Residents will have little hope of effectively resolving a conflict if they do not have the appropriate information that will allow them to do so. The recent distribution of the 'Living With Possums' booklet[1] (Department of Natural Resources and Environment 1997) to key groups in Victoria, such as local councils and wildlife shelters, will undoubtedly

Table 2. Respondent attitudes (Resident Sample) versus aspects of possum ecology/biology and management the respondent would like to learn about.

Option respondent would like to learn about	Proportion of 'positive attitude towards possums' subgroup (%) (n = 36)	Proportion of 'negative attitude towards possums' subgroup (%) (n = 47)	Significance (two-sample z test) z	p
Possum ecology/biology	64	19	4.17	0.000
How to live with possums	61	30	2.83	0.002
How to remove possums	17	51	3.20	0.001
What happens to translocated possums	33	23	1.01	0.156
Other	6	0		
One or more of the above	94	79	1.95	0.026

Statistical analysis could not be conducted due to small sample sizes.

increase many residents' knowledge of possums, particularly those who are having possum problems.

Conclusion

This study has demonstrated that members of the community, including special interest groups, generally have a poor knowledge of possum biology. The study also showed that there is an important link between attitudes towards possums and knowledge of possums, that people within the community are interested in learning about possums and that people with a positive attitude towards possums are more interested in learning more about possums than those with a negative attitude. These findings support the suggestion that communication and education programs are important aspects of wildlife management (Peyton and Decker 1987; Penland 1987). The key requirement highlighted by this study is the need for community education. As well as providing basic information (via government agencies and community groups) to those who have problems with possums, it is also important that the broader community is given the opportunity to learn more about and experience not only possums but all native wildlife.

Acknowledgements

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[1] The 'Living With Possums' booklet can be obtained by contacting the Flora and Fauna Branch, Department of Natural Resources and Environment (250 Victoria Parade, East Melbourne, 3002), or the RSPCA (3 Burwood Highway, Burwood East, 3151).

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Mother and baby Common Brushtail Possum *Trichosurus vulpecula* feeding. Supplementary feeding of possums and other wildlife is a common, though not recommended, practice. Photo by Rhonda Miller.

A New Inland Record of the Swamp Skink *Egernia coventryi* Storr, 1978

Nick Clemann[1] and Cam Beardsell[1]

Abstract
The threatened Swamp Skink *Egernia coventryi* occupies a predominantly coastal distribution in south-eastern Australia. Few inland records exist from western Victoria. This note reports a new inland record of *E. coventryi* from the vicinity of Ballarat. This population was located in habitat considered somewhat atypical for this species. (*The Victorian Naturalist* **116** (4), 1999, 127-128)

The Swamp Skink *Egernia coventryi* is listed as vulnerable in Victoria (NRE 1999) and has a disjunct distribution in southeastern Australia, predominantly in coastal regions (Cogger 1996). Within this range this lizard occupies swamp and salt-marsh habitat characterised by dense sedge and tussock vegetation (Smales 1981; Schulz 1985; Clemann 1997). Due to the structure of this vegetation, and the retiring nature of this lizard, *E. coventryi* is difficult to capture by hand and is more reliably collected using Elliott aluminium traps (Robertson 1980; Clemann 1997).

Egernia coventryi is known from only a small number of inland locations, generally in eastern Victoria at Yellingbo and in East Gippsland (Atlas of Victorian Wildlife database, NRE). There are also inland records for the west of the State, from the Casterton district, the Grampians National Park, and a single historical record from Ballarat. Despite recent searches, the population in the Grampians has not been observed for some time (J. Coventry *pers. comm.*). The details of the record from Ballarat, including collection date and specific locality, are incomplete and unsubstantiated.

While conducting herpetofauna surveys for the Regional Forest Agreement process during January 1999 in the Enfield State Forest (143° 45' E, 37° 44' S), approximately 20 km southwest of Ballarat, one of the authors (NC) observed what was suspected to be an adult individual of *E. coventryi* in a low-lying area at the headwaters of a drainage line. In an effort to confirm this identification, 25 Elliott traps were positioned in the vicinity of the original sighting on 9 February 1999, and baited with pilchards, a proven bait for this species (Clemann *et al.* 1998).

The vegetation in the immediate vicinity of the traps was heathy woodland dominated by Prickly Tea-tree *Leptospermum continentale* and Dwarf Bush-pea *Pultenaea humilis* with an open overstorey of Messmate *Eucalyptus obliqua*, Scent-bark *E. aromaphloia* and Shining Peppermint *E. willisii*. Co-dominant vegetation in the ground layer included Small Grass-tree *Xanthorrhoea minor*, Common Rapier-sedge *Lepidosperma filiformis*, Many-flowered Mat-rush *Lomandra multiflora*, Slender Tussock-grass *Poa tenera* and Slender Dodder-laurel *Cassytha glabella*.

The following morning the traps were checked and yielded a single adult female *E. coventryi* and two Agile Antechinus *Antechinus agilis*. The lizard was gravid and produced four young on 14 February 1999 while it was temporarily captive. The length and weight of the adult and the neonates are presented in Table 1. All animals were released where caught after suitable observations had been made and photographs taken (Fig. 1).

A brief survey of the immediate area revealed a number of sympatric scincid species, including White's Skink *Egernia whitii*, Southern Water Skink *Eulamprus tympanum*, Garden Skink *Lampropholis guichenoti* and Eastern Three-lined Skink *Bassiana duperreyi*.

It is interesting to note that, despite its proximity to a major town, this population of *E. coventryi* has previously gone undetected. The habitat at this site is uncharacteristic for *E. coventryi* in that it has an overstorey of *Eucalyptus* spp., and contains no *Melaleuca* spp., usually evident in this skink's habitat.

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Table 1. Length and weight data of adult female and four neonate *Egernia coventryi* from Enfield State Forest.

	Weight (g)	Snout-vent length (mm)	Tail length (mm)
Adult female	16.5	90	92 original plus 36 regrown
Juvenile 1	1.0	37	48
Juvenile 2	0.9	34	44
Juvenile 3	0.9	36	44
Juvenile 4	1.0	37	48

Acknowledgements

The authors thank Richard Loyn and Graeme Newell from the Arthur Rylah Institute, Department of Natural Resources and Environment, for encouraging the confirmation of the original tentative sighting. John Coventry (Curator of Herpetology at the Museum of Victoria) and Peter Robertson provided helpful comments on the distribution of this species. Peter also kindly measured and weighed the lizards. Geoff Brown, Richard Loyn and Graeme Newell commented on the manuscript. The authors thank an anonymous referee for reviewing the manuscript. The surveys were funded by State and Commonwealth Governments as part of the process of developing the Regional Forest Agreements.

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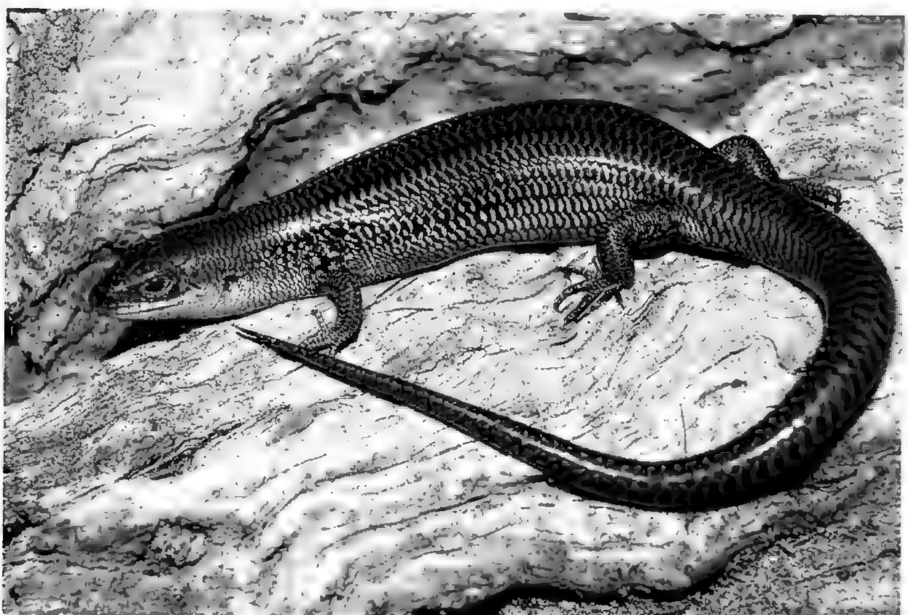

Fig. 1. *Egernia coventryi*, gravid female. Enfield State Forest. Photo by Nick Clemann.

The Use of 'Forms' for Denning by the Common Ringtail Possum *Pseudocheirus peregrinus* at Subalpine Altitudes

Ken Green[1]

Abstract
Daytime observations of Common Ringtail Possums on the ground in subalpine woodland are attributed to the use of forms, similar to those used by hares. These areas of flattened vegetation are used both in summer and in winter, when they are found beneath the snow. (*The Victorian Naturalist* **116** (4), 1999, 129-130).

The local abundance of Common Ringtail Possums *Pseudocheirus peregrinus* is thought to be affected by the availability of nest sites (McKay 1983). The nest is usually a ball of grass or shredded bark in a hollow limb or amongst dense foliage, but at the northern extent of the range of the species a nest is rarely constructed, although the possum still sleeps in tree hollows (McKay 1983). In stands of regrowth Snowgum *Eucalyptus niphophila* above 1500 m in the Snowy Mountains, relatively few trees have had sufficient time to develop hollows, but Ringtail Possums may still be observed (Green and Osborne 1994).

In February 1999, Ringtail Possums were disturbed on the ground in snowgum woodland on Disappointment Spur at about 1:30–2:00 pm by Glenn Sanecki (*pers. comm.*) and two days later at 9 am by the author. In the first case, the possum was simply disturbed as the observer walked through thick woodland, so no deductions could be made about its behaviour on the ground. Because the Ringtail Possum is strictly nocturnal (McKay 1983) this is, however, indicative of behaviour other than foraging. In the second instance, the author had spent some minutes within one metre of a Ringtail Possum while handling two captured Dusky Antechinuses *Antechinus swainsonii*. It wasn't until the animals had been released, equipment packed away and traps folded that the author, stepping over a leaning tree, disturbed the possum which quickly ran up a nearby tree. On investigation, there was no evidence of a ground-level nest. However, beneath a tree and under a nearby grass tussock there was evidence of flattening of the herbaceous stratum in what could best be described as a minimalist 'form', similar to that used by Hares *Lepus capensis* in long grass, rushes or heath (Hewson 1977, Mahood 1983). Denning in such a 'form' by Ringtail Possums has not previously been recorded in the literature but their occurrence on the ground in the late afternoon has also been observed in woodland at Mt. Kaputar (Bill Foley *pers. comm.*) and at Round Mountain (Will Osborne *pers. comm.*)

The use of 'forms' by Ringtail Possums in winter is even more unexpected, although conditions beneath the snow may be more comfortable than in a drey situated in thick scrub, a sight uncommon above the winter snowline (Green and Osborne 1994). Generally mammals weighing more than 250 g are rare beneath the snow surface (Pruitt 1984) except in the case of burrowers and/or hibernators, which in Australia include the Fox *Vulpes vulpes* and Common Wombat *Vombatus ursinus* (Green and Osborne 1994) and Echidna *Tachyglossus aculeatus* (Grigg *et al.* 1992).

In mid July 1996, in an area with no old Snowgums, the author observed a Ringtail Possum at 9.20 am emerging from a possum-width tunnel chewed through thick shrubs leading to below the snow surface. The site was marked, and investigated after the thaw. All that was present at the site was a branch of down-turned gum leaves about 40-50 cm off the ground, with a space beneath but no evidence of a nest. This form was more protected than Hare forms in winter which are sometimes no more than a scrape beneath an overhanging tree (*pers. obs.*). Extensive movement under the snow would be impossible for

[1] NSW National Parks and Wildlife Service, Snowy Mountains Region, PO Box 2228, Jindabyne NSW 2627.

such a large non-burrowing mammal as a Ringtail Possum and their tracks are seldom recorded on the snow (*pers. obs.*), so their normal behaviour would probably be to descend a tree directly to their 'form'.

In a sample of 1159 fox scats from a subalpine transect containing many Hares, evidence of Hares was only found in one scat while remains of Ringtail Possums were found in five. Compared with nine occurrences of Rabbits *Oryctolagus cuniculus*, which are less common than either species above the winter snowline (Green and Osborne 1994), these figures are quite low. This suggests that, unless the Rabbits were scavenged after dying for some other reason, denning on the ground is not as dangerous as it might first appear, as long as an animal has some well-developed predator-avoidance mechanism such as speed (in the case of the Hare) or tree-climbing (in the Ringtail Possum). The greater degree of protection afforded to a Ringtail Possum in winter by submerging itself completely beneath the snow may be an indication of a low tolerance of cold. Comparative studies on the thermal biology of Ringtail Possums and Hares have not been conducted. However, the non-burrowing Hare (Mahood 1983) is able to survive heavy snow years without moving to lower altitudes, both in New Zealand (Flux 1967) and Australia, and without being forced to enhance its insulation from the cold by using the space beneath the snow.

Based on the observations reported here, it appears possible that the use of 'forms' by Ringtail Possums may be widespread but infrequently noted. The occurrence of this behaviour at subalpine altitudes raises interesting questions about the thermal biology of the species, particularly in winter.

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Editor's note:
Hewson (1977) describes a hare's form as 'a shallow depression in long grass, rushes, heather or scrub'.

Fifty Years Ago

MONTHLY NOTES FROM THE PORTLAND F.N.C.

by Noel F. Learmonth

Among the exhibits brought to our last meeting were two Rufous Bristle-birds (*Dasyornis broadbenti*), a Ground Thrush (*Oreocincla lunulata*), a Goshawk (*Astur fasciatus*) and an Allied Rat (*Rattus assimilis*) - all from among that morning's catch in a member's line of rabbit traps. Bristle-birds are frequently killed in this way and, though difficult to see in the thick undergrowth south of Portland, are quite common; the writer saw five birds on one bush track at Cape Nelson recently. Ground Thrushes are rare here, though widespread. The goshawk was only just dead when found at dawn, so it must be a very early hunter.

From *The Victorian Naturalist* **66**, p. 68, August 1949.

Fauna Survey Group (FSG) Contribution No. 22

A Survey of the Vertebrate Fauna of the Rushworth State Forest

S.D. Myers[1] and S.G. Dashper[1]

Abstract

Surveys were conducted in the Rushworth State Forest by the Fauna Survey Group of the FNCV for about four years. The main motivation for the work was to detect and monitor the presence of Brush-tailed Phascogale *Phascogale tapoatafa*, but we have also kept records for all vertebrate species detected. These records include a number of species that are declining, threatened or endangered and provide a picture of the current status of the fauna in the forest. (*The Victorian Naturalist*, **116** (4), 1999, 131-141).

Introduction

Box and Ironbark forests contain some of the most threatened habitats in Victoria. Approximately 85% of these forests and related ecosystems have been cleared since pre-European settlement and less than 3% of that remaining receives any form of protection (Robinson 1993). A large proportion of the Box-Ironbark forests in Victoria now exist only in fragmented and degraded remnants. This has had a considerable, deleterious effect on the fauna of these woodlands and forests. Since European settlement, three groups of species in particular (Bennett 1993) have declined in the Box-Ironbark forests. These are 1) the hollow-dependent species requiring large areas (e.g. Powerful Owl *Ninox strenua*, Brush-tailed Phascogale *Phascogale tapoatafa*, Squirrel Glider *Petaurus norfolcensis*); 2) mobile species that utilise resources in different locations (e.g. Little Lorikeet *Glossopsitta pusilla*, Swift Parrot *Lathamus discolor*, Regent Honeyeater *Xanthomyza phrygia*); and 3) forest-dependent species that utilise fallen logs and ground litter for nesting, foraging and shelter (e.g. Hooded Robin *Melanodryas cucullata*, Bush Stone-curlew *Burhinus magnirostris*). A range of activities such as mining, timber cutting and land clearing within the Box-Ironbark forests has led to a reduction in the resources required by these groups.

The Rushworth State Forest is the largest, most intact block of Box-Ironbark forest remaining in this State. It is located in north central Victoria and lies approximately 23 km north-east of Heathcote and 12 km west of Nagambie, covering an area of *circa* 32 630 ha (Environment Conservation Council 1997). Within the forest, conservation reserves include the Mount Black Flora Reserve (1630 ha) and the Whroo Historic Reserve (490 ha). The remaining forest area is classified as State Forest for hardwood production (Land Conservation Council 1981).

The terrain is generally flat to undulating, gentle hills with Mount Black being the highest peak at 328 m. There are many creeks throughout the Rushworth State Forest that rarely flow except during periods of heavy rain. Annual rainfall varies from 400–700 mm (Land Cconservation Council 1981). The Rushworth-Whroo area was a major goldfield last century; the forest has been seriously damaged in the past by the activities of gold miners. To this day evidence of these past activities is quite visible. The forest is still heavily used for logging and firewood collection. Timber is extracted by selective logging and permit holders may take firewood. Certain areas of the State Forest have not had as many trees removed; consequently the number of hollow-bearing trees is higher in these areas (*pers. obs.*). The forest is also used for a number of recreational activities such as fossicking, rally car driving, trail biking and horse riding.

Vegetation

There are a number of vegetative structural forms within the forest as classified by the Land Conservation Council (1981) and the Environment Conservation Council (1997). (See also Muir *et al.* (1995) for a description of EVCs (Ecological Vegetation Classes) for this area.) The general vegetative structure is

[1] 7A Park Street, Hawthorn, Victoria 3122

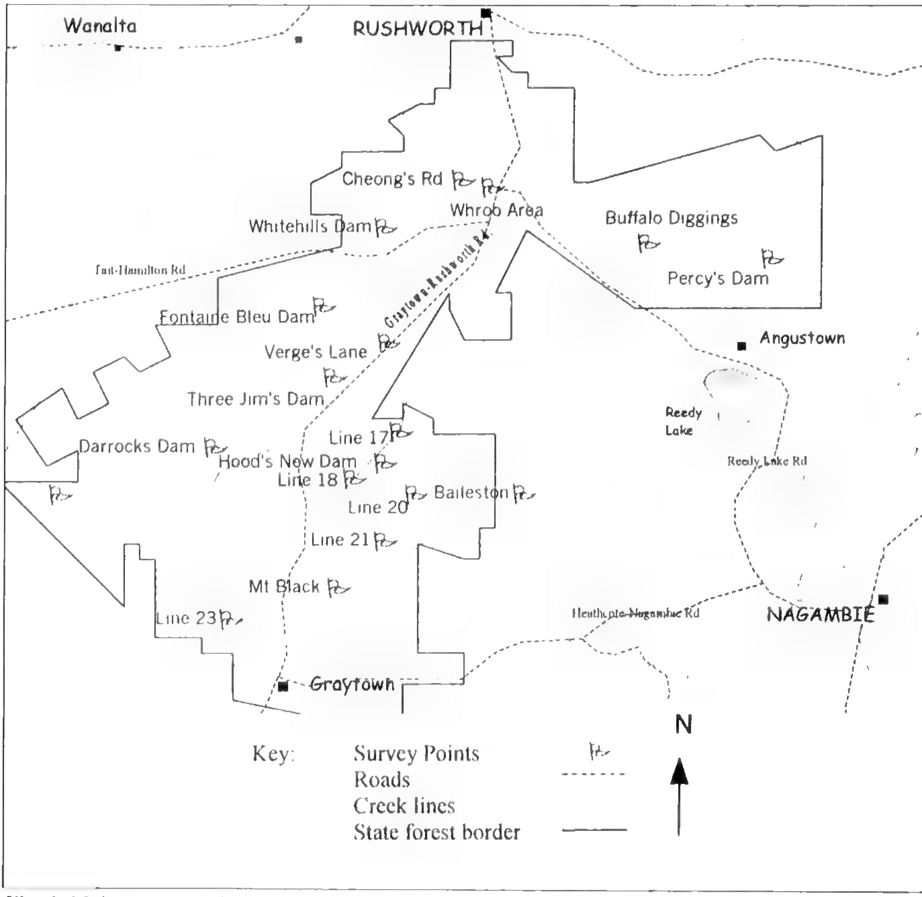

Fig. 1. Major survey points in Rushworth State Forest. (Scale 1 km = 3.2 mm approximately)

classified as Open Forest II where Red Ironbark *Eucalyptus tricarpa*, Grey Box *Eucalyptus microcarpa* and Yellow Gum *Eucalyptus leucoxylon* are the dominant species of the tallest stratum (Land Conservation Council 1978). The lower strata consist of Gold-dust Wattle *Acacia acinacea*, Hedge Wattle *A. paradoxa*, Chinese Tea-tree *Cassinia arcuata* and Austral Grass-tree *Xanthorrhoea australis*. Austral Grass Trees are especially conspicuous around the slopes of Mount Black. In addition to the above forest type, large areas of Open Forest I consisting of Red Ironbark, Red Stringybark *E. macrorhyncha* and Red Box *E. polyanthemos* are also extant. Patchy areas of Open Forest I Woodland I, where the major tree species are Grey Box and Yellow Gum, and Open Scrub of Bull Mallee *E. behriana* and Blue Mallee *E. polybractea*, are also found within the State Forest (Land Conservation Council 1978). Most of the Open Scrub mallee in the northern section of the forest is used for Eucalyptus-oil production. Altered fire regimes combined with invasion by introduced herbaceous species has changed the forest's substrata since historic times.

The Fauna Survey Group (FSG) of The Field Naturalists Club of Victoria has been conducting fauna surveys in the Rushworth State Forest since the beginning of 1995 with particular emphasis on determining the status and distribution of the Brush-tailed Phascogale *Phascogale tapoatafa* (Dashper and Myers *in prep.*). This report serves to catalogue records of all vertebrate species recorded by the FSG in the region over the past four years.

Table 1. Total survey effort by the FSG in Rushworth State Forest.

Survey date	No. of nest boxes checked	Trap nights	Spotlighting (minutes)	Bat trapping (nights)
June 94	-	240	330	3
December 94	-	776	405	
April 95	-	220	-	
Dececember 95	92	210	105	1
April 96	12	-		
May 96	142			
September 96	28		30	
January 97	142	100		
June 97	142	200	160	
July 97	-		190	
January 98	142	80	95	1
May 98	92	30	180	
Total	**792**	**1856**	**1495**	**5**

Survey Methods and Results

Fauna surveys have been conducted over a period of three and a half years from 1995 to 1998. Surveys were carried out every 4 to 6 months at various locations throughout the forest (Fig. 1). A variety of survey techniques were used including checking nest boxes, trapping, spotlighting, bird observations and incidental sightings. Table 1 shows the survey effort for each technique.

Nest boxes

A total of 142 nest boxes were routinely checked including 92 nest boxes originally erected in 1992 (Soderquist *et al.* 1996) and 50 nest boxes erected by the FSG in 1995. The 92 nest boxes are at 23 sites consisting of four nest boxes along a transect, the boxes each approximately 100 m apart. The 50 nest boxes erected by the FSG are in lines of 10 boxes, at five sites in the central section of the forest. All nest boxes have entrance holes of 35 mm in diameter, which is a size thought to favour Brush-tailed Phascogales and Sugar Gliders *Petaurus breviceps* (Soderquist *et al.* 1996). Therefore, nest box usage may not be an actual reflection of the status and distribution of mammals other than phascogales and Sugar Gliders.

Table 2 shows the number of records and occupancy rates for each species observed using the nest boxes. By far the most commonly recorded species was the Sugar Glider, followed by the Brush-tailed Phascogale. Only five species in total have been recorded using the nest boxes; of those, two have been recorded only once each and one has been recorded twice. Sugar Gliders had a significantly higher nest box occupancy rate than the Brush-tailed Phascogale, the next most commonly recorded species.

Trapping

Cage and Elliott traps were set in lines of 10 traps about 10 m apart. The bait used was a mixture of peanut butter, rolled oats, honey and vanilla essence. Trapping was not carried out during the phascogale breeding season from August to December or during particularly cold weather.

A small effort at pitfall trapping was made during a single visit in December 1994 to January 1995. One pitline with 10 buckets spaced at 10 m intervals was opened for 5 nights. Unfortunately, no animals were trapped by this method.

Spotlighting

Spotlighting was carried out on a regular, but not intensive, basis by members during FSG camps in a number of areas, mainly in the central south section of the forest (Table 3). It was carried out on an opportunistic basis and usually conducted by two groups of two to six people walking at a pace of approximately 3 km/h.

Bat trapping

Bat trapping was carried out using harp traps and trip lines (Table 1). Further surveys of bats in the area are required.

Bird records

A bird list was maintained during each of the eighteen mammal survey trips as well as during some independent trips by the authors (survey trips were up to four days in length). Observations were made throughout the forest (Fig. 1); while carrying out other survey efforts, all birds seen and heard were recorded.

Table 2. Species recorded in nest boxes (Total No. = number of individuals recorded) and occupancy rate (Occ. Rate = no. species records/no. boxes checked). Key: BTPh, Brush-tailed Phascogale; SG, Sugar Glider; YFA, Yellow-footed Antechinus; CBP, Common Brushtail Possum; CRT, Common Ringtail Possum.

Date	BTPh	SG	YFA	CBP	CRT
Dec-95	1	25	1		
Apr-96	1	18			
May-96	4	93		1	
Sep-96	1	34			
Jan-97	6	62	1		1
Jun-97	4	114			
Jan-98	4	76			
May-98	1	68			
Total No.	**22**	**490**	**2**	**1**	**1**
Occ. Rate	0.03	0.77	0.01	0.01	0.01

Chance observations and indirect signs

Vocalisations, scats and tracks encountered were duly noted.

Discussion

Survey work by the FSG in the Rushworth State Forest area is an ongoing process that we hope to continue for many years to come. This is an interim report of survey records to date. The group has recorded a number of species that are of particular interest.

The aim of trapping by the FSG at Rushworth was chiefly to detect the presence of phascogales. Therefore, we have generally employed the strategy of setting traps in seemingly suitable habitat, especially near hollow stumps and logs and at the base of hollow-bearing trees. Trapping has been a rather selective process, however this has not excluded other mammals such as the Yellow-footed Antechinus *Antechinus flavipes* from being trapped. To date, trapping in Rushworth has not been particularly successful, highlighting the trap shyness of the animals combined with low densities of phascogales and other small mammals in this Box-Ironbark forest.

Mammals

The following is an annotated list of mammals recorded in the Rushworth State Forest by the FSG over the past four years. Mammals in the forest were detected by means of trapping, spotlighting and by indirect and chance observations (vocalisations, scats, tracks). Measures of abundance (Tables 2 and 3) are given for mammals that were recorded by trapping, spotlighting or nest box checks.

Table 3. Spotlighting results. Mean Spotlighting Rate (MSR) = No. of records/total spotlighting time (minutes); No. = Number of records. *see discussion.

Species	No.	MSR
Australian Owlet-nightjar	1	0.04
Barn Owl	1	0.04
Brush-tailed Phascogale	1	0.04
Common Brushtail Possum	21	0.84
Common Ringtail Possum	19	0.76
Feathertail Glider	1	0.04
Koala	1	0.04
Southern Boobook	3	0.12
Squirrel Glider	8 *	0.32
Sugar Glider	36	1.44
Tawny Frogmouth	1	0.04

Short-beaked Echidna *Tachyglossus aculeatus*

One direct sighting of a very large, pale individual was recorded with signs of diggings reasonably common although not widespread. Despite the apparent abundance of ants in the forest, echidnas do not seem to be common; it is possible that the very hard soil limits the ability of the species to exploit this food source.

Yellow-footed Antechinus *Antechinus flavipes flavipes*

The Yellow-footed Antechinus was recorded using nest boxes, in traps and through incidental observations during the day. Scats and nests in nest boxes are also reasonably common. This indicates that it is a relatively common species in the Rushworth Forest.

The Yellow-footed Antechinus is restricted to a band running roughly along the line of the Great Dividing Range from the north-east to the south-west of the State where it occurs mainly in dry forest and woodland. This species is heavily reliant on natural tree hollows for shelter (Menkhorst 1995). Naturally occurring ground litter and logs, where the Yellow-footed Antechinus forages for arthropods and small vertebrates, are also necessary. Menkhorst (1995) states that the degradation of the dry woodland habitats of this species inevitably leads to concern over its long-term survival prospects.

Brush-tailed Phascogale *Phascogale tapoatafa*

The most significant mammal recorded is the Brush-tailed Phascogale. The phascogale is classified as rare in Victoria by the Department of Natural Resources and Environment and listed in Schedule 2 of the Fauna and Flora Guarantee Act. This species was first recorded by others in 1993 when phascogale nests and scats were recorded in nest boxes, although no animals were sighted (Soderquist *et al.* 1996). The FSG has 22 records in total of phascogales using nest boxes (Table 2). *Phascogale tapoatafa* has been observed twice during spotlight surveys and recorded three times in traps. Additionally, signs, including scats and nests, have been noted in 28 of 142 nest boxes (19%) regularly checked by the FSG. Obviously use of nest boxes by the Brush-tailed Phascogale is considerably lower than that of the Sugar Glider but we believe that even this low occupancy rate is important. The phascogale requires large areas of forest in order to maintain viable populations (Soderquist 1995). A lack of mature-age, hollow-bearing trees may lead to phascogales selecting hollows with inadequate protection against predators, leading to an increase in mortality rates. As the Box-Ironbark forest continues to be degraded and fragmented, local extinctions are likely to occur. Rushworth State Forest is the largest block of Box-Ironbark forest remaining in Victoria, and is important for the conservation of this species. With the erection of nest boxes in the Rushworth State Forest it is possible we are encouraging the phascogale population to increase in number, as a lack of hollows limits populations.

Common Dunnart *Sminthopsis murinus*

One female with 5 pouch young was trapped in tall open woodland grading to low open woodland in the southern end of the forest. In Victoria the Common Dunnart's status is uncertain (Menkhorst 1995), it is classified as Rare by the Environment Conservation Council (1997). Rushworth may possibly represent an important population.

Koala *Phascolarctos cinereus*

One Koala was recorded while spotlighting in the Spring Creek area in the southern section of the forest.

Common Brushtail Possum *Trichosurus vulpecula*

Menkhorst (1995) records the Common Brushtail Possum as common in Box and Ironbark forests. They were the second most commonly observed species after the Sugar Glider during spotlighting (MSR 0.84 *cf.* 1.44; Table 3). One was recorded in a decrepit nest box.

Sugar Glider *Petaurus breviceps*

The Sugar Glider was the most frequently recorded mammal. Its use of nest boxes appears to be mostly in areas with low densities of hollow-bearing trees. It was the most frequently observed species when spotlighting (Table 3).

This species is widespread and relatively common in Victoria and its status is classified as secure (Menkhorst 1995). The Sugar Glider is also dependent on tree hollows. The extremely high rate of nest box usage by Sugar Gliders (Table 2) may indicate a paucity of natural hollows. We often found Sugar Gliders using nest boxes in areas that are almost totally devoid of hollow-bearing trees. Lunney (1987) found that in forests such as Rushworth State Forest that are managed intensively as a timber resource leading to reduced numbers of hollow bearing trees, Sugar Glider numbers are consequently reduced. In the Rushworth area large stands of coppiced eucalypts have replaced much old-growth forest, leading the fauna survey group to suspect that the species' future in the Rushworth area is by no means secure.

Squirrel Glider *Petaurus norfolcensis*

This species was observed in an area of roadside vegetation consisting of some large hollow-bearing Yellow Box on the southern border of the forest. It is possible that this species has been recorded during spotlighting in the Spring Creek area but due to difficulties with identification of the Squirrel Glider (Traill 1998) further work is required in order to confirm the existence of this species within the Rushworth State Forest. Sherwin (1996) classifies the Rushworth forest block as a key location for this species.

Common Ringtail Possum *Pseudocheirus peregrinus*

The Common Ringtail Possum was recorded once while using a nest box which was in very poor condition. The animal gained access to the box via the broken lid. This species was recorded many times in edge habitat during spotlighting but rarely within the forest.

This species is common in forested areas in Victoria but it appears that in Rushworth State Forest it uses hollows rather than dreys for nesting. A lack of hollows in the area may lead to reduced numbers in Rushworth State Forest.

Feathertail Glider *Acrobates pygmaeus*

One Feathertail Glider was recorded by the group while it was foraging in a large flowering Yellow Gum near a dam. This species has only been recorded once in the Rushworth State Forest in 1990 (Atlas of Victorian Wildlife database, NRE). It may be under reported due its diminutive size.

Eastern Grey Kangaroo *Macropus giganteus*

This species is common throughout the forest, particularly in areas abutting farmland. It is commonly recorded by direct observation and signs such as scats and skeletal remains.

Black Wallaby *Wallabia bicolor*

The Black Wallaby is one of the most common mammals observed throughout Rushworth State Forest. It is frequently sighted while driving, walking and spotlighting. Road kills are also commonly observed. The thumping, warning sound is frequently noted, as are scats. Young animals are also often seen, suggesting a high breeding rate.

Gould's Wattled Bat *Chalinolobus gouldii*

One Gould's Wattled Bat was captured in a harp trap.

Little Forest Bat *Vespadelus vulturnus*

The Little Forest Bat was recorded from harp trapping in the central section of the forest. The species is common and widespread in Victoria (Menkhorst 1995).

Red Fox *Vulpes vulpes*

Four sight records of foxes were made within the forest. Scats are regularly, though not commonly, noted. Anecdotally, this species does not appear to be common in Rushworth State Forest.

Cat *Felis catus*

We have one sight record of a cat, and scats have been noted on occasions. It does not appear to be common in the forest.

Goat *Capra hircus*

We have no direct sightings of Goat. Tracks and scats have been recorded in the central section of the forest. What is believed to be goat hair has been observed in phascogale nests. Tracks have been noted at some dams.

Feral Pig *Sus scrofa*

The group has one record of a dead pig near Spring Creek in the southern end of the forest.

European Rabbit *Oryctolagus cuniculus*

Sight and sign records were frequently made. Anecdotally, we have noted a decrease in abundance since the introduction of the Calicivirus.

Birds

Over 100 species of bird have been recorded by the FSG, with approximately 30 days of bird observations of varying intensity being carried out. This represents a rich avifauna. Table 4 shows a list of bird species recorded by the FSG in the Rushworth State Forest. Measures of abundance are given for birds where reporting rate and abundance were measured. A number of species recorded by the FSG in Rushworth State Forest are classified by the Department of Natural Resources and Environment as depleted. These are: Collared Sparrowhawk, Wedge-tailed Eagle, Little Lorikeet, Australian Owlet-nightjar, White-bellied Cuckoo-shrike, Jacky Winter, Crested Bellbird, Spotted Quail-thrush, White-browed Babbler, Speckled Warbler, Chestnut-rumped Heathwren, Grey Currawong and Emu (see also Robinson 1994). Water birds such as herons and cormorants have been recorded at numerous dams scattered through the forest. Most dams are man-made for fire-fighting purposes. Interesting sightings are discussed below.

Emu *Dromaius novaehollandiae*

An artificially established population at Puckapunyal Military Reserve (Emison *et al.* 1987) was the only record for central Victoria collected over the period from 1977 to 1981. This leads the FSG to believe that the Emu has possibly spread to the Rushworth State Forest. Our percentage-reporting rate of 22.2% suggests that the species has possibly become well established in the area although no signs of breeding have yet been observed.

Little Lorikeet *Glossopsitta pusilla*

This species mainly inhabits Box-Ironbark and associated forest but is not common in the Rushworth region. Little Lorikeets are highly nomadic and have been recorded by the group when eucalypts are flowering in spring and winter. It is also declining in Victoria (Robinson 1994).

Swift Parrot *Lathamus discolor*

Classified as Vulnerable and listed under Schedule 2 of the Flora and Fauna Guarantee Act 1998, the Swift Parrot relies on winter-flowering eucalypts in its non-breeding range, such as are found in the Box-Ironbark forests.

Powerful Owl *Ninox strenua*

The Powerful Owl has been recorded once by the group in an area abutting Mount Black where larger, hollow bearing trees remain in reasonable numbers. It has been estimated that fewer than 500 breeding pairs remain in Victoria (Garnett 1992). It is estimated by the Environment Conservation Council (1997) that fewer than 50 breeding pairs remain in the Victorian Box-Ironbark forests. Rushworth State Forest could therefore be an important area for the conservation of this species. The Powerful Owl is classified as rare and vulnerable in Australia and Victoria, although widespread (Environment Conservation Council 1997).

Yellow-rumped Pardalote *Pardalotus punctatus xanthopygus*

The Yellow-rumped Pardalote was only ever observed in the mallee area in the north of the forest. This is probably an isolated population and may hybridise with the more commonly occurring nominate race, Spotted Pardalote *Pardalotus punctatus punctatus*.

Chestnut-rumped Heathwren *Hylacola pyrrhogia*

We have found this species to be locally common within the Rushworth State Forest, although it is declining in Victoria (Robinson 1994).

Speckled Warbler *Chthonicola sagittata*

This species is classified as declining by Robinson (1994); it is a ground feeding and nesting species that is particularly vulnerable to introduced predators. The Speckled Warbler's main distribution in southeastern Victoria is within the dry Box forests and woodlands. Where the habitat is highly modified or disturbed (e.g. where timber cutting occurs as in Rushworth) the populations disappear (Robinson and Traill 1996)

Regent Honeyeater *Xanthomyza phrygia*

The Regent Honeyeater is listed as a threatened taxon in Schedule 2 of *the Flora and Fauna Guarantee Act 1988* and classified as Endangered by the Department of Natural Resources and Environment. This species has declined in or disappeared from much of its range. Its present population may be less than 1000 individuals, and its decline is believed to be due to habitat loss, degradation and fragmentation (Garnett 1992).

Tawny-crowned Honeyeater

This species was recorded only in areas of mallee near the town of Rushworth in the northern section of the forest.

Black Honeyeater *Certhionyx niger*

A single bird was observed drinking at a dam in January 1995 after a period of below average rainfall. Rushworth forest may represent an important drought refuge area for such species. The importance of these sites to species such as Black Honeyeater, in terms of long-term viability, requires further research (Ford and Paton 1986) especially in view of continuing fragmentation of dry woodland habitats.

Red-capped Robin *Petroica goodenovii*

The Red-capped Robin is classified as declining in Victoria (Robinson 1994). It appears to be uncommon in Rushworth State Forest.

White-browed Babbler *Pomatostomus superciliosus*

The White-browed Babbler is declining in Victoria (Robinson 1994), and although not uncommon in Rushworth, anecdotally we have noted a decrease in numbers. The White-browed Babbler

Table 4. Birds Recorded in Rushworth State Forest. Surveys = number of survey trips in which the species was detected out of 18 carried out; % = percentage of surveys on which the species was recorded. Common and scientific names follow Christidis and Boles (1994).

Common Name	Scientific Name	Surveys	%
Emu	*Dromaius novaehollandiae*	4	22.2
Brown Quail	*Coturnix ypsilophora*	2	11.1
Australian Wood Duck	*Chenonetta jubata*	3	16.7
Pacific Black Duck	*Anas superciliosa*	4	22.2
Australasian Grebe	*Tachybaptus novaehollandiae*	5	27.8
Pied Cormorant	*Phalacrocorax varius*	1	5.6
Great Cormorant	*Phalacrocorax carbo*	1	5.6
White-faced Heron	*Egretta novaehollandiae*	2	11.1
White-necked Heron	*Ardea pacifica*	1	5.6
Nankeen Night Heron	*Nycticorax caledonicus*	1	5.6
Brown Goshawk	*Accipiter fasciatus*	4	22.2
Collared Sparrowhawk	*Accipiter cirrhocephalus*	1	5.6
Wedge-tailed Eagle	*Aquila audax*	4	22.2
Little Eagle	*Hieraaetus morphnoides*	1	5.6
Peregrine Falcon	*Falco peregrinus*	1	5.6
Painted Button-quail	*Turnix varia*	4	22.2
Common Bronzewing	*Phaps chalcoptera*	12	66.7
Brush Bronzewing	*Phaps elegans*	2	11.1
Crested Pigeon	*Ocyphaps lophotes*	3	16.7
Galah	*Cacatua roseicapilla*	12	66.7
Sulphur-crested Cockatoo	*Cacatua galerita*	11	61.1
Rainbow Lorikeet	*Trichoglossus haematodus*	1	5.6
Musk Lorikeet	*Glossopsitta concinna*	12	66.7
Little Lorikeet	*Glossopsitta pusilla*	9	50.0
Purple-crowned Lorikeet	*Glossopsitta porphyrocephala*	4	22.2
Crimson Rosella	*Platycercus elegans*	17	94.4
Eastern Rosella	*Platycercus eximius*	15	83.3
Swift Parrot	*Lathamus discolor*	1	5.6
Pallid Cuckoo	*Cuculus pallidus*	2	11.1
Fan-tailed Cuckoo	*Cacomantis flabelliformis*	3	16.7
Shining Bronze-Cuckoo	*Chrysococcyx lucidus*	4	22.2
Horsfield's Bronze-Cuckoo	*Chrysococcyx basilis*	2	11.1
Powerful Owl	*Ninox strenua*	1	5.6
Southern Boobook	*Ninox novaeseelandiae*	4	22.2
Tawny Frogmouth	*Podargus strigoides*	1	5.6
White-throated Nightjar	*Eurostopodus mystacalis*	2	11.1
Australian Owlet-nightjar	*Aegotheles cristatus*	5	27.8
White-throated Needletail	*Hirundapus caudacutus*	5	27.8
Laughing Kookaburra	*Dacelo novaeguineae*	13	72.2
Sacred Kingfisher	*Todiramphus sanctus*	3	16.7
Rainbow Bee-eater	*Merops ornatus*	2	11.1
White-throated Treecreeper	*Cormobates leucophaeus*	15	83.3
Brown Treecreeper	*Climacteris picumnus*	10	55.6
Superb Fairy-wren	*Malurus cyaneus*	12	66.7
Spotted Pardalote (includes Yellow-rumped Pardolote)	*Pardalotus punctatus*	16	88.9
Striated Pardalote	*Pardalotus striatus*	12	66.7
Chestnut-rumped Heathwren	*Hylacola pyrrhopygia*	3	16.7
Speckled Warbler	*Chthonicola sagittata*	2	11.1
Weebill	*Smicrornis brevirostris*	14	77.8
Western Gerygone	*Gerygone fusca*	1	5.6
Brown Thornbill	*Acanthiza pusilla*	1	5.6
Chestnut-rumped Thornbill	*Acanthiza uropygialis*	2	11.1
Buff-rumped Thornbill	*Acanthiza reguloides*	16	88.9
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*	4	22.2
Yellow Thornbill	*Acanthiza nana*	2	11.1
Striated Thornbill	*Acanthiza lineata*	4	22.2
Red Wattlebird	*Anthochaera carunculata*	18	100.0
Little Wattlebird	*Anthochaera chrysoptera*	1	5.6

Table 4. continued.

Common Name	Scientific Name	Surveys	%
Noisy Friarbird	*Philemon corniculatus*	3	16.7
Little Friarbird	*Philemon citreogularis*	1	5.6
Regent Honeyeater	*Xanthomyza phrygia*	1	5.6
Noisy Miner	*Manorina melanocephala*	3	16.7
Yellow-faced Honeyeater	*Lichenostomus chrysops*	7	38.9
White-eared Honeyeater	*Lichenostomus leucotis*	11	61.1
Yellow-tufted Honeyeater	*Lichenostomus melanops*	18	100.0
Yellow-plumed Honeyeater	*Lichenostomus ornatus*	3	16.7
Fuscous Honeyeater	*Lichenostomus fuscus*	17	94.4
White-plumed Honeyeater	*Lichenostomus penicillatus*	8	44.4
Black-chinned Honeyeater	*Melithreptus gularis*	8	44.4
Brown-headed Honeyeater	*Melithreptus brevirostris*	17	94.4
White-naped Honeyeater	*Melithreptus lunatis*	5	27.8
New Holland Honeyeater	*Phylidonyris novaehollandiae*	5	27.8
Tawny-crowned Honeyeater	*Phylidonyris melanops*	3	16.7
Eastern Spinebill	*Acanthorhynchus tenuirostris*	4	22.2
Black Honeyeater	*Certhionyx niger*	1	5.6
White-fronted Chat	*Epthianura albifrons*	1	5.6
Jacky Winter	*Microeca fascinans*	3	16.7
Scarlet Robin	*Petroica multicolor*	6	33.3
Flame Robin	*Petroica phoenicea*	5	27.8
Red-capped Robin	*Petroica goodenovii*	1	5.6
Rose Robin	*Petroica rosea*	1	5.6
Hooded Robin	*Melanodryas cucullata*	1	5.6
Eastern Yellow Robin	*Eopsaltria australis*	7	38.9
White-browed Babbler	*Pomatostomus superciliosus*	9	50.0
Spotted Quail-thrush	*Cinclosoma punctatum*	3	16.7
Varied Sittella	*Daphoenositta chrysoptera*	2	11.1
Crested Shrike-tit	*Falcunculus frontatus*	4	22.2
Crested Bellbird	*Oreoica gutturalis*	9	50.0
Gilbert's Whistler	*Pachycephala inornata*	1	5.6
Golden Whistler	*Pachycephala pectoralis*	8	44.4
Rufous Whistler	*Pachycephala rufiventris*	9	50.0
Grey Shrike-thrush	*Colluricincla harmonica*	12	66.7
Satin Flycatcher	*Myiagra cyanoleuca*	1	5.6
Restless Flycatcher	*Myiagra inquieta*	4	22.2
Magpie-lark	*Grallina cyanoleuca*	3	16.7
Grey Fantail	*Rhipidura fuliginosa*	11	61.1
Willie Wagtail	*Rhipidura leucophrys*	8	44.4
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	10	55.6
White-bellied Cuckoo-shrike	*Coracina papuensis*	2	11.1
White-winged Triller	*Lalage sueurii*	1	5.6
Olive-backed Oriole	*Oriolus sagittatus*	9	50.0
Black-faced Woodswallow	*Artamus cinereus*	1	5.6
Dusky Woodswallow	*Artamus cyanopterus*	10	55.6
Grey Butcherbird	*Cracticus torquatus*	1	5.6
Australian Magpie	*Gymnorhina tibicen*	10	55.6
Pied Currawong	*Strepera graculina*	5	27.8
Grey Currawong	*Strepera versicolor*	16	88.9
Australian Raven	*Corvus coronoides*	13	72.2
Little Raven	*Corvus mellori*	2	11.1
White-winged Chough	*Corcorax melanorhamphos*	15	83.3
Diamond Firetail	*Stagonopleura guttata*	1	5.6
Mistletoebird	*Dicaeum hirundinaceum*	3	16.7
Welcome Swallow	*Hirundo neoxena*	4	22.2
Tree Martin	*Hirundo nigricans*	4	22.2
Silvereye	*Zosterops lateralis*	4	22.2
Common Blackbird	*Turdus merula*	1	5.6
Common Starling	*Sturnus vulgaris*	2	11.1

previously occurred in the Geelong area but now only occurs north of the Great Dividing Range in Victoria.

Spotted Quail-thrush *Cinclosoma punctatum*

The Spotted Quail-thrush is declining in Victoria (Robinson 1994) and was observed infrequently by FSG members.

Crested Bellbird *Oreoica gutturalis*

This species is fairly widespread, though not common in the Rushworth State Forest. Since the local extinction of this species in the Chiltern forest (Traill *et al.* 1996), the Rushworth population possibly represents the easternmost population in Victoria and is likely to be an important population at the outer limit of the birds' south-eastern distribution.

Grey Currawong *Strepera versicolor*

Although declining in Victoria (Robinson 1994), this species is fairly common in Rushworth State Forest.

Herpetofauna (Tables 5 and 6).

No systematic surveys for reptiles and amphibians have been carried out to date. However, casual observations have revealed a number of species. In particular Bibron's Toadlet *Pseudophryne bibronii* and Eastern Banjo Frog *Limnodynastes dumerelli* are common around dams within the forest. Given that these dams are relatively recent, man-made additions to the landscape it seems likely that populations of these species have increased since historic times. Both *Varanus varius* and *V. gouldii* have been observed on one occasion. They require hollow logs and dense litter for shelter. Both of these commodities have been depleted in Box-Ironbark forests since European settlement.

Conclusion

The Fauna Survey Group has recorded a number of species that fall within the three groups of declining species described by Bennett (1993). The relative paucity of records for many of these species suggests that a lack of large hollow bearing trees has had an impact on the distribution and abundance of these species. Other disturbances in the Rushworth State Forest have led to a decline in species reliant on fallen and rotting logs and a deep litter layer.

Unfortunately, the Box-Ironbark forests of Victoria have, in the past, fallen victim

Table 5. Amphibians recorded at Rushworth State Forest. Common and scientific names follow Cogger (1996).

Common Name	Scientific Name
Common Froglet	*Crinia signifera*
Eastern Smooth Frog	*Geocrinia victoriana*
Eastern Banjo Frog	*Limnodynastes dumerili*
Bibron's Toadlet	*Pseudophryne bibronii*
Southern Brown Tree Frog	*Litoria ewingii*
Peron's Treefrog	*Litoria peronii*

Table 6. Reptiles recorded at Rushworth State Forest. Common and scientific names follow Cogger (1996).

Common Name	Scientific Name
Marbled Gecko	*Christinus marmoratus*
Tree Dragon	*Amphibolurus muricatus*
Gould's Monitor	*Varanus gouldii*
Lace Monitor	*Varanus varius*
Bougainville Skink	*Lerista bougainvillii*
South-eastern Morethia	*Morethia boulengeri*
Common Bluetongue	*Tiliqua scincoides*
Red-bellied Black Snake	*Pseudechis porphyriacus*Eastern
Brown Snake	*Pseudonaja textilis*

to an unglamorous image. In large part the forest was all but destroyed before people had a chance to realise its intrinsic value (Calder *et al.* 1994). Compared to the wet forests of Victoria, dry forests have received little attention in recent years. The importance of this type of forest to Australia's history and ecology cannot be overstated. An increase in awareness of conservation issues in regard to biodiversity has recently helped to overcome some of these problems but ongoing effort is required. Many species rely wholly or in large part on the Box-Ironbark forest. In order to protect biodiversity in this State the protection of Box-Ironbark forest is of tantamount importance.

The Fauna Survey Group is continuing its work in the Rushworth State Forest in the hope that a picture can be created of the fauna in this area in regard to status, distribution and occurrence. We will continue to place emphasis on the Brush-tailed Phascogale as we believe this species to be not only of particular intrinsic interest but an indicator of the overall health of the forest. At the same time we will of course keep records of all species detected.

Acknowledgements
The Fauna Survey Group would particularly like to thank the M.A. Ingram Trust for financial support with this survey. The authors wish to express their gratitude to Ray Gibson, Rob Gration, Russell Thompson and Ray White, as well as all FSG members who assisted with fieldwork. Trapping was carried out under Research Permit number RP-97-144 under the provisions of the Wildlife Act 1975. We would like to thank an anonymous referee for helpful comments on the draft of this paper.

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One Hundred Years Ago

A Large Dingo - I wish to bring under the notice of this Club particulars regarding a large half-bred Dingo killed recently at Tatong, about 20 miles south-east of Benalla. A paragraph in the Age of 24th April last stating that a Dingo a shade over 6 feet long had been captured at Tatong, struck me as being very interesting, on account of the size of the animal, and I accordingly made inquiries on the matter. Mr. Z. Anthony, of the Vermin Destruction Branch of the Department of Lands and Survey, kindly wrote to Mr. M.J. Delahenty, the Vermin Inspector of the Benalla district, who replied that the animal was a half-bred Dingo, black in colour, and nearly as large as a Newfoundland dog. As this is a most unusual size, even for a half-bred wild dog, the fact appears worthy of record. - A.E. Kitson, 10th July, 1899.

From *The Victorian Naturalist* **XVI**, p. 76, August 1899.

Moss Bed Lake on the Nunniong Plateau

R.J. Fletcher[1]

Abstract
A pristine sphagnum bog on the Nunniong Plateau is visited and a start is made to determine the suite of plants that furnish it. (*The Victorian Naturalist* **116** (4), 1999, 142-145).

A network of tracks of varying quality, virtually all of them created for logging, covers the Nunniong Plateau in Gippsland. On the one hand this has destroyed much of the habitat, but on the other has made a rather remote area accessible.

Many of these tracks have fascinating names, such as Jam Tin, Blue Shirt, Diggers Hole and so on. Following an excursion to Brumby Point in April 1998, we took some time to examine some of the tracks and follow a circuit beginning at Brumby Point Track, then along Diggers Hole Road to Wheatfield Road and to Ryans Creek Road, which comes to a dead end at Ryan Creek below Mount Nunniong. A short distance further along Wheatfield Road there is the Missing Link, less than a kilometre long, which connects with Moss Bed Track. Along Moss Bed Track, about 1.25 km short of its intersection with Mellick Munjie Road, and just to the south, there is an expanse, quite circular, of water forming a sphagnum bog and bordered by a eucalypt forest. It is marked on the Deception-Deddick 8523-N Mapsheet, co-ordinates EU953906 and accessible by a track from the Moss Bed Track.

The winter and spring of 1997 were particularly dry, and followed by a hot summer, so that when we first saw the 'Lake' it was in fact a completely dry vista of dried *Sphagnum* moss extending over the whole bed, which is about 300 m in diameter. Clumps of dried rushes broke the monotony (Fig. 1). Time was not available to make any real examination, but having established the locality we determined to come back at another time, preferably after rain. In a normal or average year this alpine area, altitude approximately 1180 m, could expect a rainfall of between 1000 to1400 mm (Bureau of Meteorology). In addition to this precipitation there would be runoff from higher country, much of the surrounding area, particularly to the west, being in excess of 1300 m. Characteristically, the alpine bog community occurs on a more or less impervious clay or peat (Ashton and Hargreaves 1983). This particular bog would appear to be on the latter base, and possibly also with a granite underlay. This observation is made because the area surrounding the Lake is covered with decaying granite in pieces up to football size. The soil depth is not very great and this is easily observed from the root structure of fallen trees.

Fig. 1. Moss Bed Lake. Dry in April 1998.

Substantial timber surrounds the Lake, including Mountain Gum *Eucalyptus dalrympleana*, Messmate *E. obliqua* and Narrow-leaf Peppermint *E. radiata*. Not far away, within a kilometre and within earshot, one could hear the chainsaws and bulldozers clear-felling. In addition to this destruction, the tracks had been widened to allow for the passage of timber jinkers, by the simple expedient of bulldozing the margin of Moss Bed Track. This road widening technique can also be observed on other parts of the Nunniong Plateau, noteably along Nunniong Road, so timber extraction is set to continue for some time yet. Huge areas have been clear-felled along Mellick Munjie Road and also further west in the Emu Plains area west of

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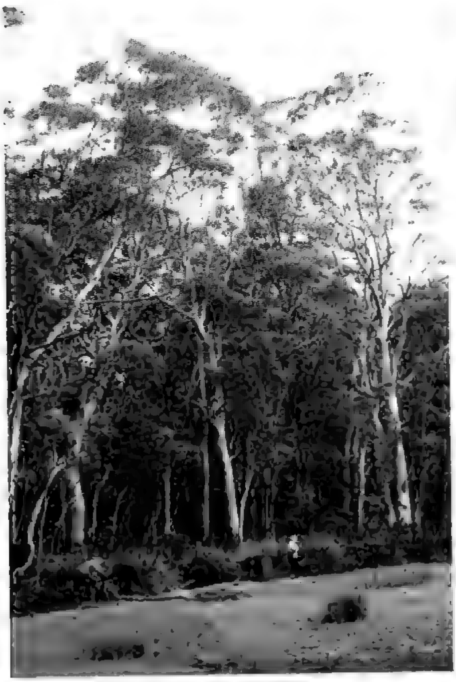

Fig. 2. A border of *Gahnia sieberiana* separates Moss Bed Lake from a stand of *Eucalyptus dalrympleana*.

the Nunniong Road. In this area, the unwanted logs have been piled into extensive windrows in preparation for burning. So much for the uses of the forest.

The good rains early in 1999, breaking the long drought, encouraged us to revisit Moss Bed Lake and the marked difference can be seen in Fig. 2. This picture illustrates well the abrupt demarcation from bog to timber, with a substantial intervening border of Red-fruit Saw-sedge *Gahnia sieberiana* between the Lake and a stand of Mountain Gum. Much of the foreground in Fig. 2 is occupied by a dense mat, with the common name of Marshwort *Nymphoides montana*, growing in shallow water. The handsome golden-yellow flowers of this aquatic plant make a marvellous mass display under these conditions, as soon as the sun has risen sufficiently high (Fig. 3).

Apart from the extensive sheets of Marshwort, and the general distribution of *Sphagnum* over most of the area, the bog is dominated by clumps of Mountain Cord-rush *Restio australis* (Fig. 4), whose flowering heads make quite a splendid

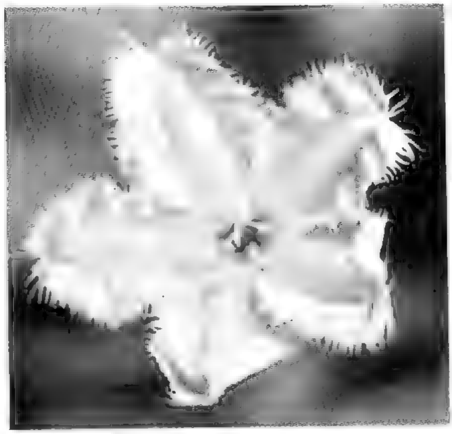

Fig. 3. Flower of *Nymphoides montana* opened up by the warmth of the sun.

show. Another dominant plant is the Tall Spike-rush *Eleocharis sphacelata*, which tends to grow in separate stands. Specimens of this plant growing near the margin of the Lake had been grazed by brumbies. We in fact observed a small mob doing just this on the western side of the Lake. We later found it was a spot where they commonly came to drink. To obtain an illustration of the flowering spike (Fig. 5) it was necessary to rather gingerly walk some distance out on a fallen log, the only alternative to wading waist deep.

Keeping just clear of the *Sphagnum* moss it was possible to walk more or less dryshod around the Lake, although close to the margin there were tracks through the moss where brumbies and wombats had been foraging or drinking. In this wet area between the open water and the beginning of the forest occur many rushes and sedges, and Table 1 contains a list of those we were able to identify. Also in this wet area there were Alpine Water-fern *Blechnum penna-marina*, Bat's Wing Fern *Histiopteris incisa* and lots of Chickweed

Table 1. Some Rushes and Sedges at Moss Bed Lake.

Carex appressa	Tall Sedge
C. gaudichaudiana	Fen Sedge
C. jackiana	Sedge
Eleocharis sphacelata	Tall Spike-sedge
Empodisma minus	Spreading Rope-rush
Gahnia sieberiana	Red-fruit Saw-sedge
Juncus subsecundus	Finger Rush
Luzula modesta	Southern Woodrush
Restio australis	Mountain Cord-rush

Fig. 4. Mountain Cord-rush *Restio australis* clumps at Moss Bed Lake.

Stellaria media. In some of the wetter spots were mats of the Small River Buttercup *Ranunculus amphitrichus*. Within a few metres of the margin, making an understorey of the eucalypts already mentioned, there is a wide variety of herbs and shrubs. River Lomatia *Lomatia myricoides* was just beginning to flower, although at lower altitudes we saw many in full flower. Cinquefoil Cranes-bill *Geranium potentilloides* made a splash of colour here and there as did the Alpine Podolobium *Podolobium alpestre* and Grass Trigger-plant *Stylidium graminifolium*, and some clumps of Golden Everlasting *Bracteantha bracteata*. Twining its way through some of the shrubs was Purple Appleberry *Billardiera longiflora* (Fig. 6).

More time and expertise would be required to make a complete census of the plants growing in and around Moss Bed Lake, but Table 2 contains a list of those identified during or since the excursion.

Acknowledgements

Thanks to Ken Hollole and Dagmar Savva for their company and assistance, and especially to John Reid and Helen Aston of the National Herbarium of Victoria for the identification of *Carex appressa* and *Nymphoides montana* respectively.

Table 2. Some Dicotyledons in and around Moss Bed Lake (* = introduced).

Acacia mearnsii	Black Wattle
A. siculiformis	Dagger Wattle
Acaena novae-zelandiae	Bidgee-widgee
Baeckea gunniana	Alpine Baeckea
Billardiera longiflora	Purple Appleberry
Bracteantha bracteata	Golden Everlasting
Cassinia longifolia	Shiny Cassinia
Coprosma hirtella	Rough Coprosma
Derwentia derwentiana	Derwent Speedwell
Epilobium gunnianum	Gunn's Willow-herb
Eucalyptus dalrympleana	Mountain Gum
E. obliqua	Messmate
E. radiata	Narrow-leaf Peppermint
Gaultheria appressa	Wax Berry
Geranium potentilloides	Cinque-foil Cranesbill
Leucopogon hookeri	Mountain Beard-heath
Linum marginale	Native Flax
Lomatia myricoides	River Lomatia
Nymphoides montana	Marshwort
Podolobium alpestre	Alpine Podolobium
Polyscias sambucifolia	Elderberry Panax
Ranunculus amphitrichus	Small River Buttercup
Rubus parvifolius	Small-leaf Bramble
**Stellaria media*	*Chickweed
Stylidium graminifolium	Grass Trigger-plant
Tasmannia xerophila	Alpine Pepper

Fig. 5. Flowering spike of Tall Spike-rush *Eleocharis sphacelata*.

Fig. 6. Purple appleberry *Billardiera longiflora*.

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Dear Editor,

This note refers to 'The Biogeography of *Pseudocephalozia paludicola* R.M. Schuster, an endemic Australian Liverwort' by Jon Sago (*The Victorian Naturalist* **115** (3), 1998, 84-86).

This liverwort has been found only twice in Victoria:

(1) At Mt Baw Baw above ski run 5; leg. and det. G.A.M Scott s.n. 25 June 1977, confirmed J. Engel 1981; MUCV 3217; and

(2) On the Alpine walking track NW of Mt Kernot; leg. and det. A.W. Thies 1452Q 26 January 1986; MEL 23301/242732 and MUCV 23301.

The latter location is within 5 km of the former. No collections are known from Mt St Gwinear and Mt Erica. The plant from Mt Torbreck was *Lepidozia laevifolia* as stated in the corrigendum on p. 82 of *The Victorian Naturalist* **116** (3). The location should be added to the first sentence of the corrigendum so that it reads 'The determination of the liverwort from Mt Torbreck referred to in "The Biogeography..." '.

Arthur W. Thies

National Herbarium, Royal Botanic Gardens, Birdwood Avenue, South Yarra, Victoria 3141.

Dear Editor,

Kibria's (1999) response to my letter which protested the inclusion of an article primarily on aquaculture (Romanowski 1999) in *The Victorian Naturalist* introduces new information which is dealt with from an aquaculture perspective only.

In particular, Kibria suggests I should have described an alternative to aquaculture as a way of rehabilitating Silver Perch populations, but this would have been inappropriate as the only mention of the entire subject in the original article is 'Such measures [to increase population] might include aquaculture'. However, as Kibria has introduced these new aspects, I will briefly show how far removed aquaculture is from conservation.

a) It is *not* 'widely accepted that overexploited and depleted fisheries can be rehabilitated through programs of artificial breeding, rearing and restocking in natural habitats' except in aquaculture circles, which is why only aquaculture references are cited in support of this sweeping generalisation. I don't know of any evidence of successful population enhancement of this kind for any fish, anywhere in the world. All improvements have been achieved by restoring habitat, and reducing fishing pressure (see also Horwitz 1995; Cadwallader and Lawrence 1995).

b) Electrophoretic methods of comparing variation between wild and hatchery populations of Rainbow Trout tell us little, but there is abundant evidence that hatchery and wild populations of trout are very different behaviourally and physiologically. Schweibert (1979) describes a comparison of a wild strain of Brook Trout with a hatchery stock originally from the same source, kept in identical adjacent pools on an identical diet for a year.

At the end of this time 'the domestic strain had reached more than five inches, while the wild fish were an inch and a half smaller ... the domestic fish were obviously attracted to the biologists, displaying no fear and expecting food, while the wild fish continued to flee'. Not surprisingly, after release into the same stream the wild fish showed higher survival and growth rates than the hatchery strains. These same phenomena can be observed in any aquaculture stock which has been captive bred for any length of time, because aquaculturalists select for individuals which breed most readily under artificial conditions, and which convert feed into flesh most efficiently.

c) Few captive breeding programs for fishes in Australia come close to using even the minimum FAO breeding group size of 50 Kibria cites. Thus, the Trout Cod restocking program he mentions uses eight fishes for breeding, while for Eastern Freshwater Cod the entire breeding group is 20 (Walker 1994). Even this figure is based on early theoretical work by Frankel and Soulé (1981), which is now universally regarded (including by Frankel and Soulé) as far below the minimum viable populations of hundreds, or perhaps even thousands, suggested by practical work on island biogeography (see for example Fiedler and Jain 1992).

The remainder of Kibria's response is largely irrelevant to the original article, or my letter – for example, discussion on 'improvement' of fish strains via triploidy. This has not been achieved with Silver Perch, but if it is, the production of faster-growing, sterile Silver Perch is certainly not going to be of any value in conservation!

Nick Romanowski
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via Colac, Victoria 3249.

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Dear Editor,

I refer to my earlier letter (Kibria 1999) in which I responded to a letter from Nick Romanowski regarding our review paper 'Biology and aquaculture of Silver Perch: A review' (Kibria *et al.* 1998).

In response to the latest letter from Romanowski, I am submitting the following:

(1) I am unsure what Romanowski means by 'aquaculture circles'. However, it is important to mention that fisheries and aquaculture scientists from all over the world work under one umbrella. Since these are interrelated disciplines (see also Kibria 1999), an integrated approach is required for sustainable fisheries and aquaculture development and management programs. Research findings generally complement each other (see the Annotated Bibliography for examples).

(2) Most of references cited in my letter (Kibria 1999) were from non-aquaculture related journals. Most importantly, the key conclusions were drawn from the findings of the world's recognised International Centre for Living Aquatic Resources Management (ICLARM), which is devoted to the management and conservation of biodiversity of aquatic organisms in Asia, Africa, Caribbean and Pacific islands.

(3) A recent paper shows that 'all research and production of Silver Perch to date used the progeny of wild broodfish and there has been no artificial selection' (Rowland 1997). Therefore the original claim, and its theoretical consequences mentioned by Romanowski (1999), is questionable.

(4) Some more examples of the success of stock enhancement programs are presented in the annotated bibliography (see also Kibria 1999).

Thank you once again. Sincerely yours,

Dr. Golam Kibria
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Editors note: The correspondence on this subject has now been closed.

Fungi Found in a Suburban Garden

Most naturalists are very aware of the interesting and intriguing things that can be found in their own gardens. There is always an assortment of invertebrates, lizards, frogs, birds and if you are lucky, mammals.

For many years I have prowled around my garden at night (regardless of weather conditions) with a torch or spotlight. A few hours spent gardening can also easily turn into double the time allowed because of interesting discoveries.

On 23 May (1999) I was unable to attend a fungi excursion led by Tom May (FNCV President) to Yarra Bend. To quell a little of the disappointment, I decided to search my own garden with a more thorough method than ever before and look for fungi.

I had previously recorded enough species to give me hope of some interesting finds. Fungi such as: *Gymnopilus pampeanus*, *Paxillus involutus*, *Schizophyllum commune*, *Lactarius torminosus*, *Amanita muscaria*, a slime mould *Stemonitis sp.*, and the ubiquitous *Agaricus xanthodermus*, the poisonous yellow-staining mushroom which seems to me to have become much more common in recent years (some common names of fungi are listed in Table 1).

Our block is the average quarter acre block, planted with exotic, native and some indigenous plants, the majority being native to Australia and indigenous to the Mitcham/Donvale areas.

The block is fairly steep which allows water to run off in winter, and is reasonably well drained. We are situated on the down side of a very steep hill where, in the sixties when we arrived here, a small creek once trickled past our house. The creek flowed into a tributary of the Mullum Mullum valley and on into the Mullum Mullum Creek and our block was surrounded by indigenous vegetation and lots of blackberry bushes

In my search, I set off with a hand lens, plastic container and a knife, heading for the area that had yielded the minute *Mycena viscidocruenta* in past years. Grasping a small stick lying on the soil I started to probe the leaf litter. I soon unearthed the first half dozen of these diminutive glistening red jewels, then something on the stick I was holding caught my eye. I could hardly believe my eyes or contain my excitement. I was looking down on a Bird's Nest Fungus, possibly *Cyathus olla*. This species has been listed as growing on soil, straw, twigs, fir cones, felled wood and planks in gardens. My specimen was growing on a small garden stake. The fungi did not have hairy cups as in *Nidula emodensis* and measured only 6 mm across the top of the goblet-like structure. The spore-bearing chambers (peridioles) were 1–2 mm. I found on further reading that this species prefers manured ground and is more frequently found in gardens than forests. My specimen was in a small vegetable garden!

As I worked my way assiduously around the garden in a clock-wise fashion I found the Smooth Ink Cap *Coprinus atramentarius*. Then as I crawled beside some railway sleepers I spied a tiny beige *Mycena* species peeping out from the cracks in the timber; next a patch of brown capped *Cortinarius* sp. growing among grass. Then a *Trametes* sp. – a polypore with pores instead of gills – growing on a dead stump, pure white, softly hairy on top at the back of the bracket, possibly *Trametes hirsuta*. Another velvet brown *Trametes* sp. with no distinctive zonation and a white under-surface remained a mystery. Finding the name adds to the interest of fungi study, but just understanding their important role in the environment and appreciating their wondrous colours and diversity of shapes is enough to keep my enthusiasm from ever diminishing.

By now a fine misty rain clothed the whole garden in a silver/grey curtain. I did wonder at the strange picture that I presented to the neighbours, looking down at me from the lofty heights of their windows over-looking our garden, as I crawled around in my wet weather gear on all fours!

Inspired by the discovery of the Birds Nest Fungus I very optimistically searched the fallen Banksia cones for the *Banksiamyces* sp. believed to grow on *Banksia spinulosa*, which is growing in my garden. With the aid of my hand lens I found four different types of fungi growing on a number of cones. One of the FUNGIMAP target species (the second for the

Table 1. Some of the fungi found in Cecily's garden at Mitcham

Scientific Name	Common Name
Agaricus xanthodermus	Yellow Stainer
Amanita muscaria	Fly Agaric
Coprinus atramentarius	Smooth (Common) Ink Cap
Coprinus micaceus	Glistening (Mica) Ink Cap
Cyathus olla	Bird's Nest Fungus
Gymnopilus pampaenus	
Lactarius torminosus	Woolly Milk Cap
Lepista nuda	Wood Blewit
Mycena viscidocruenta	
Nidula emodensis	Bird's Nest Fungus
Paxillus involutus	Brown Roll Rim
Schizophyllum commune	Split Gill
Stropharia aurantiaca	
Trametes hirsuta	Hairy Trametes

day, *Mycena viscidocruenta* being the first; see below for more details on FUNGIMAP) *Mycoacia subceracea* and a small white Ascomycete (Cup Fungus) with a stalk measuring 0.5 to 1 mm with hairy, deeply concave cups measuring 1.5 mm. As the cup matures it flattens out, possibly a *Lachnella* sp. The third species found on the cones was a small 2 mm white fungus with a 4–5 mm long translucent stalk (stipe). Under the lens it looked incredibly beautiful and fragile. The fourth species was a tiny pink gilled fungus with a cap 1.5 mm wide and a white stipe: a tiny gem with all the beauty of its larger counterparts that anyone with a land lens can enjoy.

The common red capped agaric *Stropharia aurantiaca* followed growing in some wood chips (mulched from cuttings from our own garden), while Glistening Ink Cap *Coprinus micaceus* was seen in grass near an old *Acacia elata* stump, looking like some exquisite art work from a child's fairy story book. On the stump, a mass of bracket fungi was growing in heavy brown solid tiers. This stump had been a source of fascination for some time as the mass had just continued to grow. During the dry autumn I had watered it, as an experiment to see just how big it would get. Unfortunately, I was unable to get spore prints from most of the Bracket species and its species name remains a mystery.

Another fascinating mystery is a small agaric with a plain white cap (diameter 5-6 mm) which will not yield a spore print. The gills have a pink tinge (maybe a clue) and the stem has a ring somewhat like a *Lepiota* without the freckles. This species also grows in indigenous bushland in the nearby Mullum Mullum valley.

Out in the front garden under the Silver Birch *Betula pendula* was a Wood Blewit *Lepista nuda* . This must surely be one of the more beautiful of fungi with its mauve gills and stem (see Bruce Fuhrer's lovely photo in *A Field Companion to Australian Fungi*). I have seen it many times before; another target species, I was delighted to find it in my own garden. *Hebeloma* sp., Fly Agaric *Amanita muscaria* and the Woolly Milk Cap *Lactarius torminosus* almost completed the collection.

I found several types of 'paint fungus' on sticks and small logs which were beyond my skills of identification. Some of them were white and some were fawn or brown.

Twenty-one species was the total that I found, many more possibly lay concealed under the ground or in places I missed altogether. I believe the total at Yarra Bend on the excursion I missed was 30. I was only 9 species down on that total and had not travelled out of my garden.

This was an interesting lesson to me to be more observant in the future, and brought to mind Tom May's suggestion recently that we could all note the fungi that we see while walking the dog, getting the paper or anywhere we take our recreation. I consider myself one of the lucky ones, I have the opportunity to walk in the nearby Mullum Mullum valley several times a week and have been recording the fungi for some time. I also walk in many bushland reserves on other days of the week. But I also believe that we can all contribute (if the interest is there). Look for some of the FUNGIMAP target species, many of which are illustrated in Fuhrer (1985). This scheme records target fungi species from all parts of Australia (recent or old records are accepted) so that their distribution can be mapped. FUNGIMAP has produced a kit and beginners can start participating by using the coloured photos of the first target species for a guide. These are included in the instruction sheet. FUNGIMAP is a joint project by the FNCV, the National Herbarium of Victoria and the School of Ecology and Environment at Deakin University[1].

People who for whatever reason cannot travel far can also contribute to basic data on fungi. What a wonderful record we could build up of our garden fungi and what they grow on, without even leaving our own homes.

Now more than ever home owners both rural and suburban are planting indigenous, so our gardens have never before had such a variety of plants mixed with both native and exotic. This variety of flora reflects the variety of fauna visiting the home block. For example, whilst conducting this fungi survey I found native cockroaches, dozens of cicada nymphal skins, spiders of many varieties and a wonderful steel blue/grey 5-inch centipede. I am visited by many different bird species and even occassionally a Blue-tongue Lizard and Possums.

I found the survey yielded many more species than I could have imagined. It was heaps of fun and I would love to hear from others about their garden discoveries. Fungiphiles unite – your gardens await you.

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[1] If you would like to participate in this exciting new project, or for more information, contact FUNGIMAP, National Herbarium of Victoria, Birdwood Avenue, South Yarra, Victoria 3141, email fungimap@rbgmelb.org.au.

Further Reading

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Ant Behaviour

During a recent FNCV Botany Group excursion to the Brisbane Ranges, my attention was drawn to a well-worn trail made, and being used, by the 'Meat Ant' *Iridomyrmex purpureus*. In one place, this trail passed near a small depression in which ants of the genus *Camponotus* (commonly known as Sugar Ants) had built a nest. At the nest site, minor *Camponotus* worker ants were bringing soil out of the nest under the 'watchful eyes' of a number of majors. Occasionally an *I. purpureus* crossed this depression, whereupon all the *Camponotus* immediately retreated into the nest even though no contact was made between the two species. This behaviour was not related to size since the Meat Ants were smaller than both the minor and major *Camponotus* workers.

Iridomyrmex purpureus is a monomorphic species with worker castes all aproximately the same size – c. 8 mm. On the other hand *Camponotus* is a polymorphic genus with worker castes showing a large, continuous range in size from the small (minor) to large (major) workers (Shattuck 1999). The *Camponotus* sp. in my observation ranged in size from c. 10 mm (minors) to c. 15 mm (majors).

This behaviour of *Iridomyrmex* and *Camponotus* species has been reported by a number of authors – including Andersen

Table 1. P.J.M. Greenslade's Ecological Categories of Ants in Australia (Andersen 1987).

Category	Major taxa	Relevant features
1. Dominant species	*Iridomyrmex*	Highly abundant; active and aggressive; able to monopolise resources
2. Subordinate species	*Camponotus*	Large body size; polymorphic; submissive behaviour; nocturnal foraging
3. Climate specialists		
(a) Hot	*Melophorus* *Meranoplus*	Behavioural and morphological specialisations
(b) Cool	*Prolasius* *Notoncus*	Restricted to cool and wet regions where *Iridomyrmex* is at its climatic limit
4. Cryptic species	*Solenopsis* many *Ponerinae*	Activity confined to soil and litter
5. Opportunists	*Rhytidoponera* *Paratrechina*	Unspecialised; likely to interact strongly with *Iridomyrmex*
6. Generalised myrmicines	*Monomorium* *Pheidole* *Crematogaster*	Unspecialised species; recently arrived in evolutionary time
7. Large, solitary foragers	*Myrmecia*	Large body size; low population densities; unlikely to interact strongly with other ants

(1984, 1986a, 1986b, 1987, 1990, 1991 and 1992), and Greenslade (1976 and 1979). Table 1 shows seven ecological categories of ants, the most important of which consists of dominant species, chiefly *Iridomyrmex* (abundant, highly active and aggressive) which are often associated with subordinate species such as *Camponotus* (large size, mainly nocturnal and submissive towards *Iridomyrmex*). Table 1 is based on Greenslade's work and is taken from Andersen (1987).

Dominant ants have been described as 'both abundant and influential' (Greenslade 1976) and as 'highly active and aggressive ants that show rapid recruitment to food resources and an important competitive influence on the remainder of the ant community' (Andersen 1992).

Although my observation was made on a single occasion, for only a few minutes, and the ants were identified by sight alone, the observed behaviour of the *Camponotus* species does appear to agree with the 'submissive towards *Iridomyrmex*' behaviour described in the literature. Andersen (1992) also notes that *Camponotus* sp. often retreat when challenged (by *Iridomyrmex*).

However, this behaviour raises a question. What triggers the submissive behaviour of *Camponotus* towards *Iridomyrmex*? Is it recognition by sight, recognition by odour (pheromones) or is it an instinctive behaviour?

Can anyone help with answers?

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Mound-building Ants

I was interested to read 'Leafhoppers in Ant Nests', published in your February issue (Day and Pullen 1999), having lived adjacent to the mallee areas adjoining the Berri Irrigation areas until I left school.

My wife and I have visited the Calperum area on many occasions and the Cooltong paddock (west of Renmark) which is now the Conservation Park of the same name. About 15 of my visits over later years, with the South Australian Field Naturalists Society's Botany and Mammal Clubs, have been to Calperum and adjacent areas of the Bookmark Biosphere Reserve.

My wife pointed out that in Fig. 1 of Day and Pullen's article, above the first four letters of the word 'characteristic' in the caption, there is apparently a soil mound of *Camponotus clarior*.

This ant species usually nests under the base of mallee and where possible brings out the excavated soil via a hollow stem and drops it from the farthest projection which often results in an almost perfect cone.

I have been collecting ant specimens for Mr Archie McArthur, mentioned in the acknowledgements, since he spoke to a meeting of the Mammal Club on ant collecting. He pointed out that pitfall traps can serve a secondary purpose as a source of ant specimens.

The last paragraph you published poses 'If the eggs are inserted into the twigs or stems of the host plant, as in other eurymelids, how do the nymphs reach the nest of a host ant?'

I have discussed the matter with Archie and have suggested the ants collect the eggs of the leafhoppers and tend the eggs as their own. Apparently this is the case with the juvenile stages of the *Ogyris* butterfly, which feeds on mistletoe and is escorted by a species of ant related to the mound builders mentioned.

Cone-shaped mound of *Camponotus clarior*, Munyaroo Conservation Park, South Australia. Photo by G.L. Howie.

Some estimates are that there may be as many as 250 species of ants in mallee associations and I suspect there may be a number of examples of this behaviour with other ant species.

The photograph (above) of the ant mounds mentioned clearly shows the excavated soil as having been dropped from hollow stems of mallee.

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For assistance with the preparation of this issue, thanks to the computer team – Alistair Evans and Anne Morton. Thanks also to Felicity Garde (label printing) and Michael McBain (web page).

Australian Ants: Their Biology and Identification (Monographs on Invertebrate Taxonomy Volume 3)

by S. O. Shattuck

Publisher: *CSIRO Entomology, ISBN 0 643 06032 4.R.R.P. $89.95.*

Ants comprise an important group of organisms in most Australian terrestrial habitats. They are conspicuous and important in Australian ecosystems, especially in our arid regions. As such, they have become increasingly crucial to studies of the Australian environment, with many researchers, students, and natural historians with no prior history of entomology taking an interest in ant communities. Ants are now considered to be useful indicators of environmental disturbance, and are often included in habitat assessments along with plants and vertebrates.

This obviously creates a need for a comprehensive and user-friendly guide to the identification and biology of Australian ants, and in this book Steve Shattuck has produced just such a publication. Prior to this excellent book, researchers and students have relied on regional publications, such as Alan Andersen's *The Ants of Southern Australia; a guide to the Bassian fauna* and Peter Greenslade's *A Guide to Ants of South Australia*, both of which dealt admirably with the regions they covered, but were inappropriate for usage in the more northern and western parts of Australia, and did not include generic changes from recent taxonomic revisions. Additional guides to ant genera were to be found in global publications such as Barry Bolton's *Identification Guide to the Ant Genera of the World*, and within Hölldobler and Wilson's *The Ants*, but the keys in both of these publications are unwieldy and difficult to use for people without background knowledge of ant taxonomy and anatomy, with few illustrations in the case of Hölldobler and Wilson, and with only SEM (Scanning Electron Microscope) photographs in the case of Bolton.

Shattuck has rectified virtually all of these shortcomings in the literature by producing a clear and well-illustrated book of the Australian ant genera. The text of the book is set into an introductory section, a key, and a section which details each genus. There are also 30 colour plates illustrating aspects of ant biology and their interactions with the environment.

The introductory section briefly and succinctly summarises the general patterns of ant diversity in Australia, the biology and life-history of ants, ants as pests, the use of ants in environmental monitoring, the classification of ants, use of keys for identification, anatomical terms, ant collection techniques, specimen preparation and curation, and suggested reading for those wishing to look further into aspects of ant biology and taxonomy. These sections have been kept to an admirable minimum - commendable given the vast quantity of published information.

The key is the heart of this book, and the author has spent much time developing and fine-tuning the key by allowing active ant researchers to use drafts during the key's development. Every couplet is illustrated, often with more than one character. The illustrations, produced by Natalie Barnett, are uncluttered, and the characters are indicated by arrows, or shading so that there is no ambiguity. Given an adequate stereo dissecting microscope, and a good light source, this key should allow confident identifications of most ants to the generic level, even for the inexperienced ant enthusiast. The layout of the key is fairly standard for ant identification; specimens are first keyed out to subfamily then, in a separate key, to genus.

The final section of the book deals with each subfamily and genus. There are 103 ant genera currently known from Australia, so this section comprises a large part of the publication. For each subfamily there is a section detailing identification, and an overview of the subfamily in Australia. For each genus there are sections detailing identification, biology, distribution and habitats, and a list of names of the currently described Australian species. There are also two or more SEM photographs for each genus, usually of a frontal view of the head and a lateral view of the alitrunk, and a distribution map which shows collection sites. The identification section is an important part of the generic descriptions, as it allows the key user to confirm their placement of a specimen. Similar genera are compared, and the characters used to separate them described, so that the reader can further clarify their identifications. The descriptions of biology are fascinating, and the reader will soon realise just how much work remains to be done on the natural history of Australia's ants. The scope of research areas available is also emphasised by the inclusion of three undescribed genera within the book; no doubt this book will encourage field workers to locate even more! The associated distribution and habitat information tells us the general distribution of ant genera both within and outside Australia. This gives the reader an idea of the endemicity of many Australian genera.

I could find no errors in this publication, and if I had any complaints at all, it might be that it would have been good to put some basic taxonomic history in the generic descriptions. This would enable the reader to compare previously published names in the literature where there have been taxonomic changes in recent times. For example, *Iridomyrmex*, a diverse and ecologically significant ant genus, formerly included the ant genera *Papyrius*, *Ochetellus*, *Anonychomyrma*, *Doleromyrma*, *Linepithema*, and *Philidris* within its scope until recently revised by Shattuck.

Shattuck has put together a book which will become the standard text for researchers, enthusiasts and students who wish to understand Australian ant diversity. It will find use in areas well removed from general entomology, such as in environmental management and botany, and is a fine inclusion in CSIRO's Monographs on Invertebrate Taxonomy series.

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Beauty in Truth: the Botanical Art of Margaret Stones

by Irena Zdanowicz

Publisher: *National Gallery of Victoria, 1996. 96 pp., 108 colour plates.*

Brilliant Careers: Women Collectors and Illustrators in Queensland

by Judith McKay

Publisher: *Queensland Museum, 1997. 80 pp., numerous illustrations (black & white and colour). RRP $19.95.*

Exhibitions are limited in time and space. But their associated publications endure and some deserve a continuing readership. I think that these two books certainly do.

Dr Margaret Stones is a remarkable and renowned botanical artist. She began her botanical work in Victoria in the 1940s, and has lived for most of her life near the Royal Botanic Gardens at Kew, England, from where she has travelled back and forth across the world to draw plants in their native habitats. In *Beauty in Truth* Irena Zdanowicz provides an insightful biography of Margaret Stones and a description of her working methods. Rarely does an exhibition catalogue include illustrations of all work exhibited, but Irena Zdanowicz convinced the

Gallery that this should be done for the mavellous retrospective exhibition held in 1996, which spanned fifty years of Margaret Stones' work. Irena Zdanowicz also insisted on high quality illustrations in the catalogue. While no reproduction can ever match the incredible light and life – the beauty and truth – in Margaret Stones' original work, the illustrations in *Beauty in Truth* are stunning – all 108 plates. They include work carried out during two major projects: on the endemic flora of Tasmania (in conjunction with the botanist Dr Winifred Curtis) and on the flora of Louisiana (USA). Botanical notes for each plate were prepared by Professor Carrick Chambers, and Drs. Don Foreman, Linden Gillbank, David Hunt and Lowell Urbatsch. The index includes taxonomic and common plant names.

Dr Judith McKay prepared *Brilliant Careers* to accompany the Queensland Museum's 1997 exhibition in its series of annual exhibitions for International Women's Day. *Brilliant Careers* 'pays tribute to a remarkable group of women who, as scientific collectors and illustrators over the past 150 years, have extended our knowledge of the Queensland environment and people. All have left a public legacy in their contributions to museums and herbarium collections, or in their publications and advocacy of conservation causes.'

The work of 34 women is discussed by various authors. Maida Allan, Elizabeth Coxen, Harriette Biddulph, Ada McLaughlin and Mabel Hobler collected specimens in the vicinity of their Queensland pastoral homes. In the 1860s Amalie Dietrich was employed to collect natural history specimens for a German museum. After retiring from teaching in 1895 Selina Lovell collected plant specimens in Cooktown, where in the 1970s Vera Scarth-Johnson, inspired by the beauty of the Endeavour River and the early work of Joseph Banks and Daniel Solander, began collecting and painting the local flora. An earlier artistic visitor was Ellis Rowan, about whom Judith McKay wrote *Ellis Rowan – A Flower-Hunter in Queensland*, which was published in 1990 by the Queensland Museum in concert with an exhibition of its collection of 125 Queensland flower paintings by Ellis Rowan. Dr Dorothy Hill taught geology and paleontology at the University of Queensland from 1946–72 and became the first female Fellow of the Australian Academy of Science. Many of the women discussed in *Brilliant Careers*, including Joan Cribb, Doris Goy, Hilda Geissmann, Mabel Hobler and Estelle Thomson, were members of the Queensland Naturalists' Club.

It is too late to visit these two exhibitions, but it is not too late to enjoy these beautiful books. Unfortunately *Beauty in Truth* is out of print, but *Brilliant Careers* is still available at the Queensland Museum, and I would hope elsewhere. They should both be in any library which claims to have a good Australiana or Australian natural history collection.

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The Victorian Naturalist

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FNCV Honorary Life Member
Jack Hyett

Jack Hyett worked for the Education Department of Victoria from 1933 until 1976, first as a primary school teacher, and after 1963 as a professional officer, Teachers' College at Burwood. Later he worked as a Science lecturer at Burwood State College. He lectured for the Council of Adult Education on *Bird Study in Australia*, directed their Outback Study Schools, and led birdwatching and wildlife tours in Australia and overseas. He toured places such as the Galapagos Islands, Ecuador, Sri Lanka, India and South Africa. Jack can tell stories of some interesting events that occurred on some of those tours, especially the African ones.

In 1933 he joined the Bird Observers' Club of Australia, and was the custodian of their historic photographic collection for several years. He was the foundation president of the Ringwood Field Naturalist Club and the Victorian Ornithological Research Group, and is a member of several natural history clubs including the FNCV, RAOU (now Birds Australia) and the Wildlife Preservation Society of Sri Lanka.

He served for seven years on the bird survey of Wilson's Promontory, and also conducted the mammal survey of the Promontory.

Jack Hyett has published several books and numerous articles on birds and mammals, edited four volumes of *The Emu*, and has sub-edited *The Australian Birdwatcher*, for which he has prepared indices, as well as a bird species index to the first 100 volumes of *The Victorian Naturalist*. Jack was the Australian Natural History Medallionist in November 1985.

N.W. Schleiger
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Jack Hyett (right), receives his honorary certificate of FNCV Life Membership from Vice President Noel Schleiger at Covenant House, Canterbury Road, Blackburn on Friday, 28 May, 1999.

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Cover: Adult male Saunders Casemoth *Oiketicus elongatus*. See story on p. 175. Photograph by Arthur Farnworth.

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Australian Natural History Medal 1999

Mary Patricia Cameron

The Queen Victoria Museum and Art Gallery in Launceston has a botanical collection of such high standard that its Herbarium is now recognised as a major centre of botanical research in Tasmania. Mary Cameron, in her voluntary capacity as Research Associate, curates the collection and provides a plant identification service for the public as well as private companies. The Herbarium contains some 20,000 plants together with a collection of Tasmanian timbers. The City Council honoured Mary in recognition of 5,000 hours of work for the Launceston Community.

In 1947 Mary Cameron graduated as Bachelor of Science from the University of Tasmania with a major in botany, and she taught science subjects in Tasmanian secondary schools for several years. She also gave long service as part time reference librarian at the Northern Regional library, Launceston, until her retirement. Mary maintained her botanical studies and pursuits wherever possible while raising a family of six children and fulfilling the demands of employment. As spare time became available she devoted an ever increasing amount of time and energy to botany. In about 1969 she became Honorary Curator of the Herbarium at the Queen Victoria Museum and set about reorganising and improving the presentation of the collection in addition to the formal tasks of collecting, identifying and preserving specimens. In 1972 she was appointed Honorary Botanist and in 1987 the City of Launceston recognised her 'enormous contribution ... to the Museum's botanical collection and to the community through the provision of information' by elevating her to the position of Honorary Research Associate of the Queen Victoria Museum and Art Gallery.

Mary Cameron's botanical investigations and vegetation surveys date from the 1960s and have been the basis for a number of publications. She collected plants and provided distribution information for Lord Talbot de Malahide who published the six volume work 'The Endemic Flora of Tasmania' during the period 1967-1978, and she edited and wrote much of the text of the Launceston Field Naturalists Club's publication 'Guide to the Flowers and Plants of Tasmania' and its three revisions. With the support of the Plomley Foundation and the Museum she has been studying the flora of many different types of wetlands in north east Tasmania, resulting in a number of joint publications on flora lists and ecological details. With the assistance of the Museum's photographer, Mark Bartkevicius, Mary has amassed a large slide collection of Tasmanian orchids to record details of soft tissues which are lost in preservation. The collection and distribution records have been used in the writing of volumes of the 'Flora of Australia' and a forthcoming 'Atlas of Tasmanian Orchids'.

The Royal Society of Tasmania and the Launceston Field Naturalists Club have benefited from Mary's contributions over many years. She joined the Royal Society in 1946, became a life member in the 1950s and was a member of its Council on several occasions. Also she was vice chairman and Chairman of its Northern Branch, contributing to the planning and conduct of the Branch's program of lectures and excursions. The Field Naturalists Club made her an honorary life member recognising her long service as committee member, librarian, vice president and president. She has given numerous talks to the Club, arranged and led botanical excursions, and written detailed reports for its publications.

In 1993 Mary Cameron was made a Member of the Order of Australia for 'outstanding service to the study of the botany of Tasmania, and botanical and environmental conservation'. She has a long history of service on a number of conservation committees and advisory groups. The Tasmanian Conservation Trust, the Australian Heritage Commission Evaluation Panel (Tasmanian Section), the Department of National Parks and Wildlife's Flora Advisory Committee and its Rare and Threatened Species

Committee are among the bodies on which she has served. She is a member of the Tasmanian Arboretum Inc. which, in an endeavour to prevent the loss of woody plant species through forest destruction, has established collections of flora from various parts of the world on a 45 hectare property at Eugenana. At a local level, Mary has directed the planting of Australian sub-alpine flora on a 60 hectare property of the Launceston Field Naturalists Club and a collection of endemic flora at a site near Scottsdale as a Bicentennial project.

The Launceston Field Naturalists Club had great pleasure in nominating Mary Cameron for the award of the Australian Natural History Medallion.

Ian Endersby
56 Looker Road,
Montmorency, Victoria 3094.

Editor's note: The Australian Natural History Medallion will be presented to Mary Cameron at a meeting of the FNCV on Monday, 8 November 1999 at 8:00 pm. The presentation will take place at the FNCV Hall, 1 Gardenia Street, Blackburn, Victoria. After the presentation, Mary Cameron will speak on 'Conservation of Tasmanian Plants'. All welcome.

Mary Cameron, awarded the Australian Natural History Medal for 1999. Photo by John Simmons, Tasmania.

Fire Effects on Selected Terrestrial Invertebrate Fauna in Heathland at Wilsons Promontory, Victoria – a Preliminary Survey

E.J. Grey[1]

Abstract

A preliminary study of ants, beetles and spiders was conducted at two heathland sites in Wilsons Promontory National Park – one most recently burnt in 1991, the other in 1998. There was sufficient difference in the ant fauna, particularly in the abundance of *Rhytidoponera* species, to indicate that a more comprehensive study is warranted. (*The Victorian Naturalist* **116** (5), 1999, 162-168.)

Introduction

The Field Naturalists Club of Victoria Inc. conducted a research trip to Wilsons Promontory in October 1998. The work undertaken included this invertebrate survey, as well as the identification of grasses and sedges by workshop and field study, mammal surveying by trapping and spotlighting and freshwater invertebrate sampling.

The invertebrate survey aimed to provide baseline data on ant (Hymenoptera), beetle (Coleoptera) and spider (Araneae) fauna in two heathland sites – one unburnt since 1991 and referred to in the text as the ***unburnt*** site, and the other burnt in 1998 and referred to as the ***burnt*** site. An evaluation of the differences in species abundance and diversity between the two habitats was also made. The study was set up so that further work could continue in order to monitor the changes in invertebrate fauna as the recently burnt heath regenerated, using the site last burnt in 1991 as a control.

Earlier work on ant diversity, seasonality and community organisation had been conducted by Andersen (1986) in heath and woodland sites near Tidal River, toward the southern end of the Park. Andersen's study found that total ant activity was temperature and weather dependent, and also that opportunistic species, such as *Rhytidoponera*, predominated.

Study site

In May 1998, Parks Victoria burnt some of the heathland in an area along Five Mile Track overlooking Corner Inlet at the northern end of the Park. The two study sites were located on an exposed saddle at 38°54'52" S, 146°21'06" E, with an elevation of 140 m above-sea-level. Both sites had a slight westerly slope but were on opposite sides of the track c. 100 m apart, and both had similar soils, derived from granite, with high clay content and medium to coarse quartz grains. Due to the clay content, the soil has low water permeability.

The heath site on the north side of the track, although not burnt in 1998, has had an extensive fire history, having been burnt in 1951, 1957, 1973, May 1988 and October 1991. In contrast, the heath site burnt in May 1998 (a prescribed burn), which lies on the south side of the track, had only been burned in 1951 and 1957 (Jim Whelan *pers. comm.*).

Vegetation on the unburnt heath site was dominated by Prickly Tea-tree *Leptospermum continentale*, Dwarf Sheoke *Allocasuarina paradoxa* and White Kunzea *Kunzea ambigua*. Other plants included Butterfly Flag *Diplarrena moraea*, Australian Dusty Miller *Spyridium parvifolium*, Pink Heath *Epacris impressa*, Silver Banksia *Banksia marginata*, Dagger Hakea *Hakea teretifolia* subsp. *hirsuta*, Furze Hakea *H. ulicina*, and Silky Hakea *H. sericea*. Vegetation height was approximately 1.0–1.5 m (Fig. 1).

There was little vegetation on the burnt heath site except for isolated clumps of Butterfly Flag and a scattering of emerging seedlings which were not identified (Fig. 2). However, prior to the May 1998 burn, the vegetation was higher and denser than at the unburnt site with *Allocasuarina paradoxa* being the most abundant species (Jim Whelan *pers. comm.*).

Methods

At each site, five lines of five pitfall traps were put in (25 traps at each site) to form a

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Fig. 1. The unburnt heath site. Installing pit-fall traps - Elsbeth Sacco, Pat Grey and Erich Sacco.

square grid. Each line was separated by five metres, with five metres spacing between traps. For the traps, plastic coffee cups were used with 200 ml capacity, height 80 mm and a top diameter of 72 mm. Each trap was dug in, so that the top was flush with the ground, and 30 ml of preserving fluid put in each trap. The preserving liquid consisted of a 50/50 mixture of ethylene glycol and ethanol (70%). The traps were open for a seven-day period from 3–10 October 1998.

The weather, while the pitfall traps were open, was cool and windy with some rain. Rainfall and min/max temperatures were measured on site – 29 mm of rain was recorded, and a temperature range of 7-16°C.

Hand collecting for ants and beetles and spiders was carried out within the boundaries of each site for 30 minutes by ten people on 10 October 1998, when the weather was mild and sunny. Material was collected from foliage, under litter and on the ground. In order to equalise the collecting effort, the same ten people were involved at each site.

Identification of ants was taken to species level, where possible, or they were assigned to a species group (indicated throughout this report by inverted commas). Andersen (1990) defines a 'species group' by saying that 'even though most species cannot be confidently named, many can be readily assigned to groups with distinct morphologies, habits and distributions'. As an example, *Anonychomyrma* (was *Iridomyrmex*) '*itinerans*' refers to a complex of species closely allied to, and including, *A. itinerans*. However, some ants could only be identified to genus. Beetles and spiders were identified to family level. All other material captured was retained as 'miscellaneous'.

The keys used for identification were taken from a variety of sources : ants – Andersen 1991, Greenslade 1979 and one derived from New *et al.* 1996; beetles – Moore 1980; and spiders – Davies 1986.

Results

Pitfall trapping

Total numbers of ants, beetles and spiders recorded from pitfall traps are shown in Table 1. Ants were by far the most numerous group in both sites, while beetles and spiders comprised only 17% and 9.5% respectively in the unburnt site, and 4.2% and 6% respectively at the burnt site.

Fig. 2. The burnt heath site.

Table 1. Total numbers of ants, beetles and spiders collected in pitfall traps.

	Ants (Hymenoptera)	Beetles (Coleoptera)	Spiders (Araneae)
Unburnt Heath	219	54	38
Burnt Heath	210	10	14

Ants (Hymenoptera:Formicidae)

The ants, when identified to sub-family level, showed considerable differences in numbers between the two sites (Table 2). In the unburnt heath, the sub-family Ponerinae far outnumbered the Ponerinae found in the burnt heath (175 v 47), while the sub-families Myrmicinae, Dolichoderinae and Formicinae in the unburnt heath were greatly outnumbered by those at the burnt site. However, the total numbers of individual animals at both sites were fairly equal (219 in the unburnt site and 210 in the burnt site).

In contrast, ant diversity was decidedly higher in the burnt heath with 24 taxa (species, species groups or genera) compared with 14 in the unburnt heath (Table 2).

In the unburnt heath site, the two most abundant species were *Rhytidoponera tasmaniensis* and *R. victoriae* (153 and 21 respectively), which together accounted for 79% of all ants collected. Species of Dolichoderinae and Formicinae made up most of the balance. *Rhytidoponera tasmaniensis* and *R. victoriae* were also recorded in the burnt heath, but in much lower numbers, 80% less than in the unburnt heath, and members of the subfamilies Dolichoderinae, Myrmicinae and Formicinae were more equally represented.

The greatest variety of taxa for both sites was found in the sub-families Myrmicinae (unburnt 4, burnt 8) and Formicinae (unburnt 4, burnt 10). *Monomorium kiliani* was the most numerous of the Myrmicinae in the unburnt heath, while *Crematogaster* sp., *Meranoplus* sp. and *Pheidole* sp. were the most numerous in the burnt heath. In the Formicinae, the most numerous were *Pseudonotoncus* sp. (unburnt site, 11), and *Paratrechina 'minutula'* (burnt site, 22).

Beetles (Coleoptera)

In contrast to ants, the unburnt heath had the greatest number of individuals captured in pitfall traps (Table 3) and the greatest beetle richness at family level – eight fami-

Table 2. Total ants (Hymenoptera: Formicidae) in Pitfall Traps. + This species was only collected by hand and did not appear in the pitfall traps.

Sub-family	Species	Unburnt Heath	Burnt Heath
Myrmeciinae	*Myrmecia forficata*	0	1
	Myrmecia nigriscapa	1	0
	Myrmecia 'pilosula'		+
	Total	**1**	**1**
Myrmicinae	*Aphaenogaster longiceps*	0	1
	Crematogaster sp.	1	14
	Meranoplus sp.	1	17
	Monomorium kiliani	3	1
	Monomorium sp.	1	3
	Orectognathus clarki	0	1
	Pheidole sp.	0	17
	Solenopsis sp.	0	2
	Total	**6**	**56**
Ponerinae	*Amblyopone australis*	1	
	Rhytidoponera tasmaniensis	153	43
	Rhytidoponera victoriae	21	3
	Total	**175**	**47**
Dolichoderinae	*Iridomyrmex 'bicknelli'*	0	1
	Anonychomyrma 'itinerans'	13	3
	Anonychomyrma 'nitidiceps'	6	65
	Tapinoma minutum	+	
	Total	**19**	**69**
Formicinae	*Camponotus 'claripes'*	3	2
	Camponotus sp.	0	1
	Camponotus 'nigroaeneus'	+	+
	Notoncus ectatommoides	3	0
	Notoncus hickmani	0	4
	Paratrechina 'minutula'	0	22
	Paratrechina sp.	0	2
	Plagiolepis sp.	1	1
	Polyrachis patiens	0	3
	Prolasius sp. nr. *bruneus*	0	1
	Prolasius sp.	0	1
	Pseudonotoncus sp.	11	0
	*Stigmacros (Hagiostigmacros)*sp.	0	1
	Total	**18**	**37**
Total number of individuals recorded		**219**	**210**
Total number of taxa in pitfall traps		**14**	**24**

Table 3. Total beetles (Coleoptera) in pitfall traps. + This family was only collected by hand and did not appear in the pitfall traps.

Family	Unburnt Heath	Burnt Heath
Buprestidae (Jewel Beetles)	+	
Carabidae (Ground Beetles)	1	0
Curculionidae (Weevils)	2	2
Chrysomelidae (Leaf Beetles)	+	
Elateridae (Click Beetles)	1	0
Pselaphidae	2	0
Ptinidae (Spider Beetles)	1	0
Staphylinidae (Rove Beetles)	42	7
Tenebrionidae (Darkling Beetles)	0	1
Trogidae	4	0
Undetermined	1	0
Total number of individuals	**54**	**10**
Total number of families in pitfall traps	**8**	**3**

Table 4. Total spiders (Araneae) in pitfall traps. + This family was only collected by hand and did not appear in the pitfall traps. Imm = immature; damed = damaged.

Family	Unburnt Heath		Burnt Heath	
	Male	Female	Male	Female
Amaurobiidae	1	0	0	0
Clubionidae	5 (2 imm)	1	3	O
Dictynidae	0	0	1	0
Gnaphosidae	2	1 (1 imm)	0	0
Hadrotarsinae	0	0	+	0
Lycosidae	19	6	4	1
Miturgidae	1 (1 imm)	0	1	0
Salticidae	0	+	+	0
Theridiidae	1	0	0	0
Thomisidae	0	0	1	0
Undetermined	1	0	3 (2 damed)	0
Total number of individuals	**30**	**8**	**13**	**1**
Total number from each site	**38**		**14**	
Total number of families	**6**		**3**	

lies were identified in the unburnt site compared with three in the burnt site. Rove Beetles (Staphylinidae) were the most abundant family at both sites, and apart from Tenebrionidae, the families found in the burnt heath were also found in the unburnt site.

Spiders (Araneae)

Male spiders (83% of the total) far outnumbered females. This is not unexpected since it is the habit of male spiders to wander around in search of mates.

Active, hunting spiders from the families Clubionidae, Gnaphosidae, Lycosidae (Wolf Spiders) and Miturgidae were the most abundant of the spider fauna captured in pitflall traps – 92% of the total in the unburnt heath and 69% of the total in the burnt heath.

One individual was trapped from each of the following families – Amaurobiidae (unburnt site) and Dictynidae (burnt site). These spiders build lacy webs, similar to those built by the commonly seen Black House Spider.

The single Theridiidae found in the unburnt site elongs to the same family as the Redback Spider and builds a gum-footed snare.

One Flower Spider (Thomisidae) was found in the burnt site.

Hand Collecting

The results of hand collecting are shown in Tables 5 and 6.

Table 5 shows the total number of individuals collected in each order. Again, over 90% were ants.

Table 5. Total numbers of ants, beetles and spiders collected by hand.

	Ants Hymenoptera	Beetles Coleoptera	Spiders Araneae
Unburnt Heath	86	5	4
Burnt Heath	56	3	2

Table 6 shows the breakdown of the ants into subfamilies and species. Numerically, 60.5% were caught at the unburnt site. In the unburnt heath the most abundant family was the Dolichoderinae (55% of total) with *Anonychomyrma 'nitidiceps'* being the most abundant species (36 individuals). The latter was also abundant at the burnt site (17), but *Meranoplus* sp. from the subfamily Myrmicinae (13) and *Camponotus 'nigroaeneus'* from the sub-family Formicinae (12) were a fairly close second.

The numbers of beetles and spiders collected by hand were small and no further analysis was done.

Discussion

It was unfortunate that no pre-fire data are available on the fauna present at the sites, and this study started five months after the 1998 burn. Another factor that must be taken into account is the difference in vegetation between the two sites prior to the 1998 burn which may have contributed to the differences in fauna found in this survey. Additionally, the burnt heath site had a long, 40 year period

Table 6. Ants (Hymenoptera) collected by hand.

Family	Species	Unburnt Heath	Burnt Heath
Myrmeciinae	*Myrmecia forficata*	0	2
	Myrmecia nigriscapa	1	0
	Myrmecia 'pilosula'	0	2
	Total	**1**	**4**
Myrmicinae	*Aphaenogaster longiceps*	0	3
	Meranoplus sp.	9	13
	Monomorium 'kiliani'	7	0
	Total	**16**	**16**
Ponerinae	*Rhytidoponera tasmaniensis*	20	4
	Rhytidoponera victoriae	0	3
	Total	**20**	**7**
Dolichoderinae	*Iridomyrmex 'bicknelli'*	5	0
	Anonychomyrma 'itinerans'	4	0
	Anonychomyrma 'nitidiceps'	36	17
	Tapinoma minutum	2	0
	Total	**47**	**17**
Formicinae	*Camponotus 'nigroaeneus'*	2	12
	Total	**2**	**12**
Total number of individuals		**86**	**56**
Total number of species		**9**	**8**

without burning and this may be a further factor in the faunal differences found. Also the cool, damp weather experienced during the trapping period may well have inhibited total ant foraging activity and influenced the number recorded. However,the results obtained from the survey show sufficient variation in the species composition of the ant fauna at each site to enable comparison with future work.

For the unburnt heath ant fauna, the outstanding feature was the abundance of the opportunistic, omnivorous *Rhytidoponera* species in contrast to the low numbers of highly active, aggressive *Anonychomyrma* species. In part this may be due to the cool weather, since *Anonychomyrma* sp. are more active in sunny areas (Andersen 1991), but a paucity of *Anonychomyrma* also occurs with less insolation (solar radiation) at ground level, for example in dense heath vegetation (Andersen 1986).

In the burnt heath site, a number of factors may have affected the results: open ground, as in the bare, burnt heath site favours pitfall trapping and thus, the results might be an artefact of the method used, as well as site differences; open habitats favour the ant species *Anonychomyrma* (33% of the total), where their aggressive behaviour and numbers suppress the subordinate *Rhytidoponera* species (Andersen *pers. comm.* November 1998), hence the difference in *Rhytidoponera* numbers between the two sites (79% and 22% of the total). However, a number of generalised Myrmicines such as *Crematogaster, Meranoplus, Monomorium* and *Pheidole* species (25% of total) which are seed harvesters/ honeydew feeders and have flexible foraging times, i.e. can forage both during the day and night, appear able to coexist with *Anonychomyrma* at this site. The nocturnal, litter-foraging *Paratrechina minutula* (11%) would not be a competitor. An interesting aspect is the virtual absence of *Aphaenogaster* at both sites compared with the numbers found in heath near Tidal River by Andersen (1986). It is possible that the high clay content of the soil may be an influence as this species is more abundant in sandy soils (Andersen 1991). The greater amount of insolation received on the bare ground surface of the burnt heath may have induced greater ant activity.

The beetle fauna was relatively similar at both sites. The greater numbers recorded in the unburnt heath might be associated with shelter and availability of food. The abundance of the predacious Rove Beetles is a point of interest, since these beetles tend to prefer wetter areas because their short elytra (wing covers) and slender form does not allow them to resist dry conditions

(Moore 1980). The cool, damp weather experienced during the trapping would have suited them.

Given the limitations of this study - the fire history of both sites, vegetation differences before the 1998 burn, no pre-fire data - the results still provide a useful starting point for documenting changes in the faunal composition as the burnt heath regenerates.

Acknowledgements
The field work was conducted under Parks Victoria Permit 10000179 and, made possible with help from Parks Victoria Rangers, members of the invertebrate survey team from the FNCV and other field naturalists. Special mention should be made of the contribution made by Erich and Elsbeth Sacco for help in setting up the trapping lines, and to members of the survey team for identification work. Alan Andersen (CSIRO) also made valuable comments on the differences in behaviour of the ant fauna. Jim Whelan (Ranger-in-Charge) provided valuable information on fire histories. Alan Yen (MOV) made suggestions which improved an early draft.

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Corroboree Frog *Pseudophryne corroboree*

My late husband and I were at Mt Kosciusko in the summer of 1968. Naturally, we enquired where we could find **the** frog and were directed to a suitable location.

Here in the very wet sphagnum beds we found frogs galore, along with their eggs. The eggs were larger than those of lowland frogs. Every puddle was full of tadpoles. The frogs were curious things; they didn't hop but crawled persistently out of focus, proving difficult to photograph as they were constantly crawling away.

J. Barker and G. Grigg (1977), in '*A Field Guide to Australian Frogs*', have this to say: 'Found in sphagnum bogs above 1500 m. Ten or twelve large eggs. Short breeding season, December to February. Tadpoles similar to other *Pseudophryne*.'

I wonder how the dry years are affecting them. Certainly 'ordinary' frogs seem to have gotten scarcer.

Corroboree Frog *Pseudophryne corroboree* with eggs. Photo by D.W. Lyndon.

Ellen Lyndon
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Leongatha, Victoria 3953

New Holland Mouse *Pseudomys novaehollandiae* (Rodentia: Muridae): Further Findings at Yanakie Isthmus, Wilsons Promontory National Park

Bruce W. Atkin[1] and Bruce R. Quin[2]

Abstract

Trapping for the New Holland Mouse *Pseudomys novaehollandiae* was carried out on the Yanakie Isthmus area of Wilsons Promontory National Park, southern Victoria, in May 1996 as part of a program aimed at determining appropriate habitat management for this species. During previous surveys in the vicinity, the New Holland Mouse had been captured only on vegetated dunes. However, on this occasion a number were trapped in open swales. This finding may increase our understanding of the habitat requirements of the New Holland Mouse. The shrub layer in the swales, dominated by Coast Tea-tree *Leptospermum laevigatum*, had been slashed within the previous three years; it is possible that the regrowth had reached a stage of succession where it was providing sufficient cover for New Holland Mice, perhaps coupled with an increased abundance of food. This paper describes the results of the trapping program and provides recommendations for future management of the New Holland Mouse and its habitat at Yanakie Isthmus, Wilsons Promontory National Park. (*The Victorian Naturalist* **116** (5), 1999, 169-172.)

Introduction

The New Holland Mouse was first recorded on the Yanakie Isthmus area of Wilsons Promontory National Park during 1993. It was found on dunes vegetated with mature *Banksia* and *Allocasuarina* woodland, with an understorey dominated by sedges and low shrubs (Quin 1996; Quin and Williamson 1996). It had previously been recorded on the Promontory near Darby Swamp and Five-Mile Road (Fig. 1) in the early to mid-1970s (Seebeck *et al.* 1996).

In an attempt to determine appropriate management of dune and swale vegetation for the New Holland Mouse, a trial exclusion plot of 25 m × 25 m was proposed, to prevent grazing by herbivores (Chesterfield *et al.* 1995). The purpose of the plot was to assist managers in determining whether or not the elimination of grazing would lead to restoration of a Kangaroo Grass *Themeda triandra* native grassland/ open woodland, thus conserving habitat of the New Holland Mouse (Quin and Williamson 1996).

The aim of this study was to determine the presence and distribution of the New Holland Mouse in the vicinity of the proposed exclusion plot. Future trapping would then reveal whether the New Holland Mouse utilised the restored grassland as habitat.

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Study Area, Materials and Methods

The study site was immediately west of the main access road to Tidal River, about three kilometres south of the entrance to the Park and 10 km north of Darby River (Fig. 1).

The dunes in the area are generally three to five metres in height and vegetated as described in the introduction. The vegetation in the swales, which are generally up to 50 m wide, has been described as rough grassland (Chesterfield *et al.* 1995). Grazing pressure from Eastern Grey Kangaroos *Macropus giganteus*, Common Wombats *Vombatus ursinus* and European Rabbits *Oryctolagus cuniculus* is heavy and bare ground is common, ranging from <5% to 40% (B.W. Atkin, *pers. obs.*). The vegetation is dominated by a few apparently unpalatable species, particularly Black-anther Flax-lily *Dianella revoluta*, Silky Guinea-flower *Hibbertia sericea* and Coast Tea-tree *Leptospermum laevigatum*.

The swales in the study area were slashed initially in March 1992 and again in December 1993, to control the spread of Coast Tea-tree (P. McDiarmid, Ranger, Parks Victoria, Yanakie *pers. comm.*). Coast Tea-tree invasion of dune vegetation is believed to threaten populations of the New Holland Mouse because the resulting Tea-tree thicket out-competes the vegetation community it occupies. The New Holland Mouse has not been located in well established Tea-tree monocultures (Quin and Williamson 1996). At the time

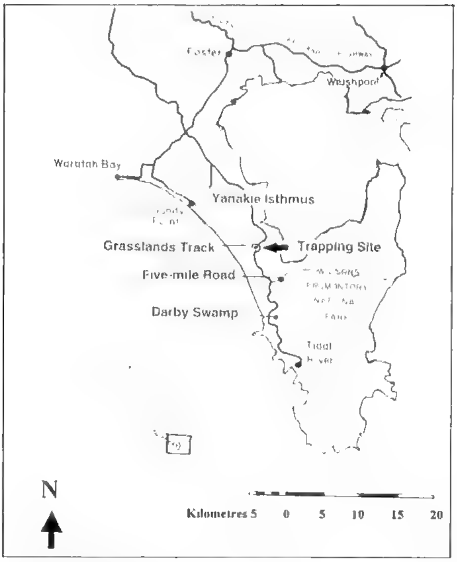

Fig. 1. Yanakie Isthmus, Wilsons Promontory National Park.

of the study, the Tea-trees and Flax-lillies had grown to around 0.3 m in height.

The area had not been burnt for 20-30 years and previous surveys in the vicinity had located the New Holland Mouse only in the dunes (Quin 1996). Since 1992, baiting with the poison 1080 has been carried out annually in the swales for the control of Red Foxes *Vulpes vulpes* and rabbits. Baiting for rabbits has been excluded from sites where the New Holland Mouse was known to occur. The baiting aims to reduce rabbit numbers and therefore assist in restoration of the Kangaroo Grass *Themeda triandra* native grassland-open woodland which formerly occurred over parts of the Yanakie Isthmus (Quin and Williamson 1996).

The weather throughout the survey period, May 7-9 1996, was generally cloudy and cool, with showers on the first two nights. The third and final night was clear and cold.

A total of 88 Elliott folding box traps (Elliott Scientific, Upwey, Vic.) measuring 33 × 10 × 9 cm was used. The survey concentrated on several dunes where New Holland Mice had been trapped earlier in 1996 (D. Carmen, *pers. comm.*) and adjoining swales, and included the site chosen for the proposed exclusion plot. Five lines of traps (63 traps) were positioned on or at the base of dunes, and four lines (25 traps) were positioned in open vegetation in the swales. Traps were spaced at 10 m intervals and baited with a mixture of peanut butter, honey and rolled oats. Traps were checked early each morning and then closed to prevent capture of diurnal animals. They were re-opened in the late afternoon, and rebaited where necessary.

Table 1. Total captures of small ground mammals during Elliott trapping at Yanakie Isthmus, Wilsons Promontory National Park, May 1996.

Date	New Holland Mouse		Bush	House
	Swales	Dunes	Rat	Mouse
7 May	4	10	3	0
8 May	7	15	2	2
9 May	3	10	3	1
Total	**14**	**35**	**8**	**3**

Trapping was carried out on three consecutive nights, realising a total of 264 trap-nights. The survey initially aimed to determine presence or absence of the New Holland Mouse in the study area. However, in view of the number captured on the first night, it was considered important to take morphological measurements thereafter. Weights of New Holland Mice were recorded on the second morning of capture; weight, gender, tail, and pes (foot) length were recorded on the third morning. A Pesola spring balance was used for measurement of weight, vernier calipers for pes measurement and a ruler for measurement of tail length. After examination, each individual animal was released at the location where it was captured.

Results

Three species of rodent were recorded during this survey: New Holland Mouse, Bush Rat *Rattus fuscipes* and House Mouse *Mus musculus*. Total captures for each species are shown in Table 1.

The overall success rate was 22.7%. The mean success rate for the New Holland Mouse was 19.3%. On 8 May the success rate for the New Holland Mouse was highest, at 25%.

Over the three nights, 14 (28.6%) New Holland Mice were captured in swale vegetation. On the first night, four New Holland Mice (28.6%) were trapped in the swales; on the second night, seven (31.8%) and on the third night, three (23.1%). No

Table 2. Morphological measurements for New Holland Mice captured at Yanakie Isthmus, Wilsons Promontory National Park, May 1996. *one individual not included as part of tail missing.

Measurement	Male				Female			
	mean	s.d.	range	n	mean	s.d.	range	n
Mass (g)	19.2	1.32	18-21	7	16.9	1.56	15.5-19.5	5
Tail length (mm)	94.6	8.22	80-105	7	91.5	5.07	85-96	4*
Pes length (mm)	16.7	0.25	16.5-17.2	7	16.4	0.47	15.7-16.8	5

House Mice or Bush Rats were captured in the swales; all were on or immediately at the foot of dunes.

One New Holland Mouse shed the last 35 mm of the skin of its tail while being handled. This technique is used by some rodents to avoid capture (P. Myroniuk, *pers. comm.*). Another had recently lost approximately one third of its tail (i.e. not only the outer skin).

Following their release, most New Holland Mice paused for three or four seconds before bounding away rapidly toward cover. One individual covered a distance of about 20 m in an estimated five-six seconds.

One of the 13 New Holland Mice trapped on the night of 9 May escaped before measurements or gender were recorded. Of the remaining 12, seven were males and five were females. Range, mean and standard deviation for all measurements are recorded in Table 2.

Discussion

The capture rate of New Holland Mice (19.3%) obtained in this survey was higher than that recorded by Quin (1996), whose work in the same area in February and April 1993 yielded 25 New Holland Mice from 157 trap nights (15.9%).

The vegetation in the swales may have been too low and sparse in 1993 to provide sufficient cover for the New Holland Mouse. Vegetative cover had increased since that time (B.R. Quin *pers. obs.*); this could be attributed to a reduction in grazing pressure due to the extensive rabbit baiting program. As a result, by 1996 the patchy Coast Tea-tree may have provided sufficient cover to enable the New Holland Mouse to venture into the swales. Alternatively, food abundance may have increased in association with the increase in cover. However, Carmen (*pers. comm.*) recorded breeding in May, so an alternative explanation may be that the New Holland Mouse population at Yanakie Isthmus was highest in May (see Kemper 1988) and competition had forced some mice into the swales.

The on-going baiting for rabbits and foxes, although peripheral to the New Holland Mouse population, may well be having a beneficial effect, leading to a higher population. Smith and Quin (1996) have demonstrated that some Australian rodents have undergone decline where feral predator abundance has been elevated by high levels of introduced prey species such as rabbits. Thus, more than one factor may be responsible for the apparent increase in size of the New Holland Mouse population.

Previous studies have demonstrated the preference of the New Holland Mouse for an actively regenerating (post-fire or post-clearing), heathy understorey (e.g. Wilson 1994; Braithwaite and Gullen 1978). The vegetation in the swales at this study site was at an early stage of succession following slashing. It is probable that in time, as Coast Tea-tree regrowth comes to dominate the site, thereby excluding other plant species, the area will become unsuitable as habitat for the New Holland Mouse as appears to have been the case at other sites on Wilsons Promontory (Quin and Williamson 1996).

The establishment of grazing exclusion plots alluded to in the introduction, was intended to be a management measure which might enable the New Holland Mouse to venture out of the dune vegetation as the *Themeda* grassland/woodland in the swales established sufficient cover. As New Holland Mice were found in the swales during this survey, and some captures occurred on the actual exclusion plot site, the proposal requires modification. (The planned grazing exclusion plot was established shortly after this survey took place.)

Future management for the New Holland Mouse should include systematic monitoring of their numbers, and monitoring of vegetation under three different management regimes within and outside a much larger exclusion zone:

- an area of swale which is slashed every 3-5 years to keep it at a stage of succession which is currently believed to be suitable for New Holland Mice;
- an area of swale in which the Coast Tea-tree is left to regenerate, to determine the post-slashing regeneration age at which the mice are no longer present;
- an adjacent area of dune vegetation.

This should provide useful information on the effect of grazing by large herbivores on swale and dune vegetation composition and on New Holland Mouse population growth and distribution.

Acknowledgements

We would like to thank the following people who assisted with this project: Susan Taylor and Ross Williamson for supervision; Linda Rippon, Susan Taylor and Sonya Feodoroff for assistance with field work; Paul McDiarmid for information; and Gordon Friend, Darren Quin, John Seebeck, Susan Taylor, Ross Williamson and Wendy Williamson for constructive criticism of drafts of this report.

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Observations of Platypus *Ornithorhynchus anatinus* Mating Behaviour

Mark De-La-Warr[1] and Melody Serena[2]

Abstract

Only three instances of apparent Platypus mating behaviour have previously been described in the wild, with three additional examples of mating described in captivity. We report here on a presumed mating sequence observed in the wild at Lake Elizabeth in the Otway Ranges, Victoria. (*The Victorian Naturalist* **116** (5), 1999, 172-174.)

Introduction

Remarkably little is known about the reproductive behaviour of the Platypus *Ornithorhynchus anatinus*. Given that eggs have been recorded in underground nests from late August to October and that gestation and incubation are respectively believed to last about one month and ten days, Platypus presumably may breed as early as July, with some evidence that eggs appear somewhat earlier in Queensland and northern New South Wales than in Victoria (Griffiths 1978). To the best of our knowledge, the breeding behaviour of wild Platypus has previously been described by only two authors, with three additional accounts of mating recorded in captivity.

Verreaux (1848, quoted in Burrell 1927) witnessed two Platypus mating in the middle of a reed bed after the male had chased the female 'for nearly an hour'. The male gripped the female's neck with his bill and her hindquarters with his back legs. The

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female struggled violently and vocalised increasingly loudly ('plaintive cries rather like the squeaks of a young porker') until the pair separated after five or six minutes. Afterwards, 'the two animals played together for more than an hour'.

Burrell (1927) (who doubted the accuracy of Verreaux's observations) reported two separate incidents along the Namoi River in August 1909 and September 1921. In the first incident, one animal floated 'perfectly still' with its body and tail submerged below the surface, while the second approached slowly and then mounted the first 'in a leisurely fashion'. The second animal then 'threw himself back into a sitting posture' at which point 'there was a great splash, and both animals disappeared'. These events were directly preceded by the animals swimming in a tight circle at the surface for about one minute. In the second incident, two Platypus were initially observed 'floundering, or wallowing' at the surface, facing in opposite directions and upside down so the tail of each animal was laid flat along the other's abdomen. At short intervals, the animals rotated around their long axis (whence the floundering) so each could breathe in turn at the surface, with these manoeuvres undertaken 'in a calm, slow, deliberate manner, and almost noiselessly'. After three minutes, the pair separated underwater and then rose together to the surface before diving and disappearing from view.

In captivity, Fleay (1980) observed a pair mating on 1 October 1943. The interaction began with the animals swimming in processional circles in the tank, the male grasping the end of the female's tail in his bill. While still holding the female's tail, the male doubled his body under her to achieve intromission. The pair subsequently adopted the posture observed by Burrell along the Namoi River in 1921, facing in opposite directions and upside down relative to each other so they had to breathe alternately. The pair separated after ten minutes.

At Taronga Zoo in Sydney, mating sequences were recorded on 10 October 1990 and 11 October 1991 (Hawkins and Fanning 1992). In both cases, the male mounted the female by grasping her tail between one hind foot and his own tail (which was curled forward) while moving his body forward so his head lay over her shoulder. The animals were supported by a log lying approximately 10 cm below the water's surface, although in 1991 the female swam the length of the tank on several occasions while the male was mounted. The pair remained coupled for 17 minutes and 28 minutes, respectively.

We describe below a fourth example of presumed Platypus mating behaviour in the wild, observed on 28 September 1998 at Lake Elizabeth, Victoria.

Description of the Waterway

Lake Elizabeth is located 8 km southeast of the township of Forrest in the Otway Ranges (143°40'55" E, 38°30'45" S). The lake was formed in 1952, when a natural landslide dammed the East Barwon River, creating a waterbody which is about 800 m long x 200 m wide at its widest point and typically 4.5-6 m deep. The habitat surrounding the lake consists of wet sclerophyll forest and subtemperate rainforest dominated by Manna Gum *Eucalyptus viminalis* and Southern Blue Gum *E. globulus*. Since 1994, one of us (MDLW) has regularly conveyed small numbers of people around Lake Elizabeth by canoe, in order to observe the behaviour of a number of species living in and around the lake, including Platypus. Up to seven Platypus are seen over a period of two hours around dawn. The animals continue to feed and otherwise appear to be undisturbed by the presence of the boat as long as its occupants remain quiet and reasonably still when Platypus are at the surface.

The observations reported below were made on a sunny day following a windy, rainy night. After a long spell of dry weather, nearly 70 mm of rain had fallen in the previous three days, causing the lake level to rise.

Description of Mating Behaviour

Two Platypus were observed at approximately 0700 hours resting in 12 cm of water on a partly submerged hollow log (60 cm in diameter, with the hollow portion extending at least 2 m back from the entrance) located perpendicular to the bank along the shady northeast margin of the lake. One animal was lying on top of the other, with its bill moving slowly back and forth along the other's back. The animals then began rolling over in tandem in a halting manner. Their bodies were pressed together closely, with their underparts mostly hidden by a tangle of legs as they rotated slowly. Both animals had their eyes shut and otherwise appeared oblivious to the presence of the observer's canoe, 8-10 m away.

After completing about four full rotations over a period of two to three minutes, the two Platypus separated and swam in a leisurely manner for a distance of about one metre to the exposed opening at the end of the log. After both animals entered the hollow, one turned around and used its bill to re-arrange some reeds growing around the entrance. The animal continued to manipulate the vegetation in a diligent manner for 30 to 40 seconds, until the opening into the hollow had been hidden from the observer's view. While it is known from radio-tracking studies that Platypus burrow entrances are often concealed from view by undercut banks, overhanging vegetation, etc. (e.g. Serena *et al.* 1998), this is the first time that a Platypus has apparently been seen actively disguising the entrance to a resting site. The log's location and orientation suggested that it may have led directly to a burrow in the bank. Alternatively, Platypus are occasionally known to shelter during the day in sizeable hollow logs at the edge of the water (Burrell 1927; M. Serena *pers. obs.*).

Discussion

Considered collectively, the accounts of Platypus breeding behaviour summarised above suggest that the following generalisations apply to this species:

(1) Platypus may mate either while supported by a structure in a few centimetres of water or while floating in deeper water.

(2) In shallow water, a pair will mate with the male mounted on top of the female. In deeper water, the animals may end up facing in opposite directions and positioned upside down relative to each other.

(3) A pair of Platypus may remain coupled for a few minutes to as long as about half an hour.

(4) Mating may be immediately preceded by the pair swimming in tight processional circles on the surface. In captivity, such circling behaviour has sometimes been recorded on a number of days in the breeding season (Strahan and Thomas 1975; Fleay 1980), possibly due to the animals being forced to share a relatively small space throughout this period.

Acknowledgements

We thank P. and C. Brown and T., V. and A. Rowe for helping to confirm the details of the observations reported here.

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Special Issues

Next year (2000) we will publish two special issues of *The Victorian Naturalist*.

One of the issues will celebrate the life and scientific work of **Sir Frederick McCoy** (1823-1899) on his centenary. Frederick McCoy was the first President of the Field Naturalists Club of Victoria and held this office for three years, from 1880-1883.

The second special issue will concentrate on **The Murray River**, its billabongs and creeks.

If you wish to contribute articles, research reports or notes to either of these issues, please contact the editor (FNCV, Locked Bag 3, P.O. Blackburn, Victoria 3130).

A Diary of the Saunders Casemoth *Oiketicus elongatus*

Joan Broadberry

Abstract
This paper includes field observations of the larval and pupal stages of the male and female Saunders Casemoth *Oiketicus elongatus*, including method of climbing vertical surfaces, indications of eclosion, timespan of pupal stage and a description of winged male and wingless female moths. (*The Victorian Naturalist* **116** (5), 1999, 175-178.)

Observations of the larval stage

On Sunday 21 February 1994 I picked up a 15 cm long, twig-decorated case of a Saunders Casemoth *Oiketicus elongatus*, which had fallen out of a prickly Grevillea in our yard. These cases are quintessentially Australian. Most of us learn as children to recognise them, but beyond the mere act of recognition there is total ignorance. I consulted Coupar (1992), and found that casemoths are the larval or caterpillar stage of a moth, and as they are interesting to keep and observe. I installed the animal in an old esky and provided several food plants *Grevillea, Acacia and Eucalyptus*, not being sure of what it ate. I keep a regular nature diary, and the following account is from the field notes I made over the next year.

That evening I was home alone when I heard a faint noise. I'll never forget the delight of that first sight of the head and thorax of a handsome orange and black caterpillar. Initially we only caught glimpses of the caterpillar if we peeped quietly into the container. But the creature gradually became used to us and began to move around freely, somehow crawling up the vertical sides of the esky and attaching near the top. It always quickly closed its case for privacy when disturbed, but over time, this action became slower.

After a day or two we established the food plant as *Grevillea glabrata* by seeing the caterpillar eat it. By the way, the best sign of casemoth 'life' and activity are the faecal pellets (frass) lying on the bottom of its container. I took many photos of the orange head and black body segments, blotched with bright orange. Up to seven body segments came out of the case, the last three showing being totally black. On the thorax were three pairs of legs tipped with curved claw-like feet (Fig. 1).

A week later the casemoth became very restless, climbing the sheer sides of the esky again and again. It took us another week of observation to realise that the caterpillar climbs vertical surfaces by making a silken ladder, with steps about 7 mm apart. The animal builds each step by moving its head from side to side and laying down many strands of the silk secreted from its mouthparts. This becomes a rung of its ladder. The caterpillar, using its first pair of legs, then pulls itself and its stick case up, until its head projects beyond the rung. It stretches its head a further few millimetres and lays down another step. The whole process is repeated over and over again. The silken ladder left behind shows clearly where the casemoth has climbed.

Fig. 1. Larval stage of casemoth showing the caterpillar's head. Photograph by Joan Broadberry.

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More observations. I noticed the back end of the animal came right out of the case when faecal pellets were being expelled. While they feed, casemoths attach the top of their case to a twig with a few strands of silk. This is cut when they are ready to move on. The case can be very tightly shut by twirling it around a stick or pulling it inwards like an old-fashioned drawstring purse. Saunders Casemoths readily climb around in foliage using their strong, hooked feet to grip onto twigs, the body inside the case always being pulled behind.

I started reading Common (1990). The Saunders Casemoth belongs to a worldwide family of the Psychidae, commonly called case or bag moths. The family includes about 600 species with an estimated 145 found in Australia. *Oiketicus elongatus* occurs in Southern Queensland, New South Wales and Victoria in all seasons of the year. Each individual animal seems to have a preferred food plant, but the species is polyphagous and has been recorded on *Eucalyptus, Leptospermum, Melaleuca*, and introduced plants including *Citrus* and *Cotoneaster. Grevillea subsp.*, the plant our casemoth feeds on, is not mentioned as a food plant.

Casemoths go through many instars over a period of years, during which they seal up their cases, become inactive and shed their skin. This is known as ecdysis. The number of instars of the Saunders Casemoth is not stated. A study of a similar West Indian species, *Oiketicus kirbyi*, estimated 12 to 20 instars. On 10 March 1994 I observed that our casemoth appeared to be going through ecdysis. It had been hanging from the side of the esky for several days, not moving and producing no frass. An alternative explanation may be that the caterpillar was going through a period of diapause, a time of decreased metabolism. On 25 March the casemoth commenced feeding again and on 21 May we released the captive animal outside to live freely on its foodplant.

Observations of the male pupal stage

On 11 March my daughter found a second, smaller casemoth attached low down on a nearby telephone box and brought it home. After a couple of days, as it wasn't eating, I put it back in the tanbark about five metres from the phone box and forgot about it. However, this little creature was destined to play a much bigger part in our lives.

Some time later, on 23 March, I noticed a small casemoth hanging in the same place on the telephone box. It may have been the same one we found earlier because it was attached on exactly the same spot. It seems intriguing that it would 'home' to the identical place. Observing closely, I noticed it seemed shrunken inside. Looking carefully I realised there was an orange and black caterpillar head and thorax, detached and dangling below the case (Fig. 2). Reasoning that this might be a sign of pupation before the emergence of an adult, I took the case home and hung it inside a glass jar resting on a cool, south facing windowsill over the sink, where I would notice it every day. We just dared to hope for an adult moth, but realised it would require patience.

Sunday 12 October 1994. What excitement! My daughter had the honour of finding a perfect adult male casemoth inside the jar (see photo on front cover). Our patience had paid off. It was a truly beautiful moth and so seldom seen, although

Fig. 2. Detached caterpillar head and thorax dangling below the twig case. Photograph by Joan Broadberry.

Fig. 3. Pupal case, after male adult casemoth has emerged. Photograph by Joan Broadberry.

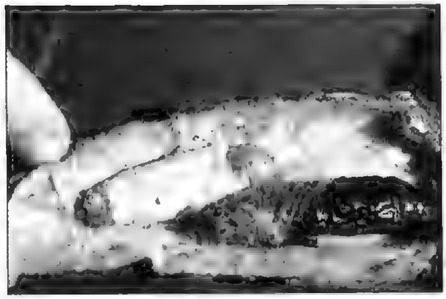

Fig. 4. Female adult Saunders Casemoth, showing pupal case. Photograph by Joan Broadberry.

they must be common. It had a wingspan of 45 mm; a black furry body 26 mm in length; a long, pointed, orange and black striped abdomen; a large hairy orange patch on its back; and black antennae. The bold orange and black colour scheme echoed that of the caterpillar. The forewings were an elongated oval shape, transparent, with a bee-like texture. The hindwings were similar but much smaller. The two pairs of wings rested in a horizontal position.

The twig case had a dark, shiny cylindrical pupal case, open at the bottom, protruding from it (Fig. 3). Now, years later, I sometimes observe such cases, a sure sign the moth has flown. Regrettably, after being photographed the adult gave its life for science, ending as a pinned specimen. Mission accomplished. But there was to be a further chapter.

Observations of the female pupal stage

The large casemoth had been outside, lost in the prickly embrace of the Grevillea. During the colder winter months we made no observations at all, but we spotted it again at the end of October moving around the shrub.

On 14 January 1995 I recorded that the twig home measured 16 cm from tip to tip. This is considerably larger than the 12 cm maximum recorded in Common (1990). From my photographs of the distinctive case, there is no doubt it was the original animal. That day the caterpillar was very restless. It climbed part way up the house wall and attached near the front door. Next day we lost the animal, but tracked it by means of the silken ladder. The caterpillar had climbed the whole height of the house up to the eaves. Later it fell to the ground. Was it too heavy or was this the only way down? How do casemoths go backwards? This behaviour was observed off and on until 5 February when it finally climbed up to the middle of a low window and made a very strong attachment. I was able to get excellent views from inside the glass, of the movement of the head in making the ladder, and the awkward heaving of the heavy body up each silken step. That final journey took tremendous effort. More of the caterpillar body segments than I had ever seen previously came out of the case. Once secure, there it stayed, tightly closed. Saturday 11 March, I became aware of a faint movement and a shiny yellow head just peeping out of the back end of the case. What was happening? The animal seemed the wrong way around as the female is fertilised inside the case and I would not expect the head to be at the rear opening. I was consumed with curiosity but the only way to look inside would have been to destroy the twig home. Again patience was required. Looking back now, I know this meant the caterpillar had turned into a mature, adult wingless female moth (Fig. 4). The pupal stage lasted only about five weeks, in comparison with the male's pupation, which took at least five months. I re-read Common (1990) more carefully. In the sub-family Psychidae, both male and female newly emerged adults turn inside the case, meaning the female genital organs are facing away from the rear opening. The male is able to greatly extend its abdomen to contact them. This is the origin of the species name '*elongatus*'.

On 21 March I noticed that the rear end of the case was gaping open, and glancing at the ground, saw a fat, yellowish grub-like animal lying there. Because I had ear-

Fig. 5. Part of a colony of casemoths containing over 70 individuals. Photograph by Joan Broadberry.

lier glimpsed its head, I realised this was the wingless adult moth. It was a very happy occurrence, as I would never have damaged the case to see the animal. Again great excitement, as I photographed the five female Saunders Casemoth.

The wingless moth, 6 cm long, looked just like a bloated yellow Egyptian mummy, with a large mustard coloured head. The body texture was smooth, with five indistinct segments covered by very loose baggy skin. The moth was very swollen, with its ovipositor extended from a brown furry ring around its rear opening. Its helpless body heaved and pulsated in a wave-like motion starting from the head and travelling to the back. Three pairs of minuscule legs were just visible below the head, but the creature was not designed to walk or fly, simply to spend its whole life inside the protective case.

Next day I cut the empty twig case open for photographs. Inside was a velvety soft silk lining and the remains of a black, shiny, tube-like pupal case similar to the one I had seen protruding after the male moth emerged. The animal had pupated head up, but must have turned after emerging from the pupal case. Later, I decided to replace the moth in its damaged home and leave it out overnight, just in case eggs were laid. The most exciting thing of all would be to watch them hatch and see tiny Saunders Casemoth larvae start to build their homes. But it was not to be, and the wingless female died about 26 March. In Common (1990), I read, 'Sometimes the spent female is said to drop from the case after oviposition.' The female had probably been fertilised and laid the eggs of the next generation, before dropping from the case.

Directions for the future investigation

There are many more aspects of Saunders Casemoth biology to explore: the number of instars and lifespan for example. The significance of the dangling remains of the head and thorax is not yet clear. It seems to be an indicator of eclosion in the male animal. I have observed this sign on two other occasions, collected the cases and in both instances, after some time, a male moth has emerged.

I continue to learn. In a recent interesting encounter with the Saunders Casemoth we found a group of over 70 individuals clustered together on a Cypress tree in an inner suburban garden (Fig. 5). In this colony I found two cases fused together. Each contained a healthy caterpillar, but the two were forced to move about together, like Siamese twins, as their cases were joined (Fig. 6). This large group raises the question of how gregarious the caterpillars are?

Studying this unique Australian animal is a fascinating part of my life. It is seemingly so common but also so secretive. The caterpillar and female moth, always hidden from our eyes inside the case, and the male, so elusive that few photographs or specimens exist.

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Fig. 6. Larval stage of casemoth, showing two twig cases fused together. Photograph by Joan Broadbury.

New Records of the Striped Worm-lizard *Aprasia striolata* in South-western Victoria

Cam Beardsell[1], Nick Clemann*[1], John Silins[1] and Edward McNabb

Abstract

The Striped Worm-lizard *Aprasia striolata* has been infrequently recorded in Victoria, and is officially listed as a threatened species. This article reports two new localities for this species in south-western Victoria. One individual was captured in an invertebrate pitfall-trap in heathy woodland south of Edenhope. Nine adults and five juveniles were hand-caught after being located beneath limestone slabs in the Glenelg River gorge south-west of Casterton. Numerous sloughs of this species were also discovered beneath rocks at this site. Sympatric reptiles species noted during brief surveys at both sites are listed. (*The Victorian Naturalist* **116** (5), 1999, 179-180.)

Introduction

The Striped Worm-lizard *Aprasia striolata* Lutken 1863 is a small, worm-like pygopodid (legless) lizard, adapted to burrowing in loose sandy or loamy soils (Cogger 1996) (Fig. 1). It has two main distributions in semi-arid regions of southern Australia (Cogger 1996). One is in the south of Western Australia, whilst the other extends from Portland to the Big Desert in western Victoria across South Australia to the Eyre Peninsula. Populations within this range may be localised and fragmented due to natural discontinuity in habitat and land clearing.

Aprasia striolata has been infrequently observed in Victoria and is officially listed as Lower Risk – Near Threatened (NRE 1999). In recent years (1990-1998) there have been only three records of this species. Similarly, for the period 1970-1990 there are 11 records and, prior to 1970, another 11 records (Atlas of Victorian Wildlife database, NRE). Most records have come from sand-hill mallee communities of the Little and Big Deserts. There is a scattering of records from heathy woodlands in the Edenhope-Casterton region, with an outlying population on limestone cliffs along the southern coast around Portland. This note reports two new records detected in summer– autumn 1998/99, during fauna surveys for the Regional Forest Agreement Process. These were of a single animal captured in an invertebrate pitfall-trap south of Edenhope and a population located during searching of the Glenelg River gorge south-west of Casterton.

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Habitats at the new sites

The Edenhope site was at the northern end of an extensive sand-plain which extends south-west to the South Australian border. To the north lie the Wimmera Plains which once supported grassy woodlands, though they are now largely cleared for grazing and cropland. Heathy woodland on the sand-plain contained an overstorey of Desert Stringybark *Eucalyptus arenacea*. The heathland understorey consisted of tall shrub copses of Desert Banksia *Banksia ornata* and a moderately dense stratum of low shrubs including Heath Tea-tree *Leptospermum myrsinoides*, Daphne Heath *Brachyloma daphnoides* and Flame Heath *Astroloma conostephioides*. The ground stratum consisted of sedges including Tassel Rope-rush *Hypolaena fastigiata* and Black Rapier-sedge *Lepidosperma carphoides*.

In the Glenelg River gorge, *A. striolata* occupied limestone cliffs, escarpments and upper river terraces. The overstorey consisted of an open shrubland of Drooping Sheoke *Allocasuarina verticillata*, Wedge-leaf Hop-bush *Dodonaea cuneata* and Tree Violet *Hymenanthera dentata*. The ground stratum on the escarpment consisted of an open tussock grassland dominated by Grey Tussock-grass *Poa sieberiana* and Rough Spear-grass *Austrostipa scabra*. The terrace supported a closed grassland of Common Tussock-grass *Poa labillardieri*. Cliffs were formed of horizontal bedded limestone while small, flat slabs lay on the escarpment. Rock screes occurred on the terrace at the foot of the cliffs. Soil consisted of friable brown alluvium.

New records of the Striped Worm-lizard

A single *A. striolata* was captured in an invertebrate pitfall-trap near Edenhope. It had a snout-vent length of 92 mm, and a tail length of 31 mm. Other reptile species recorded at this site included Garden Skink *Lampropholis guichenoti*, Bougainville's Skink *Lerista bougainvillii*, Eastern Three-lined Skink *Bassiana duperreyi* and Tree Dragon *Ampibolurus muricatus*.

Fourteen *A. striolata* were located under limestone slabs in the Glenelg River gorge during a 90-minute search by the authors on 25 March 1999. Nine of the individuals were adult (one collected, Fig. 1) and five were juvenile. Numerous shed skins (sloughs) were also observed beneath the slabs. A single animal was captured during a brief search of the same area the previous day. Sympatric reptiles recorded during the search of the Glenelg River gorge included Common Brown Snake *Pseudonaja textilis* (two juveniles), Bougainville's Skink (two adults), Garden Skink (three adults) and Southern Grass Skink *Pseudemoia entrecasteauxii* (four adults). This site was private property which retained most of its original vegetation and had not been subjected to ground disturbance. These factors probably account for the persistence and density of the lizards in the area.

Acknowledgements

The field work was a component of the Regional Forestry Agreement wildlife survey of western Victoria. The authors thank Ivor Graney of the Portland Field Naturalist Club who drew our attention to the presence of unspecified worm-lizards in the Glenelg River gorge. Geoff Brown and Richard Loyn, both of the Arthur Rylah Institute, provided helpful comments on the manuscript.

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Fig. 1. The Striped Worm-lizard *Aprasia striolata*. Photo by Nick Clemann.

Early Devonian Fossils from Eglinton Road and Rail Cutting, Alexandra, Central Victoria

Clem Earp[1]

Abstract

A brief report is given of an allochthonous fossil assemblage of Pragian (Early Devonian) age from marine shale at a location near Alexandra, central Victoria, Australia. The fossils include large early land plants, of which illustrations are given of an unnamed species, possibly related to *Drepanophycus* (Lycophytina, Drepanophycales). Rare shelly fossils include *Hercynella* (Mollusca, Bivalvia); the literature relating to this genus is reviewed. (*The Victorian Naturalist* **116** (5), 1999, 181-186.)

Introduction

Eglinton Cutting is a large road cutting approximately 4 km northwest of Alexandra on the Goulburn Valley Highway (Fig. 1). At the crest of the road, another cutting branches off to the northeast; this was formerly the line of the Yea-Alexandra railway.

In 1994, the local council reduced the slope on the south side of the cutting to prevent rockfalls. On inspecting the new face, I found that numerous fragments of the Siluro-Devonian fossil plant, *Baragwanathia*, were visible. On subsequent visits, I found a number of other fossils, mostly in the talus left by the road works. Some of these fossils are described below, others are still under study. Those figured in this paper are deposited with the National Museum of Victoria (indicated by NMV specimen numbers).

Previous studies

The area was examined in 1929 by a team of geologists from the Mines Department, who were specifically looking for *Baragwanathia* and associated graptolites. The north end of the cutting (road and rail combined) was referred to as location 8 in the published report by Harris and Thomas (1941), and the railway cutting was referred to as location 9.

Location 9 produced specimens of graptolites and *Baragwanathia longifolia* occurring together, which were pictured by Lang and Cookson (1935) in the first description of this species. At location 8 however, Harris and Thomas reported only a succession of basal shelly 'grits', overlain by sandstones, and mudstones containing *Monograptus*.

The shelly fossils collected in 1929 were subsequently examined by Dr. J. A. Talent, who identified the brachiopods *Boucotia australis* and *B. loyolensis*, as well as noting the occurrence of indeterminable gastropod remains (Couper 1965). On this basis, Couper (1965) considered the horizon at location 8 to represent the Flowerdale Sandstone Member of Williams (1964).

As for the graptolites, location 9 is one of the original localities for the species *Monograptus thomasi* Jaeger 1966 (see also Jaeger 1967). A specimen from Eglinton Cutting was figured by Garratt and Rickards (1984, fig. 5E).

Lithology

The new south face of the cutting exposes a stratigraphic thickness of nearly 40 m (Fig. 2). The rock is almost entirely thin-bedded light to dark grey mudstone, weathering to a buff colour at the top 2-3 m of the cutting. The beds dip uniformly at around 82° to the southeast, and strike at about 130°. Near the top of the exposure are two beds of massive ungraded fine-

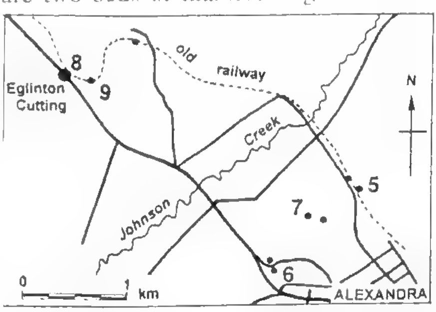

Fig. 1. Small dots show fossil localities north of Alexandra, from Harris and Thomas (1941), redrawn on a modern map base. The large dot (8) shows the location of the Eglinton Road and Rail Cutting.

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grained quartzitic sandstone, 15 and 30 cm thick, separated by 60 cm of mudstone.

The thickness of the mudstone beds varies from millimetres up to about 15 cm, but is most commonly in the range 6-9 cm. Many of these thin beds are graded, with siltstone (sometimes very fine sandstone) and minor current-bedding at the base, fining up to laminated claystone at the top. The contacts between the beds are usually planar and often marked by a millimetre-thick iron oxide stain; this is taken to represent oxidation of sulphides from organic matter which settled at the top of the bed. The lithology indicates deposition by turbidity currents in quiet, deep water.

I have not closely examined the north side of the cutting, which is now overgrown and weathered, except to note that the bedding and structure are more complex.

I have been unable to find any 'grits' (coarse sandstones and granule conglomerates) corresponding to those seen by the Mines Department geologists in 1929. This can be accounted for by the vastly altered nature of the cutting. In 1929 the road would have been little wider than a modern single lane. It is now a four-lane highway, with a parking area equivalent to a fifth lane. Clearly, an enormous amount of material has been removed from the south side of the cutting.

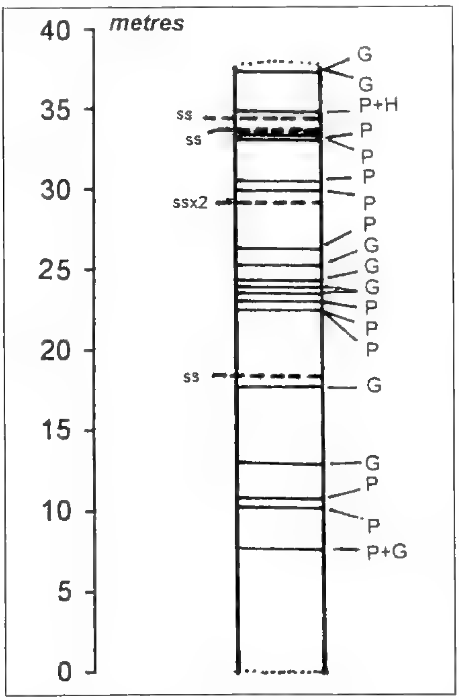

Fig. 2. Stratigraphic column, south face of Eglinton Cutting. G – graptolites, P – plants, H – *Hercynella*, ss – sandstone.

The strata are part of a marine shale sequence, at least 500 m thick, to judge by exposures to the south of Alexandra. This sequence, in turn, belongs in the formation known as the Norton Gully Sandstone (VandenBerg 1975). The name is somewhat misleading, by the way, as the formal definition states: 'The predominant type consists of claystone and siltstone shale with thin bedded fine sandstone'. This describes the observed facies exactly. The relationship between the Norton Gully Sandstone and beds previously assigned to the Flowerdale Sandstone Member is currently under investigation (see e.g. Edwards *et al.* 1997).

Palaeontology

General remarks

All the fossils I have so far found have been on the bedding planes between mudstone layers. I have seen none in the sandstone, whereas at Mt Pleasant, on the other side of Alexandra, where the lithology is very similar, it is the thin-bedded sandstones which are known for their plant fossils, while the mudstones are barren (Cookson 1935).

The stratigraphic distribution of known fossil horizons is shown in Fig. 2. Although the fossil biota is rather scanty, the locality in this paper shares some species with localities in the Lilydale district. Numbers given in the following text for the Lilydale locations correlate with those on a chart in Garratt (1983, fig. 5). Most localities from the Lilydale district comparable with the locality in this study are well into the *Boucotia loyolensis* zone, suggesting an age younger than that for the Flowerdale Sandstone Member (Garratt 1983, fig. 6).

Flora

Numerous fossil plant remains have been exposed; they include vague carbonaceous films, well-preserved coalified compressions, mineralized impressions and leached-out moulds. The better preserved specimens will be described at a later date;

for now a brief summary will be given.

Baragwanathia longifolia Lang and Cookson.

Very common; occasional specimens can be definitely identified in at least five different horizons, ranging from the top to the bottom of the cutting. Sometimes all that can be seen is a vague outline of an arched branch, at other times there are splendidly foliaceous specimens with coalified remnants.

Hedeia corymbosa Cookson.

As well as a couple of isolated stems, the site has yielded a substantial specimen with more than 20 sporangial heads. This is thought to be the largest specimen of *Hedeia* yet found (J. G. Douglas *pers. comm.*).

Yarravia cf. *oblonga* Cookson.

A single stem 12 cm in length with poorly preserved sporangia appears identical to one described by Cookson (1949, Plate 4, figs. 4 and 5) from location G1, Lilydale. These forms are more slender overall than *Y. oblonga* Lang and Cookson *sensu stricto*.

Zosterophyllum? sp.

Thin axes up to 10 cm in length, occasionally branching dichotomously. No connected sporangia have been found, the suggested assignment is based purely on the appearance of the axes.

Unknown tracheophyte.

Naked stems 5-15 mm diameter, one of which has a pseudomonopodial branch 7 mm in diameter. There is a prominent vascular trace. More frequent short branches 2-3 mm in diameter and 2-3 cm long occur at intervals, often springing from the same locus, in a K-configuration (Fig. 3). These seem to terminate in club-shaped endings, which are sometimes surrounded by a halo suggesting the remains of a globose structure, or in other instances, there seem to be a number of short, erect sporangia-like objects attached (Fig. 4).

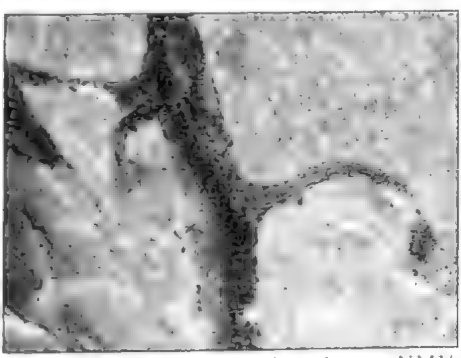

Fig. 3. Unnamed tracheophyte. NMV P208597A. Detail of two secondary branches in K configuration, ×1.75. At left, a third branch originates from the opposite side of the axis.

This last species I regard as identical to plants found in the Wilson Creek Shale at Frenchman's Spur, described in manuscript by Tims (1980). Tims assigned the species to the zosterophylls on the basis of their branching, but the size and appearance of the specimens is so remarkable that this hardly seems likely. Specimens with larger diameter axes somewhat resemble an Eifelian (Middle Devonian) plant, *Drepanophycus devonicus* Weyland and Berendt, as illustrated by Schweitzer and Giesen (1980), but the secondary branches are significantly longer in our specimens (Fig. 5).

Fauna

The observed fossil fauna consists of abundant graptolites, and a very few isolated, more or less complete brachiopod and bivalve shells. The latter are relatively large (smallest diameter > 1 cm). Whereas the graptolites have left substantial carbonaceous remains, the shelly fossils are reduced to impressions, which leads to difficulty in identification. All fossils are highly compressed parallel to the bedding, and there is a further component of distortion which is most obvious in the graptolites (Jaeger 1966).

Although the very rare brachiopod and bivalve shells may have been directly emplaced by turbidity currents, little sup-

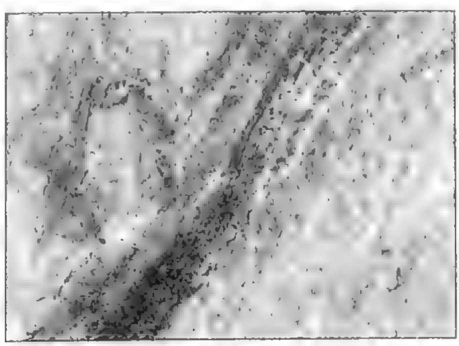

Fig. 4. Another detail from NMV P208597A, ×2.5. Single branch with possible sporangia on the clavate termination.

porting evidence for this mode of deposition is present. The size of the shells is anomalous in the fine sediments. There are no coarse sand grains, lithic clasts or broken shell fragments which one would expect to be entrained by currents sufficiently strong to carry the large complete valves. I consider the association with the abundant drifted fossils, such as the land plants, to be significant, and suggest that these shells were rafted by epibiotic seaweed and dropped into position.

Graptolithina
Monograptus thomasi thomasi Jaeger.

This is observable at intervals at all levels of the cutting (Fig. 2). This well-known index species fixes the age of the rocks as Pragian – for a recent discussion see Carey and Bolger (1995).

Brachiopoda
Fascicostella? sp.

A battered fragment of an external mould shows coarse angular ribs arranged in bundles of 3, the middle being more prominent, at either side of a central area occupied by a panel of finer ribs. This type of ornamentation is characteristic of the Resserellinae (Walmsley and Boucot 1971). Two species of this subfamily have previously been reported from the Lower Devonian of Victoria. Of these, the one with coarse ornament is a *Fascicostella*, which Gill (1942) considered identical to specimens from New Zealand, then called *F. gervillei*, but now known as *F. batonensis* Walmsley and Boucot. Gill reported this species from locations G7, G9, G20 and G21 at Lilydale.

Two other brachiopod specimens have been found, but the impressions are not clear enough to be identifiable.

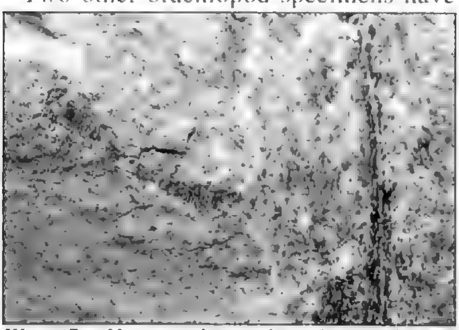

Fig. 5. Unnamed tracheophyte, NMV P208598A. Detail of a single branch with clavate termination, originating from a thick axis; ×2.

Mollusca (Nautiloidea)
Geisonocerina? sp.

Two poorly preserved specimens were encountered in this study. One is a faint impression which shows the apical 6 cm of an orthoconic nautiloid conch with the numerous transverse striae (8-10 per cm) common in this genus. Although *G. australis* Chapman has been recorded from the Norton Gully Sandstone at 'Kelly's Hill' (Mt Matlock), it differs from the specimens examined in this study by having nodular rather than smooth striae (Chapman 1912).

Mollusca (Bivalvia)
Hercynella killarensis Gill.

Two reasonably clear impressions of right valves, both having the hinge portion missing. One of these was the only shelly fossil found in place within the outcrop exposure; it was concave side up. In the field, *Hercynella* is easily recognised as a large, almost circular shell with one radius marked out by a low ridge (Fig. 6). *Hercynella killarensis* was originally described from location G35, Killara, near Lilydale (Gill 1950). *Hercynella* also occurs at Seymour in a very similar lithology (Schleiger 1964).

Notes on *Hercynella*

The previous Victorian papers on *Hercynella* were written at a time when it was thought to be a gastropod. This

Fig. 6. *Hercynella killarensis* Gill. NMV P303521A. Inner mould of a right valve, ×0.625. The anterior ridge, at upper right, is intact only in its central half.

includes two palaeo-ecological studies (Chapman 1917; Gill 1950), and one can appreciate that the ecology of a bivalve may very well be different from that of a gastropod. As the overseas literature is relatively inaccessible, I think it worthwhile to summarize it here.

Hercynella is thought to have evolved during the Upper Silurian from the genus *Silurina*, by migration of the apex of the shell from its normal place at the margin, towards the centre (Termier and Termier 1950). The two genera are members of the family Antipleuridae. *Hercynella* is found in Europe, North Africa and North America as well as in Victoria, and was considered characteristic of the Old World faunal province of the Early Devonian by Forney *et al.* (1981).

Following the discovery of articulated specimens at a couple of European locations, Prantl (1960) emended the original diagnosis of Kayser (1878) as follows (my translation):

> 'Homomyarian, with strikingly inequivalve asymmetric shells with a subcentral to submarginal summit. The shells are subconical to clypeate, with a prominent anterior wing. The wing is convexly arched on one radius, forming a ridge along its course from the summit to the hinge. The hinge is curved inwards with a prominent external ligament groove. The pallial line is entire.'

It should be added that the valves are edentulous. The external ornament consists of concentric growth lines, and in some species a radial sculpture (e.g. *H. victoriae* Chapman, illustrated by Gill 1950).

The anterior ridge mentioned in the diagnosis is referred to in the older literature as a 'fold', a term more appropriate to gastropods. It is perhaps the location of the byssal gland (Termier and Termier 1950), but my personal opinion is that it serves some function analogous to that of the posterior ridge in many other bivalves.

Following the recognition of the genus as a bivalve by the Termiers, Prantl (1960) observed that there were numerous instances of pairs of similar species reported from the same location. Given the inequivalve nature of known articulated specimens, he suggested that these pairs of species represented opposing valves of a single species. One of his examples is the pair *H. petasoida* and *H. killarensis*, which Gill (1950) described from the same location; but any conclusive proof must await the discovery of an articulated specimen.

As regards the ecology of *Hercynella*, it is now believed that this genus followed a reclining mode of life in deep water (Kríz 1979, 1984). By 'reclining', it is meant that the shell was lying on or just beneath the sediment surface, with the sagittal plane at an oblique angle to the vertical, and without a strong, permanent byssal attachment (Stanley 1970, p. 35-36). Kríz (1984) considered *Hercynella* to represent the perfection of a trend among the Antipleuridae towards the reclining lifestyle. Members of this family began life as equivalved semi-infaunal juveniles attached to the substrate by a byssus. As they grew, one of the valves (randomly left or right) became lower than the other as the oblique position demands. The lower valve developed a conical shape (cf. *H. petasoida*) while the upper became more flat and lid-like (cf. *H. killarensis*); left and right valves are to be found equally among either form.

Conclusions

The fossils reported in this paper represent the remains of species which were free-swimming (nautiloids) or floating marine organisms (graptolites), or which drifted out to open sea, either on their own (plants) or attached to floating debris (the rare molluscs and brachiopods). On settling to the ocean floor, they were buried by deposition from turbidity currents, which at this location consisted of very fine sediment, indicating some distance from land.

Acknowlegements

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One Hundred Years Ago

A report of the botanical results of the excursion to Cheltenham on Saturday, 19th August, was read by the leader, Mr. C. French, jun., who stated that a very interesting afternoon had been spent. Some twelve varieties of orchids had been noted in bloom, besides numerous other plants. On one of the orchids a parasitic fungus new to science had been found. Mr. J. Stickland stated that those members inerested in pond life had also experienced a profitable outing, as among other captures were the males of the rotifers *Lacinularia pedunculata* and *L. elliptica*, which are somewhat uncommon.

A paper was read by Mr. D. M'Alpine, entitled 'Description of a New Parasitic Agaric.'

The author described a new species of fungus of the genus *Hebeloma* (Agaricaceæ), which had been found by Mr. C. French, jun., during the Cheltenham excursion, growing on the stem of an orchid, *Pterostylis pedunculata*, R. Br., it being most unusual for a *Hebeloma* to be parasitic.

From *The Victorian Naturalist*
XVI, October 5, 1899.

Australia's Flying Frogs?

A number of 'flying frogs' are known from around the world e.g. *Litoria graminea* from New Guinea (Tyler 1976), *Hyla miliaria* from Mexico (Pough *et al.* 1998) and *Rhacophorus pardalis* from Indonesia (Heusser 1974). A detailed analysis of gliding performance by two species of *Rhacophorus* frogs has been published (Emerson and Koehl 1990), but to my knowledge no-one has investigated the gliding (or parachuting) abilities of Australian frogs. If a frog is able to fall at an angle less than 45 degrees it is said to glide whereas if the angle is greater than 45 degrees it is said to parachute (Pough *et al.* 1998).

While examining a live specimen of a large Peron's Tree Frog *Litoria peronii* from north of Wagga Wagga, New South Wales, it took a flying leap off my desk and landed about a metre away on the curtain. There was nothing special about that except that it appeared to land a little higher on the curtain than what I thought it should have done, given the take-off velocity and initial trajectory. I decided to investigate further and observed several jumps. On close examination of the frog I found an axillary webbing which stretched from approximately mid-body almost to the elbows. The photograph (Fig. 1) shows this webbing which is slightly less than fully extended here. Furthermore, the spreading of this webbing appeared to be under voluntary control. As the muscle involved in the stretching of the axillary webbing has an origin in the lateral body wall and an insertion in the distal humerus area, it may represent a component of the pectoralis muscle. When subjected to a simple stretch reflex by drawing the foreleg forwards (as might occur naturally when a frog was in flight or about to land) the webbing was extended briefly and then partially relaxed. At maximum extension the webbing appeared to pull the sides of the abdomen out a little too, so that the effective increase in planing area stretched almost from the groin to the elbows.

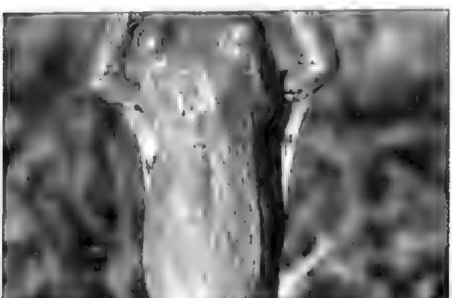

Fig. 1. Peron's Tree Frog *Litoria peronii*, Wagga Wagga, N.S.W., showing axillary webbing. Photo by T. Annable.

The efficiency of gliding depends on a number of factors such as mass, velocity, drag, shape of planing surfaces, angle of attack as well as the dimensions and orientation of the planing area. The axillary webbing of *L. peronii* together with finger and toe webbing and the head, body and limb surface areas is significantly less than in the oriental flying frogs (e.g. *Rhacophorus* species) which are able to glide up to 15 m or more at an angle of about 18 degrees (Pough *et al.* 1998), but certainly sufficient in my opinion to give significant lift. Whether the frog was gliding or parachuting is not certain as the angle of fall appeared to be close to 45 degrees. Unlike *Rhacophorus* species the interdigital webbing is not extensive in *Litoria* species.

Whether the frog can actually steer in flight with this webbing is another interesting question. The fact that the webbing has voluntary muscle control suggests the possibility. The excellent diurnal and nocturnal vision of these frogs would certainly be a very useful adjunct to controlled gliding. Such an ability would be very useful in the high, swaying branches of trees in which the species lives. Examination of several other arboreal or semi-arboreal *Litoria* species (Green Tree Frog *L. caerulea*, Eastern Dwarf Tree Frog *L. fallax*, Bleating Tree Frog *L. dentata* and Jervis Bay Tree Frog *L. jervisiensis*) shows they all have extensible axillary webbing to varying degrees, but whether all *Litoria* species do is not known. Other questions needing investigation involve a comparison of the terrestrial and arboreal species of the genus *Litoria*, bearing in mind that the genus as currently accepted is probably polyphyletic (Cogger 1996); also whether or not other hylid frogs possess a similar structure. More detailed research on structure and function with high-speed cinematography and moving targets is needed to clarify this interesting phenomenon.

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Southern Right Whale in Port Phillip Bay

Southern Right Whales *Eubalaena australis* are regular visitors to Victorian waters. They migrate from their summer feeding grounds in the sub-Antarctic to the coastal waters of southern Australia during late autumn/early winter and remain until mid-late spring. The coastal range is from about Perth, WA to Sydney, NSW.

In the 1830s and 1840s, the annual visits to shallow bays in western Victoria and Wilsons Promontory were the basis for an intense shore-based whaling industry. Indeed, the first settlement in Victoria was at Portland Bay and focussed on this natural resource. The intensity of the hunting soon reduced the numbers, although Southern Right Whaling continued until the 1950s – but not in Victorian waters – and the species came very close to extinction. It is now estimated that there are about 6-800 Southern Right Whales in Australian waters during the winter months. The largest concentration of these is at the Head of the Bight, in South Australia, where some 200 animals may congregate. Southern Right Whales are fully protected under State and Commonwealth legislation. In Victoria, the species is listed under the *Flora and Fauna Guarantee Act* 1988 and management and conservation actions have been prepared and were recently published (Seebeck *et al.* 1999) in a formal Action Statement.

The principal Victorian site is centred on Logan's Beach, just east of Warrnambool, a regular calving and nursery area. Numbers of whales present vary from year to year; in 1997 there were five adults and a calf, in 1998 three adult females, each with a calf. An observation platform has been built and many hundreds of people watch the whales each season. The Department of Natural Resources and Environment (NRE) closely monitors the whales and collects and collates sightings of the species from other places along the Victorian coast.

In August 1998, a Southern Right Whale paid a visit to Port Phillip Bay. This was an unusual occurrence; since 1977 there have been four records of this species in the Bay – August 1977, July 1988, May 1989 and August 1992. All these involved single animals. There is no evidence to suggest that Southern Right Whales have been anything more than occasional visitors to the Bay, even at the beginning of European settlement.

The animal was first observed close to the shore in the Mornington/Mt Martha area on Saturday 1 August, and reported to NRE Fisheries and Wildlife officers during the weekend. It was not reported on 3 August, but on the following day was seen cruising along the coast between Martha Point and Balcombe Point. It was only some 10-15 m offshore for much of the time, and excellent video footage and still photographs were obtained. The characteristic callosities on its head were clearly visible, as was a diamond-shaped white mark on its back. The pattern of callosities is unique and is used as the basis for identification of individuals. A National Photographic Index is maintained for all Southern Right Whales, to help in population monitoring. Many of these photographs are obtained using extensive aerial surveys for the species, or at congregation sites such as Head of the Bight. All the whales which visit Logan's Beach are photographed from the air by local NRE staff.

I visited Mornington on 5 August. The whale had been seen off the Mornington Jetty earlier that morning, but had left and was reported to be heading up the Bay. Over the next couple of hours I followed the steady stream of whale watchers to various vantage points along the coast and had good views of the animal. It was swimming quite rapidly, about 3-400 m off the coast and I last saw it off Olivers Hill at Frankston. It was seen that evening in the shipping channel off Black Rock.

On 6 August, NRE mounted a shore search and the whale was located in Sorrento Harbour in the afternoon, at which time its presence caused the Sorrento-Queenscliff ferry to delay berthing for a short while until the whale moved out of the way. At sunset, it was seen heading north, off Blairgowrie.

Despite a 3-1/2 hour flight by NRE officers on 7 August, during which the Bay was searched intensively, the whale was not seen again, and it is presumed that it safely left the Bay late on 6 or early on 7 August.

Several points emerge from this event. Probably the most exciting was that so many people were able to get a good look at the animal, which was often very close to shore. Many people did as I did, and followed the whale from vantage point to vantage point along the coast. The regulations that are in place to protect whales from interference by boats or aircraft were obeyed, with only a couple of boats venturing too close and having to be warned. Media interest was high, with television, radio and newspaper stories over several days. Other than some minor traffic congestion, whale watchers were able to share this rare event in a great spirit of cooperation and wonder.

NRE's Port Phillip region were responsible for managing issues of concern, but were only required to maintain their watching and recording role, and the many staff involved in this exercise have helped the community to experience a truly great natural event.

Acknowledgements

Rod Barber and Bob Hutton, from NRE's Mornington office, were instrumental in recording the movements of the whale, obtaining video footage and managing the public. Bob Warneke provided comment on early records of Southern Right Whales in Victorian waters. The Atlas of Victorian Wildlife database provided records of the species in Port Phillip Bay, and the account in *Mammals of Victoria* (P.W. Menkhorst, ed., p. 195) and the Action Statement (Seebeck, J., Fisher, J., Warneke, R. and Lowe, K. 1999, Action Statement No. 94, Southern Right Whale *Eubalaena australis*, NRE: Victoria) the relevant background material.

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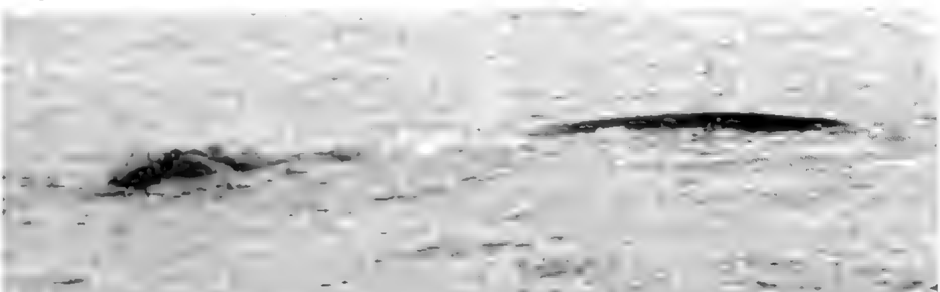

The Southern Right Whale near Mornington, August 1998. Note the callosities on the whale's head. The white patch on its back is just visible. Photo by Rod Barber, NRE, Mornington

The Weaver

Autumn is my favourite time of year. The mild, drawn out, in the main sunny days, followed by cool or comfortably warm evenings. Often wind free or perhaps with just a gentle breeze. It is almost as if nature is having a rest in preparation for the heavy work it has to do in winter.

Describing permaculture gardens around the world, a series of ABC TV programs during January gave me a renewed interest in my garden. To see what I would have to do to turn my backyard into a permaculture plot, I went for a walk. Frankly, what I saw was a wilderness, the grass under the apple tree was up into the branches. But there was also a great surprise. For the apple tree was struggling with an enormous load of apples. Really unbelievable. Without any human attention, nature, assisted by the bees, had just been doing its own thing.

To start things, I planted some sweet corn, some silverbeet and a few parsley seedlings given to me by a friend. I also developed the habit of taking a walk around the garden before going to bed.

The sweet corn was planted late in the season and when it has noticeably grown a bit I praise and encourage it. The warm weather may last just long enough to bring me some corn cobs. Then over to the compost heap. Putting my hand on the top, I feel the reassuring warmth telling me that in this world of uncertainty Nature continues in its mysterious wisdom, no matter what.

Thus it was that one evening, two months ago now, in the dark, I walked into a spider web. That is to say, my face walked into it while the spider must have seen me coming. For there was no trace of 'The Weaver'. Coming back half an hour later to see how things stood, the Weaver was busily restoring its shop front, the work already half completed.

Since then I call on the Weaver every night, a beautiful Garden Orb Spider. Seen from up close, its back is a light sandy brown. Superimposed in black is a motif that looks a bit like the Crown and Anchor of the merchant navy. The first segment of each front leg is a brilliant red. On the underside, the hind legs are set off in alternate short lengths of black and white bands. The outer hind legs are a different length from the other legs, enabling one claw to be above the other as the Weaver descends to the ground. Head down, it rapidly abseils by its own spider line. I assume that those claws, one above the other clasping the thread, keep the strain off the spinnerets while they exude the spider silk during the descent.

Belonging to the sheet web family of spiders, the web is some 30 by 50 centimetres. It is started every night at dusk and is packed up again at early dawn.

Strung out between the ground and overhead twigs, high enough from the ground for me to walk under, it is quite a large and elaborate affair. With guy lines going here and going there to secure it. When you consider that the Weaver's legs easily span 3 to 5 centimetres from claw to claw, it is not surprising that the Weaver can move with the speed of lightning across its scaffold. This was brought home to me when an electronic flash from the camera disturbed the Weaver. It went suddenly into the packing up behaviour which you can observe every morning before dawn. The Weaver moves around the centre a bit, I think undoing key tie points in the web, for it then drops half the web in a flash, gathering the web into what seems an untidy bundle of thread. It then packs up the top half and takes the untidy bundle of fluff with it into the branches.

During wind-still nights the Weaver sits in the centre of the web waiting, quite flat in the web. But when one night a breeze sprang up, the centre of the web was tossed 3 to 4 centimetres backwards and forwards, at times quite forcefully. The Weaver now stood off the web, hanging on in a manner which reminded me of a sail surf-board rider in a storm.

When it was warm and wind-still, the Weaver wove those large nets every night. Abseiling to the ground to set its guy lines, returning to the canopy of leaves by climbing, head up, in a hand over hand manner. However when a large high pressure area developed over the Bight and Adelaide, the anti-clockwise winds brought cold air from the Antarctic and some rain. I noticed that the Weaver then built a very much smaller web, sheltered to some extent by hanging amongst the canopy of leaves.

I had hoped that the Weaver would find a mate and reproduce, to keep the unwanted bugs down. Well it seems my hopes will be fulfilled. We have passed the autumn equinox and relative calm has returned for a while. While I haven't seen the Weaver again, there are lots of tiny Weavers. With bodies the size of grains of barley, they make just like Mammie did. Playing at abseiling, hanging around in very small bits of web hung up between the leaves. And like Mammie, you don't see hide nor hair of them during the day. A new cycle has started, a new generation is taking over. That is how life is.

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Defending the Little Desert: the Rise of Ecological Consciousness in Australia

by Libby Robin

Publisher: *Melbourne University Press, 1998, 203 pp., paperback, RRP $24.95.*

The controversy that developed around the Victorian government proposals to subdivide and clear the Little Desert for agriculture in the late 1960s has entered folklore as a turning point in conservation in Australia. The anti-development campaign is important in that it prevented the destruction of an area of extraordinary natural riches. However, the campaign's role in developing the ecological consciousness of the 1970s, and beyond, is seen by many as even more important. Out of this controversy grew the 'balanced' approach to land development and reservation that characterised the subsequent 15 years or so – particularly through the Land Conservation Council of Victoria; but also in national issues such as the Lower Gordon in Tasmania, Fraser Island in Queensland and Kakadu in the Northern Territory. The 'Little Desert Controversy' is important in itself. It is also important because of the accretion of historical perceptions and retrospective assessments of those exciting times.

This new account grew out of a postgraduate project, but the book's style is certainly not that of a dry academic thesis. It is decidedly readable. The book is divided into chapters based on the Little Desert issue itself and the various protagonists, and attempts to place the people and events in the wider social context. The book opens by presenting a simple history of the development of the region and the dispute, wisely avoiding an account of the natural history of the area. After all, many other references have covered these values and, for many of us, they are best 'discovered' directly and personally. Subsequent chapters deal with the campaign from the perspectives of the Victorian National Parks Association, 'ecologists', the locals in the Wimmera and the bureaucrats from Melbourne. The political perspective is not presented in depth, but I suspect that this is no intentional oversight by the author. Verbatim records of cabinet meetings and other political discussions are still not available. Politicians are renowned for responding to the questions they would like to have been asked, rather than the questions they were asked.

The book is obviously the result of meticulous research, all of which is thoroughly referenced. Robin has had access to many sources. At times this has led to notably different styles in the various chapters. The points of view of the main public conservationists are engagingly and personally presented. By contrast, the chapter dealing with the contributions from public servants is clearly based on voluminous records from public service archives and less so on personal interviews. Nevertheless, Robin astutely realised that such contributions, although less visible, were no less important, and perceptively presents this critical input. The aboriginal material is least satisfactorily treated, either from a current or an historical context. However, I suspect that this is a 'fact of life' for historians dealing with a non-literate culture and a dispersed and substantially dispossessed remnant.

We are offered some insights into the way the central characters approached their various roles in the unfolding drama. Personal aggrandisement seems to have driven no-one, except perhaps the politicians. Ego played only a small part and grandstanding was used to further a public cause, rather than personal profiles. Unlike more recent controversies, the 'conflict' was relatively respectful – at least in public. In some respects, times have changed. In other respects, very little has changed, as those with a longer perspective than the next election were painted as naive and out of touch with 'modern economic realities'.

After the specifics of the Little Desert Controversy have been presented and tied together as a coherent story, Robin attempts (a little less successfully) to put the implications of this history and its perceptions into a wider and current social context. There is a tendency to categorise and classify people and points of view, occasionally losing sight of the distinctiveness of individuals and their particular personalities. But as with all good historical accounts, by the final few sentences, readers will find themselves drawing further lessons and conclusions pertinent to current issues, beyond the Little Desert itself.

My most significant reservation about the book is its approach of seeing 'history' as an unfolding of events with a certain inevitability about them, given a particular social context. As Robert Ingpen has argued elsewhere (1980, *Turning Points in the Making of Australia*, Rigby: Melbourne), history is a weaving together of chance and contrivance, of planning and happenstance. As with other turning points, the 'Little Desert Controversy' is also a mixture of the inevitable with the purely fortuitous. Idiosyncrasies did matter and were important in the unfolding of events. Robin seems to have emphasised the social streaming of events and down-played the input of chance. Nevertheless, this reservation may be saying as much about the prejudices of this reviewer as it says about the book itself.

The book is very readable. It is an interesting and informative history of the development of environmental consciousness in Australia. It is an insight into people and social attitudes, not too far removed in time. It resonates with contemporary issues, such as alienation of the public estate for private profit and publicly-subsidised native forest destruction for wood chip export. Perhaps it is true that 'the only lesson of history is that we do not learn anything from history'. I hope not …

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From the Editor

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Cover: The Heath Mouse *Pseudomys shortridgei*, photographed at Pomonal in the Grampians by John Seebeck. See Research Report on p. 196.

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Is the Home Range of the Heath Mouse *Pseudomys shortridgei* an Anomaly in the *Pseudomys* Genus?

Edward P. Meulman[1] and Nicholas I. Klomp[1,2]

Abstract

The home ranges of Heath Mice in three different areas of the Grampians National Park, Victoria, were determined by radio-tracking and trapping. Eight individuals were radio-tracked over 11 days in February-March 1996, revealing a mean home range, using the Minimum Convex Polygon method, of 5.65 ha (se = 1.72 ha). This was significantly larger than the mean home range revealed by trapping on three grids of 91-100 folding aluminium traps during 1995-1997 (0.74 ± 0.47 ha, n = 57 animals). There were no significant differences between the mean home ranges of males and females, nor among the three different areas, despite differences in floristics and time since fire. The home ranges recorded in this study are significantly larger than those predicted from allometric equations based on the size of the Heath Mouse (70 g) of 0.07 0.18 ha. Although this anomaly has been recorded in other *Pseudomys* species, it is yet to be explained adequately. (*The Victorian Naturalist* **116** (6), 1999, 196-201.)

Introduction

The area used by an animal for its home range is likely to be the minimum necessary to provide the key resources required, with the actual shape of the home range being determined by the nature and distribution of these resources. Among adult mammals, a primary determinant of home range size is access to food (Hansson 1979; Hixon 1980). Therefore, it is not surprising to find that among different species of mammals there is a clear relationship between home range size and body weight (McNab 1963; Turner *et al.* 1969; Harestad and Bunnell 1979), and between home range and metabolic rate (Mace *et al.* 1983; McNab 1988). Given such relationships, one might predict that populations of the same species, living in habitats of differing productivity, would occupy ranges of correspondingly different sizes.

Studies of the home ranges of many animals are inherently difficult, particularly for the more cryptic and nocturnal small mammals. Before the development of miniature radio-tracking packages, most home range studies of small mammals were based on live-trapping and mark-recapture techniques (e.g. Broughton and Dickman 1991; Stoddart and Challis 1991). The data obtained from trapping grids can be used to provide an estimate of the home ranges of animals within the population if the trapping areas are greater than the home ranges of the animals, and if there are an adequate number of captures of individuals (Stoddart and Challis 1991). Eight to ten repeat captures are considered the minimum required to estimate home range size with reasonable accuracy (Hawes 1977, Montgomery 1979, Desy *et al.* 1989).

Still, there are often significant differences between the sizes of trap-revealed home ranges and estimates obtained using radio-tracking (Jones and Sherman 1983; Attuquayefio *et al.* 1986; Desy *et al.* 1989). Bubela *et al.* (1991) reported that trapping underestimated the home range of the Broad-toothed Rat *Mastacomys fuscus* by as much as 40-60%. Further, resources are not evenly distributed over the home range of an animal; rather, certain areas will be rich in resources while other areas are poor. Certain 'core areas' are likely to be used more frequently than other areas and would probably contain the nest site and dependable resources (Desy *et al.* 1989).

Despite these limitations, studies of home range afford a greater understanding of various aspects of a species' biology, such as food requirements, population density, territoriality and competition. Home range size might also reflect mating systems (Gaulin and Fitzgerald 1988). Several studies have recorded disproportionately large home ranges of some species of *Pseudomys*, perhaps reflecting an anomaly in this genus (e.g. Brandle and Moseby 1999). This paper investigates the home range size of the Heath Mouse *Pseudomys*

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shortridgei, as revealed by live-trapping and radio-tracking and considers whether the sizes recorded are an artefact of the methods used to determine home range, an anomaly of this group of mammals and/or a reflection of the biology of the *Pseudomys* species.

Methods

Study area

The Grampians National Park is located in central western Victoria approximately 270 km northwest of Melbourne. Three areas of heathland in the park (locations A, B and C; Fig. 1) were surveyed every 1-2 months over three years (1993-1996). One hundred individual trap sites in a 10 × 10 grid formation (sites 20 m apart) were established at locations A and B, while location C comprised 91 individual trap sites in a 13 × 7 grid configuration. Locations A and B had last been burnt in 1987, giving a seral stage of 7-8 years, while location C was last burnt in 1980 (15 years earlier).

Trapping procedures and data collection

A single folding aluminum Elliott trap was placed at each trap site and baited with a mixture of peanut butter, rolled oats and honey. Each trap was covered with a plastic bag and a liberal amount of clean cotton wool was placed in each trap to provide insulation for captured animals. During hot weather, traps were closed during the day and reset in the evening. Captured Heath Mice were weighed, examined for sex and reproductive condition, given an individual mark (ear-clipping) and released at the point of capture.

Only those animals that were caught ten or more times were used in the analysis of trap-revealed home range. For paired comparisons of home ranges of individuals in breeding and non-breeding seasons (October-February and March-September respectively), only those animals that had been caught five or more times in each season were used in the analyses.

Radio-tracking procedures and data collection

Five male and three female Heath Mice were each radio-tracked for 10-11 days during February-March 1996 at Locations A and B. Each Heath Mouse was fitted with a small radio transmitter attached around the neck (Fig. 2) just behind the mandible and secured using surgical tubing (Meulman and Klomp 1997). Each radio-collar weighed approximately 3.5 g, representing 5-6% of the body weight of the animals. After attachment of the collar, animals were placed in a holding cage (Meulman and Klomp 1996) for five minutes of observation prior to release. Radio-tracking of Heath Mice was conducted using two fixed towers and a null-peak system (after O'Connor *et al.* 1987). The direction of each transmitted signal was recorded simultaneously by each operator, but independently from each tower (after Swihart and Slade 1985), yielding a minimum of 14 and a maximum of 42 recorded locations for each individual Heath Mouse. The operators at each tower synchronized their hourly readings during the tracking period, although successive fixes of a given animal (i.e. successful triangulation) were often several hours apart. Previous studies have shown this species to be largely nocturnal, although data were collected over 24-hour periods on a number of occasions.

The accuracy of bearings taken from the two fixed towers and the accuracy of determined signal directions were validated using radio transmitters removed from

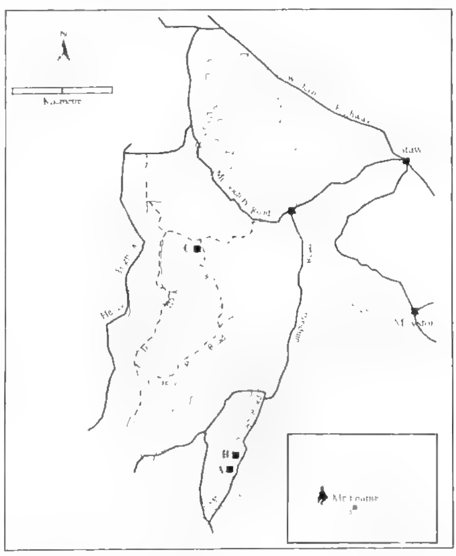

Fig. 1. The Grampians National Park showing trapping and radio-tracking locations (A, B and C) used in this study.

Fig. 2. Heath Mouse fitted with a small radio transmitter. The surgical tubing used to secure the transmitter is clearly visible. Photo by Reeto Zollinger.

individual Heath Mice and a surveyors theodolite (see Meulman and Klomp 1997).

Data analysis

Bearings taken from the two towers were converted to local co-ordinates using *Locate II*, a computer program, and an error ellipse was described around each group of co-ordinates for each Heath Mouse, allowing rejection of any reading having too large an error. Co-ordinates obtained from radio-tracking and trapping were analyzed using another computer program, *Calhome*, to estimate home range using the minimum convex polygon method (MCP). The MCP method determines home range from the convex polygon formed by joining the most peripheral points (fixes) with straight lines (Mohr 1947, Trevor-Deutsch and Hackett 1980). Core areas were defined as the area encapsulating 75% of all captures, and were calculated using the harmonic mean (75% isopleth) method. The 75% isopleth was chosen as the core area following Dixon and Chapman (1980), because estimates of home range expand rapidly when the outlying 25% of points are included. All data were checked for normality of distribution (Kolmogrov-Smirnov, all $Ps > 0.2$) and homogeneity of variances (Bartlett's test, all $Ps > 0.7$) prior to any parametric-tests being used to test the significance of any differences recorded among groups.

Results

Home range revealed by trapping

The mean size of trap-revealed home range of Heath Mice was 0.74 ± s.d. 0.47 ha ($n = 57$). A two-way ANOVA revealed no significant differences between the home range sizes of male and female Heath Mice ($F_{1,49} = 0.361$, $P = 0.550$), or among the home range sizes of Heath Mice occupying different locations ($F_{3,49} = 0.969$, $P = 0.415$), and no significant two-way interaction was found between location and sex ($F_{3,49} = 0.062$, $P = 0.980$).

A two-way ANOVA was used to examine differences between mean home range sizes observed in breeding and non-breeding seasons and different sexes. No significant difference was found between sexes ($F_{1,22} = 0.272$, $P = 0.607$), nor between seasons ($F_{1,22} = 0.011$, $P = 0.918$), and no significant two-way interaction was found between sex and season ($F_{1,22} = 0.026$, $P = 0.958$).

The mean trap-revealed core areas of male Heath Mice (0.31 ± s.d. 0.22 ha, $n = 31$) and those of female Heath Mice (0.27 ± s.d. 0.21 ha, $n = 26$) were not significantly different (Student's $t = 0.591$, d.f. = 55, $P = 0.556$). While MCPs overlapped for some individuals, the core areas of female Heath Mice did not overlap, but rather adjoined along common boundaries. The shape of core areas varied considerably among individual females, depending on the number of intensively used sites within the home range. The core areas of five males overlapped almost completely (90-100%) with female core areas. However, not all male core areas were associated with individual females, but overlapped the core areas of both females and other males.

Home range revealed by radio-tracking

Table 1 presents the home range sizes of the eight Heath Mice radio-tracked in this study. The mean home range size (MCP) determined from radio-tracking (5.65 ± s.d. 4.85 ha) was significantly larger than trap-revealed home range size (Student's $t = 2.897$, d.f. = 66, $P = 0.005$). The mean home range size of radio-tracked male Heath Mice (7.48 ± s.d. 5.18 ha) and that of female Heath Mice (2.60 ± s.d. 2.52 ha) did not differ significantly (Student's $t = 1.492$, d.f. = 6, $P = 0.186$).

Table 1. Home ranges and core areas (in ha) of the adult Heath Mice *Pseudomys shortridgei* radio-tracked in this study. Areas were estimated using the harmonic mean method (Dixon and Chapman 1980), and minimum convex polygon (MCP) (Mohr 1947). n = number of fixes per animal.

Sex	Weight (g)	n	Core area size	Home range size (harmonic mean)	Home range size (MCP)
F	62	19	0.005	0.26	0.37
F	68	37	0.590	3.99	5.34
F	63	20	0.290	5.90	2.09
M	64	32	0.327	4.01	5.67
M	60	41	0.328	3.09	4.95
M	65	35	0.433	8.32	11.60
M	68	42	0.827	2.84	13.94
M	70	14	0.018	0.68	1.23
Mean	**65.0**	**30.0**	**0.35**	**3.64**	**5.65**
se	**1.21**		**0.10**	**0.93**	**1.72**

Discussion

The mean weight-loss incurred by animals wearing radio-collars was 5.0 g (± 3.2 g), approximately 7% of body weight. No animals were injured as a result of the radio-collar attachment. The minimum convex polygon method was used for home range analyses in this study because it is the only technique that is strictly comparable between studies, and is more robust than other techniques when the number of locations is low (Harris *et al.* 1990). Many authors have reported sex-related differences in home ranges of rodents, with larger home ranges occupied by males, particularly during the breeding period (Mineau and Madison 1977; Wolton 1985; Attuquayefio *et al.* 1986). Gaulin and Fitzgerald (1988) suggested that home range size might be a predictor of mating systems. In rodent populations characterised by a promiscuous mating system, males have larger home ranges than females because of the intense male to male competition for mates. In contrast, monogamous rodent species would have home range areas that are similar for both sexes (Swihart and Slade 1989), with breeding pairs normally sharing a home range that they defend against same-sexed conspecifics (Kleiman 1977). Home ranges of Heath Mice examined in this study were found to be similar for both sexes. Although the sample size of radio-tracked animals is too small to be confident of this result, the total number of trapped animals from which trap-revealed home range sizes were calculated (n = 57) is comparatively large, and strongly supports this conclusion. This result is also consistent with Happold's (1976) suggestion that Heath Mice are largely monogamous, so would be expected to have similar home ranges.

Variations in the size of home ranges of mammals have been associated with social factors, such as access to females (Bubela and Happold 1993), metabolic requirements (Mace *et al.* 1983) and dispersion of resources (Montgomery *et al.* 1991). Comparative studies of mammals have repeatedly indicated that home range size correlates positively to body size (McNab 1963; Harestad and Bunnell 1979; Lindstedt *et al.* 1986; Reiss 1988; Swihart *et al.* 1988; du Toit 1990; Gompper and Gittleman 1992). A number of allometric equations have been developed to predict the size of an animal's home range based on its body mass. These are all modifications on McNab's (1963) original hypotheses, and all depend on the basic assumption that home range size varies as a function of metabolic requirements. Simply stated, larger mammals have larger home ranges because they need more energy resources. While density of food is considered an important factor, Harestad and Bunnell (1979) found that body-weight accounted for 75-90% of the variation in mammalian home ranges. Using a mean body weight of 70 g for Heath Mice (Cockburn 1979), the allometric model of Harestad and Bunnell (1979) relating home range to body mass of herbivorous mammals ($H = 2.71M^{1.02}$, where H is the home range in hectares and M is body mass in kg) predicts a home range of 0.180 ha for Heath Mice. The predicted home range based on the equation $H = 4.90M^{1.06}$ as proposed by Swihart *et al.* (1988) calculates a home range area of 0.07 ha.

These predicted home ranges are significantly smaller than the mean home range (MCP) of Heath Mice calculated from trapping data (0.74 ha) and from radio-tracking data (5.65 ha). The core home ranges of 0.27 ha for females and 0.31 ha for males determined in this study are still 1.5 times larger than those predicted by either equation. These calculations of core home range are based on trapping data, which underestimate actual home range area (Bubela and Happold 1993). Hence it is clear that the home range of the Heath Mouse does not fit either of the proposed allometric equations relating home range to body mass.

Other Pseudomys *species*

While there is only limited published information available on the home range of the *Pseudomys* species, the Heath Mouse appears not to be alone within the genus in having a disproportionately large home range. Anstee *et al.* (1997) reported that radio-tracking revealed a home range of up to 14.4 ha for the Pebble-mound Mouse *Pseudomys chapmani* (12-15 g), with core areas also being very large. Radio-tracking studies of the Shark Bay Mouse *Pseudomys fieldi* have revealed that this species also has a large home range of between 3-4 ha (Speldwinde *pers. comm.*). The New Holland Mouse *Pseudomys novaehollandiae* (20-25 g) was found to have a home range (MCP) of 0.84 ha for males and 0.51 ha for females (Lock 1995). Again, this is much larger than would be predicted from body size alone, despite this latter study using trapping to determine home range – a technique that usually underestimates the home range of small mammals (Bubela *et al.* 1991).

However, not all *Pseudomys* species have disproportionately large home ranges. Stoddart and Challis (1991) estimated the mean home range of the Long-tailed Mouse *Pseudomys higginsi* as 0.20-0.26 ha, using the inclusive boundary strip method. This method estimates home range in a similar way to the MCP method, but includes the addition of a peripheral boundary strip around the polygon, the width of which is equivalent to half the inter-trap distance (Trevor-Deutsch and Hackett 1980). Although the Long-tailed Mouse is of similar size and weight to the Heath Mouse, its estimated home range is closer to that predicted by the standard allometric equations. Given the different methods used, further investigation of the home range of the Long-tailed Mouse would be useful.

One explanation of the apparent variation in home range sizes used by different species of *Pseudomys* may be that the recorded differences are not species specific, but rather simply reflect habitat quality in a given area. For example, the home range of the Plains Rat *Pseudomys australis* appears to vary with habitat quality (Brandle and Moseby 1999). In areas containing high quality habitat, females occupied home range areas of around one hectare, while those of males were around 4-5 ha (Brandle *pers comm.*). In poor quality habitat, female home range areas were seen to increase to 8 ha. As this species weighs between 40-45 g, its home range is considerably larger than would be predicted by any of the allometric equations.

However, this study found no differences in size of home ranges of Heath Mice in different areas, despite variation in time since last fire and floristics between the study sites, which presumably reflected variation in habitat quality. Clearly, more detailed studies of the home range of *Pseudomys* species are required to determine the reasons for their apparently large home ranges, and how biotic and abiotic factors may influence and reflect home range.

Acknowledgements

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Germination and Sowing Depth of Wallaby Grass *Austrodanthonia eriantha*: Techniques to Maximise Restoration Efforts

C. O'Dwyer[1]

Abstract

Knowing the germination requirements of a particular population of plants is essential in the process of habitat restoration, so that germination and establishment in the field is maximised. This study investigated the temperature required for germination, the sowing depth for maximum emergence and the effects of treatments in overcoming dormancy in a population of Wallaby Grass *Austrodanthonia eriantha* from Mount Piper, Broadford, Victoria, the habitat of the endangered Golden Sun Moth *Synemon plana*. The temperature required for maximum germination was 15°C. Removing the palea and lemma from freshly-harvested seeds or storing seeds for two years at room temperature resulted in a twenty-fold increase in germination. Treatment with sulphuric acid (chemical scarification) increased germination from 4% to 56%, whilst soaking in potassium nitrate and stratification for 50 days or 100 days had no significant effect on germination. Burial at a depth of 20 mm or greater had a pronounced inhibitory effect on the emergence of seeds of *A. eriantha*. Therefore these results suggest that establishing *A. eriantha* at Mount Piper would best be achieved by sowing caryopsides in autumn when air temperatures average 15°C and water is not limiting. Caryopsides should be collected in December, stored for approximately 4 to 5 months and sown directly on the surface of the soil. Further field trials are required to test these suggestions. (*The Victorian Naturalist* **116** (6), 1999, 202-209.)

Introduction

Plants in the genus *Austrodanthonia* (family Poaceae), previously *Danthonia* (Linder 1997), are commonly known as Wallaby Grasses and are a common feature of open forests, woodlands and grasslands. Native grasslands are one of the most endangered vegetation types in Australia (Groves 1979; McDougall and Kirkpatrick 1994) and those that are dominated by *Austrodanthonia* spp. are becoming increasingly rare. These particular grassland types provide habitat for the endangered Golden Sun Moth *Synemon plana* (Figs 1 and 2). Once widespread throughout southeastern Australia, the Golden Sun Moth is now known from only four sites in Victoria, 12 sites in the Australian Capital Territory and 15 sites in New South Wales (Clarke and O'Dwyer 1997). The population of Golden Sun Moths found at Mount Piper, 80 km north of Melbourne, inhabits a native grassland dominated by Wallaby Grass *A. eriantha* Linder, H.P. (Lindl. in T. Mitch.) (O'Dwyer and Attiwill 1999).

Knowing the germination requirements of a particular plant population is essential in the process of habitat restoration, so that germination and establishment in the field is maximised. Previous work on the mechanisms of seed germination and the effects of environmental influences on germination to increase crop production has concentrated on economically important species for agriculture, forestry and horticulture (e.g. *Pisum sativum*, Eeuwens and Schwabe 1975; *Phaseolus vulgaris*, Van Onckelen *et al.* 1980; *Lupinus albus*, Davey and Van Staden 1979; *Hordeum vulgare*, Collins and Wilson 1975; *Acer saccharum*, Webb *et al.* 1973; *Pinus radiata*, Donald and Jacobs 1990; *Audouinia capitata*, de Lange and Boucher 1990; *Anigozanthos manglesii*, Sukhvibul and Considine 1994; see Appendix for common names). However, Australian native species are now receiving considerably more attention as conservation and restoration efforts are increasing (Morgan and Myers 1989; Myers and Morgan 1989; Sindel *et al.* 1993; Baxter *et al.* 1994).

There has been little work on the germination requirements of *Austrodanthonia* spp. (Toole 1939; Laude 1949; Lindauer 1972; Hagon 1976; Lodge and Whalley 1981; Lodge 1993; Lodge and Schipp 1993a, b). However, these investigations revealed that different *Austrodanthonia* spp., and different populations, differed in

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Fig. 1. Female Golden Sun Moth *Synemon plana*. Photo by E.D. Edwards, CSIRO.

Fig. 2. Male Golden Sun Moth *Synemon plana*. Photo by G. Clarke, CSIRO.

their germination requirements. For example, seeds of *A. caespitosa* (as *Danthonia caespitosa*) collected from areas in higher latitudes germinated at higher temperatures than those collected from lower latitudes (Hodgkinson and Quinn 1976). Trumble (cited in Cashmore 1932) found that *Austrodanthonia* (as *Danthonia*) seeds germinated at 18-20°C, whilst both Maze *et al.* (1993) and Lodge and Whalley (1981) found that *A. caespitosa* (as *Danthonia caespitosa*) germinated over a range of temperatures and concluded that *Austrodanthonia* was not significantly affected by temperature. This variability is also common in other grass species (Hagon 1976; Mott 1978; Sawhney and Naylor 1979; Groves *et al.* 1982). Temperature, moisture and seed dormancy affect the germination and establishment of native grasses (Hagon 1976).

No published information has been found on the germination requirements of *A. eriantha*. This study investigated the temperature required for maximum germination, the sowing depth for maximum emergence and the effects of treatments in overcoming dormancy in a population of *A. eriantha* from Mount Piper, Broadford, Victoria. The results will be used to attempt to maximise germination of *A. eriantha* in the field at Mount Piper.

Methods

Fully mature dispersal units (caryopsides; the seed together with the surrounding palea and lemma) of *Austrodanthonia eriantha* were collected from Mount Piper, Broadford in December 1995. Germination tests began soon after harvest. Air-dry, non-dormant caryopsides were collected from Mount Piper in 1993 and stored in paper bags in the dark for two years at 25°C. Prior to treatment, caryopsides were dusted with fungicide (Thirum).

Laboratory germination at constant temperatures

To examine the effects of temperature on germination, seeds were germinated in chambers at constant temperatures of 8°, 15°, 20°, 26°, and 32°C. The germination of caryopsides that were freshly harvested, dry-stored for 2 years, or cold-treated (method described below under Dormancy), were compared for each of the temperature regimes. Experiments ran for 30 days and under favourable conditions, all viable seeds germinated within 7 days of imbibition.

In each treatment, five replicates of 20 caryopsides were placed in 9 cm sterile petri dishes with 5 ml of distilled water, on top of two layers of Whatman filter paper, No. 41. Petri dishes were sealed using clinical test-ware tape. Light intensity of 300 lux was supplied by Philips warm-white fluorescent tubes, set for a 12 hour photoperiod. A seed was considered to have germinated when the radical reached 1 mm in length.

The viability of each seed lot was determined by dissection of all the un-germinated seeds at the completion of the germination test. Seeds were classified as viable if the embryo and endosperm were still firm and intact, or as dead if the seeds had turned pulpy and begun to decay. Germination was expressed as the percentage of viable seed.

Dormancy

Freshly-harvested caryopsides of *A. eriantha* were treated in a variety of ways in an attempt to break dormancy. The treatments were (a) cold stratification, (b) removal of palea and lemma, (c) dry storage, (d) soaking in potassium nitrate KNO_3, and (e) soaking in sulphuric acid H_2SO_4. For cold stratification caryopsides were placed in 9 cm petri dishes, with 5 ml of distilled water. The petri dishes were sealed with clinical test-ware tape and placed in a refrigerator at 5°C for 50 days and 100 days. For the KNO_3 treatment, caryopsides were soaked in 20 ml of 0.8% (w/v) of KNO_3 at room temperature for 24 hours and rinsed once with distilled water. Treatment with H_2SO_4 (chemical scarification) involved soaking caryopsides in 20 ml of 50% (v/v) of H_2SO_4 at room temperature for 25 minutes. Caryopsides were washed thoroughly for 10 minutes with distilled water.

Both untreated and treated caryopsides were placed in petri dishes and incubated in a controlled temperature incubator at 15°C, which was found in the first experiment to be optimal for the germination of *A. eriantha*. All other conditions were as described for the previous experiment. Only healthy, well-developed seeds were selected based on the results of viability developed in the preceding experiment.

Emergence from varying depths

Caryopsides of *A. eriantha* that had been kept in dry-storage for 2 years were sown at four depths (0 mm, 5 mm, 10 mm, 20 mm) in a commercial grade potting mix and in soil collected from the field site at Mount Piper. The soil was surface-sterilised and soaked with water for two days prior to sowing. Two wooden seedling boxes (500 × 500 × 70 mm) were filled, one with field soil and the other with the potting mix. To prevent compaction in the box, soil collected from Mount Piper was mixed with commercial mineral sand in a 1:1 ratio prior to sterilisation. There were four replicates of each treatment in each seedling box, with each treatment in a different row and column set out in a latin square design. Twenty-five caryopsides were sown, approximately 10 mm apart at each depth. A buffer-zone of 20 mm was left between each treatment. Caryopsides were placed on the surface of the soil (0 mm) or at depth using a ruler to create a furrow. Seeds were kept in a glasshouse at 23°C with natural lighting and watered when required. The experiment ran for 60 days. Only healthy, well-developed seeds were used in these trials.

Data analysis

All data sets were tested for normality and homogeneity of variance and were log transformed if required. A t-test was used to compare means. A two-factor repeated measure ANOVA was calculated on the transformed data, which was then back-transformed for data presentation.

Results

Temperature

The percentage germination (after 30 days) of viable dry stored seeds of *Austrodanthonia eriantha* (86%) was greatest at 15°C (Fig. 3). The decrease in germination of dry stored seeds at each temperature above and below 15°C was significant ($p < 0.05$). Seeds did not germinate at 32°C, for any treatment. Only a small percentage of fresh seed (17%) and cold stratified seed for 50 days (13%) germinated at 15°C. Viability was 50%.

Dormancy

Germination of *A. eriantha* increased twenty-fold after storage ($p < 0.05$; Fig. 4). Similarly removing the palea and lemma from freshly-harvested seeds also resulted in a twenty-fold increase in germination ($p < 0.05$; Fig. 4). Treatment with H_2SO_4 (chemical scarification) increased germination from 4% to 56% (Fig. 4). However, this was significantly less than increases due to air-dry storage or glume removal. Soaking in KNO_3 and stratification for 50 days or 100 days had no significant effect on germination relative to the control ($p > 0.05$; Fig. 4).

Emergence from varying depths

Seeds of *A. eriantha* germinated and emerged at all depths but there was a significant reduction in emergence when seeds were sown at 20 mm ($p < 0.05$; Fig. 5). There was no significant difference between the emergence of seeds sown at 0 mm, 5 mm, and 10 mm on either of the soils. Emergence was greatest when seeds were sown at 0 mm (38%).

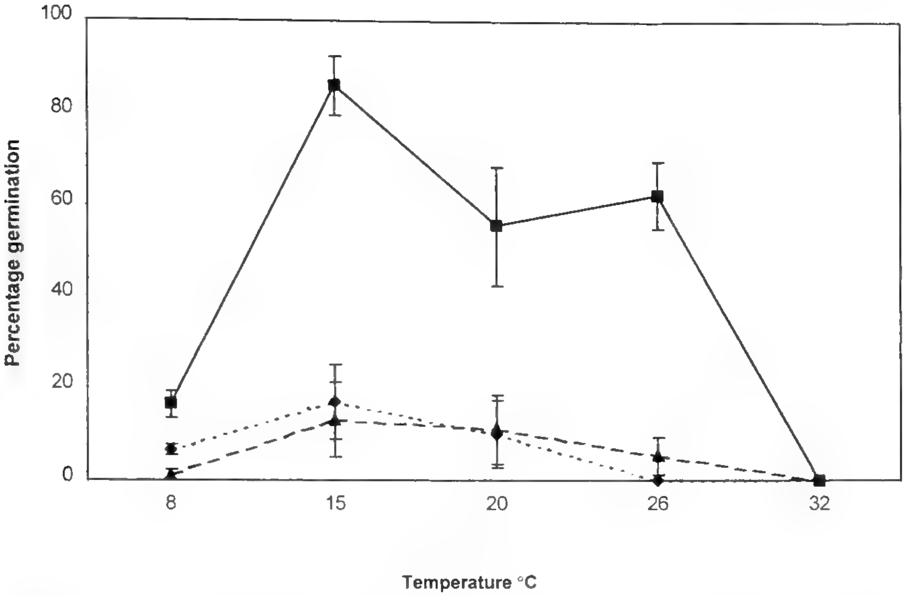

Fig. 3. Effect of temperature on germination of *Austrodanthonia eriantha*, immediately after dispersal (◆, dotted line), after air dry storage for two years (■, solid line), and after cold stratification of fresh seed for 50 days (▲, dashed line). Percentage germination was determined from 5 replicates of 20 dispersal units after 30 days. (Intermediate temperatures were not tested.) Error bars show the standard error of the mean.

Discussion

Maximum germination of *Austrodanthonia eriantha* was at 15°C (Fig. 3), and at Mount Piper this would be met in late autumn or early spring, when the air temperature averages 15°C. This supports the work by Lodge (1981) and Hagon (1976) who found that *Austrodanthonia* species and other cool-season grasses germinated from mid autumn to late winter. Lack of germination at 32°C (Fig. 3) suggests that high air temperatures in summer may restrict the germination of *A. eriantha*.

Inflorescences of *A. eriantha* are produced in December and most of the seeds are dormant at the time of dehiscence (seed release). Dormancy is overcome by a time lag (Fig. 4) after dehiscence, during which seeds after-ripen. The loss of dormancy with time has been attributed to an increase in biosynthesis of gibberellins in the caryopsis or a loss of inhibitors from the palea and lemma (Hagon 1976). In this study the exact nature of the physiological role of the lemma and palea in dormancy was not investigated. However, previous experiments have shown that these structures may contain inhibitors (Bradbeer 1988), may mechanically restrict the protrusion of the radicle (Ikuma and Thimann 1963), may reduce oxygen to the embryo (Roberts and Smith 1977), or may prevent the leaching of inhibitors, thus preventing germination (Webb and Wareing 1972).

The germination of dormant *A. eriantha* seeds increased after the removal of the palea and lemma (Fig. 4), ruling out the possibility that embryo dormancy has a major role in inhibiting germination, although embryo dormancy has been observed in other *Austrodanthonia* species. Lodge and Whalley (1981) showed that by removing the palea and lemma from *Austrodanthonia linkii* (as *Danthonia linkii*), germination did not increase and Laude (1949) found that hulling *A. california* (as *D. california*) only marginally increased germination. The lack of response to germination by chilling and soaking in KNO_3 (Fig. 4) also provides evidence for coat induced dormancy as both of these treatments involve conditions inside the embryo. Toole (1939) found that *A. spicata* (as *D. spicata*) germination

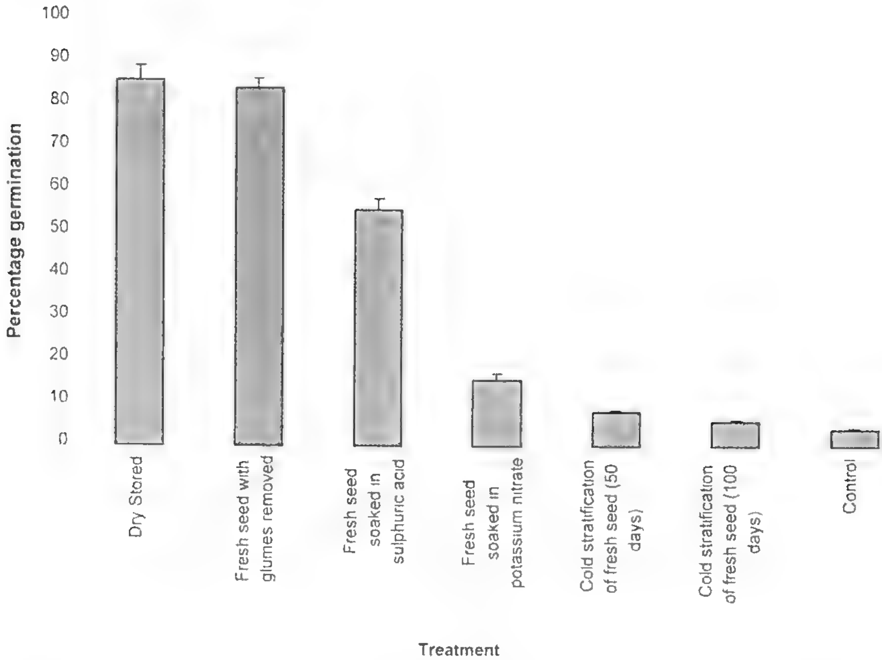

Fig. 4. Effects of different storage and dormancy breaking treatments on the germination of *Austrodanthonia eriantha* seeds. Percentage germination was determined from 5 replicates of 20 caryopsides after 15 days at 15°C. (Fresh seed was soaked in 50% H_2SO_4 and 0.8% KNO_3.) Error bars show the standard error of the mean.

increased after chilling at 3°C for 63 days, and also responded to the addition of 0.2% KNO_3. However, Toole (1939) concluded that dormancy was coat-induced as, at the time of publication, the effects of KNO_3 and cold stratification were unknown. It can be concluded that the dormancy of *A. eriantha* from Mount Piper is coat-induced, imposed by the palea and lemma.

Chemical scarification did not result in complete germination (Fig. 4) and this may be due to the incomplete digestion of the palea and lemma; i.e. remnants may have had an inhibitory effect. Morgan and Myers (1989) found that germination of dormant *Diplachne fusca* seeds decreased when treated with a solution derived from macerated lemmas. It is likely that the lemma and palea of *A. eriantha* contain an inhibitor, as chemical scarification would enable gas to be exchanged between the embryo and the external environment, and the radicle to protrude resulting in complete germination.

As previously mentioned the degree of dormancy varies between populations, but it also varies within populations. Laude (1949) found non-dormant seeds of *A. california* (as *Danthonia californía*) germinated over a 16-week period illustrating the variability within the population. This was also shown in *A. sericea* (as *D. sericea*; Lindauer 1972). In the present study, the germination of *A. eriantha* was also variable. Some seeds (17%) germinated immediately after dehiscence, indicating that these seeds were non-dormant whilst the majority required an after-ripening period. A small percentage (14 and 16%) of both dry-stored seeds and those with palea and lemmas removed did not germinate. Dormancy in these seeds, which were probably still viable, may be embryo-induced. This variability in dormancy would spread the risk of establishment and ensure that some seeds from the same population persist for several seasons (Lodge and Whalley 1981).

Removing the palea and lemma may not be economically feasible on a large scale and may actually hinder germination in the field. Awns and glumes protect the seed in

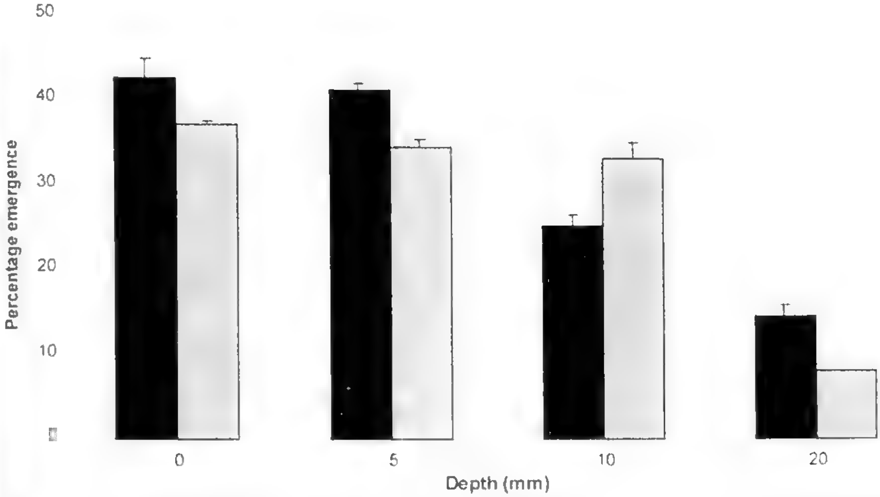

Fig. 5. Effects of different sowing depths on seedling emergence of viable seeds of *Austrodanthonia eriantha*, in a commercial potting mix (solid bars), and in soil collected from Mount Piper, Broadford (shaded bars) Caryopsides were germinated under glasshouse conditions. Percentage emergence was determined from 4 replicates of 25 caryopsides after 30 days. Error bars show the standard error of the mean.

the field, orientate the seed for maximum seed/soil contact and enable the seed to lodge in the most favourable microsite (Peart 1979; Peart 1981; Sindel *et al.* 1993).

Burial at depth of 20 mm or greater has a pronounced inhibitory effect on the establishment of seeds of *A. eriantha* (Fig. 5). The germination of buried seeds may be dependent upon the exposure to light (Wesson and Wareing 1969). At depths greater than 2 mm insufficient light penetrates the soil to induce germination of some seeds (Woolley and Stoller 1978). Since some seeds of *A. eriantha* germinated at depths of 20 mm, it can be concluded that light is not required for germination of all seeds. Work on other *Austrodanthonia* species found that germination of non-dormant units was not restricted by light (Hagon 1976; Maze *et al.* 1993). Wesson and Wareing (1969) showed that by aerating the soil, inhibiting gases are removed allowing germination to proceed. As a light effect is not involved, soil aeration may be an active factor in preventing germination. The present study showed that there was no difference in the emergence of *A. eriantha* in a well-aerated potting mix compared with that of the field soil ($p > 0.05$; Fig. 5) and therefore soil compaction was not involved. It is more likely that the food reserves in the seed are depleted before the seedlings reach the surface and establish.

Further field trials are required, nonetheless these results suggest that establishing *Austrodanthonia eriantha* in the field would best be achieved by sowing caryopsides in autumn, when air temperatures average 15°C and water is not limiting. Caryopsides should be collected in December, stored for approximately 4 to 5 months and sown directly on the surface. The presence of inhibitors in the palea and lemma limits germination immediately after seed fall even though temperature and moisture may be suitable for germination. This prevents the loss of seedlings due to high summer temperatures. A few months after seed fall, the concentration of inhibitors in the palea and lemma, enforcing dormancy would decrease as a result of after-ripening. By this time temperature at Mount Piper would be suitable for the germination of *A. eriantha* (15°C) and seedlings would be expected to establish in the cool autumn conditions and continue growing through winter and spring.

Acknowledgements

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Glossary

awn – a fine bristle-like appendage, especially occurring on the glumes of grasses.
caryopsides (caryposis) – a dry, indehiscent, one-seeded fruit in which the seed coat is closely fused to the fruit wall, e.g. in most grasses.
dehiscence – to open spontaneously along certain lines or in a definite direction when ripe, as seed capsules.
gibberellins – plant growth substances; can have spectacular effects upon stem elongation in certain plants; can break dormancy in some seeds.
glume – the chaffy lower-most organs of a spikelet, which forms the inflorescence of grasses and similar plants.
inhibitors – a restraining or preventing factor.
lemma – the lower of two bracts enclosing an individual grass flower.
palea – the upper of two bracts enclosing an individual grass flower.
radicle – the part of an embryo giving rise to the shoot system of a plant.

Appendix.

Common names of plants mentioned in the text.

Acer saccharum	Maple
Anigozanthos manglesii	Kangaroo Paw
Audouinia capitata	False Heath
Hordeum vulgare	Barley
Lupinus allus	Lupin
Phaseolus vulgaris	Bean
Pinus radiata	Monterey Pine
Pisum sativum	Pea

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Barbed Wire Fencing as a Hazard for Wildlife

Rodney van der Ree[1]

Abstract
Anecdotal reports from landholders and biologists suggest that the entanglement and subsequent death of animals on barbed wire fences is widespread in Australia. In this report, I collate records of at least 62 species of wildlife that have become entangled on barbed wire fences in Australia. This paper is divided into two components; the first focuses on an area near Euroa in northern Victoria as a case study, and the second lists records from throughout Australia. In the Euroa study area, the species most commonly encountered on fences were gliding marsupials (Sugar Glider *Petaurus breviceps* and Squirrel Glider *P. norfolcensis*) (26 individuals), followed by birds (7 individuals). On a continental scale, species found entangled in barbed wire include gliding marsupials, flying-foxes, aquatic birds, night birds and birds of prey. Records were collected from a wide range of habitats and localities, including the urban-rural fringe, forests and woodlands, agricultural landscapes, semi-arid areas and around water bodies. All individuals were found entangled with barbed wire, and more than 95% of entanglements occurred on standard height farm fencing. Recommendations for alternatives to barbed wire fencing are discussed. (*The Victorian Naturalist* **116** (6), 1999, 210-217.)

Introduction

During a study of the ecology of arboreal marsupials in a network of roadside and streamside vegetation near Euroa, Victoria, a number of Squirrel Glider *Petaurus norfolcensis* and Sugar Glider *P. breviceps* carcasses were discovered suspended from barbed wire fences (Fig. 1). There have been several incidental observations of such deaths for a range of species in Australia and overseas (Russell 1980; Allen and Ramirez 1990; Andrews 1990; Krake 1991; Nero 1993; Land for Wildlife 1994; Platt and Temby 1994; Johnson 1995; Anonymous 1996; Tischendorf and Johnson 1997; van der Ree 1997; Campbell 1998; Johnson and Thiriet 1998) but the extent of this problem is still relatively unknown. The aim of this study was to quantify the extent of the situation by collecting records from a range of sources and describing the actual event (e.g. species, fence type, which strand of wire, location).

Study area and methods

Case study – Euroa, Victoria

The study area lies within the northern plains of Victoria and is bounded by the towns of Euroa, Violet Town, Nagambie, Avenal and Murchison. Formerly dominated by open eucalypt woodland, there is now 3.6% remnant vegetation cover, approximately 85% of which occurs as linear strips along roads and streams (van der Ree, *unpubl. data*). The remaining 15% is made up of small patches of woodland. The major land use is agriculture, with extensive dryland cropping and grazing (Bennett *et al.* 1998).

Observations of animals caught on barbed wire fences were made opportunis-

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Fig. 1. Dead Squirrel Glider *Petaurus norfolcensis* caught in a barbed wire fence. Photo by R. van der Ree.

Table 1. Observations of wildlife entangled with barbed-wire fencing from the Euroa case study area. Species listed in taxonomic order according to Christidis and Boles (1994) (birds) and Menkhorst (1995) (mammals).

Species	Scientific name	Number of individuals	Fence type	Wire type
Mammals				
Squirrel Glider	*Petaurus norfolcensis*	15	f	b
Sugar or Squirrel Glider	*Petaurus* sp.	11	f	b
Birds				
Spoonbill	*Platalea* sp.	1	f	b
Rock Dove	*Columba livia*	1	f	b
Galah	*Eolophus roseicapilla*	1	f	b
Southern Boobook	*Ninox novaeseelandiae*	1	f	b
Australian Magpie	*Gymnorhina tibicen*	2	f	b
White-winged Chough	*Corcorax melanorhamphos*	1	f	b

Fence type: f = standard height farm fence. Wire type: b = barbed wire.

tically while undertaking fieldwork on the ecology of arboreal marsupials. Additional records were obtained from local landholders. There was no systematic searching to detect entangled animals, and consequently the results of this study are likely to underestimate the severity of the problem.

Whenever possible, the following parameters were obtained for each entanglement:

- date found;
- approximate time since death or entanglement;
- species, sex and approximate age (the approximate age of *Petaurus* species was determined using the level of upper incisor wear (refer Suckling 1984; Quin 1995);
- location (latitude and longitude), and description of site;
- the point of entanglement on the animal's body (e.g. wing, neck, tail, gliding membrane);
- the fence characteristics (fence type, barbed or plain wire strand, strand position in the fence).

Australia-wide Perspective

This section is a preliminary report of records from a wide range of people across Australia and is intended to highlight the issue and present initial findings. I collated the same information as that collected for the Euroa study area, from sources including Field Naturalist groups, Landcare groups, landholders and biologists, between 1996 and the present. I also requested records from members of the Ecological Society of Australia, Australasian Wildlife Management Society, Field Naturalist Club of Victoria, and Birds Australia via their electronic mail discussion lists and newsletters. The wildlife atlas data-bases from Victoria and New South Wales were investigated, as was the Wildlife Information and Rescue Service (WIRES) data-base.

Results

Euroa study area

Number and type of species entangled

A total of 33 animals was recorded entangled on barbed wire between 1994 and 1998 in the Euroa study area (Table 1). Fifteen were positively identified as Squirrel Gliders and 11 gliders could not be reliably identified to species and are referred to as *Petaurus* sp. (this group includes only Sugar Gliders and Squirrel Gliders). Other species entangled with barbed wire fencing included the Australian Magpie *Gymnorhina tibicen* (2 individuals) (Fig. 2), and a single Rock

Fig. 2. Ausralian Magpie *Gymnorhina tibicen* caught on barbed wire fence. Photo by R. van der Ree.

Table 2. Point of entanglement of gliders found on barbed wire fences in the Euroa study area, 1994-1998. No. = number of gliders found.

Point of entanglement	No.
Tail only	11
Tail and gliding membrane	4
Gliding membrane and leg	2
Unable to tell (decomposed too far)	3
Not recorded	6
Total found	**26**

Dove (Feral Pigeon) *Columba livia*, Spoonbill *Platalea* species, Southern Boobook *Ninox novaeseelandiae*, White-winged Chough *Corcorax melanorhamphos* and Galah *Eolophus roseicapilla*.

Fence characteristics

All individuals were entangled with barbed wire on standard farm fences approximately one metre high. The apparent point of entanglement of the animal was with the barb on the wire. Where entanglement position was recorded (n=17), 12 entanglements occurred on the top strand of the fence, one occurred on the second strand from the top, and four occurred on the third strand from the top. Once caught on the barbed wire, it appeared that many gliders and birds became further entangled as they struggled to free themselves. On one occasion, the strand of wire was cut and the glider taken, with the wire *in-situ*, to a wildlife shelter for removal and rehabilitation. In the Euroa study area, all 33 records occurred where fences were positioned between cleared paddocks and vegetated roadsides.

Carcass characteristics

The advanced decomposition of many carcasses limited observations on the sex and age of the animals. Four female and one male Squirrel Glider were identified; the sex of 21 gliders and seven birds was not determined. Using the degree of tooth wear on the upper incisors of the gliders as an index of age, four individuals were identified as juvenile and four as adults. Age was not determined for the remaining 18 gliders or seven birds.

For gliders, the most common point of entanglement was the tail (11 records) (Table 2), followed by a combination of the tail and gliding membrane (four records) and the gliding membrane and leg (two records). Three gliders were too decomposed to determine the point of entanglement, and point of entanglement was not recorded for six individuals. Only two gliders were found alive and released, and these were entangled by the tail only. One magpie was entangled by a combination of wing and neck, and the feral pigeon was caught by its leg ring; the point of entanglement was not recorded for the remaining birds.

Australia-wide perspective

Number and type of species entangled

Sixty-two species of wildlife have been observed entangled with barbed wire fencing across Australia (Table 3). The types of species include gliding marsupials, bats, ground-dwelling birds, water birds, night birds and birds of prey. The most numerous group reported entangled with barbed wire fencing were flying foxes from northern Australia. The Little Red Flying-fox *Pteropus scapulatus* appears particularly susceptible to entanglement in north Queensland, with a published report of over 450 individuals entangled in one year (Johnson 1995), and another respondent reported 200 individuals on one fence at the same time (Jon Luly, *pers. comm.*). Many respondents reported observing numerous macropods (Black Wallaby *Wallabia bicolor*, Eastern Grey Kangaroo *Macropus giganteus*, Western Grey Kangaroo *M. fuliginosus*, and Red Kangaroo *M. rufus*) and Emus *Dromaius novaehollandieae* with their legs entangled in the top two strands of fences but could not give detailed information about specific incidents because of the regularity with which they were observed. This problem is not specifically related to barbed wire, as plain wire also entraps kangaroos and Emus by their legs as they attempt to jump the fence, and hence these records have not been included in Table 3.

Mesh fencing may pose a barrier to those species that are too large to pass through the mesh and unable to jump or climb over the fence. Certain species of reptile appear to be particularly susceptible because their rear facing scales and body shape allows them to place their heads through the tightly fitting mesh – but does not allow the rest

Table 3. Observations of wildlife entangled with barbed-wire fencing from across Australia (excluding the Euroa case study records) as reported by volunteer observers. Species listed in taxonomic order according to Christidis and Boles (1994) (birds) and Menkhorst (1995) and Strahan (1983) (mammals).

Species	Scientific name	State (Number of individuals)	Fence type	Wire type
Mammals				
Koala	*Phascolarctos cinerus*	NSW (2), QLD (4)	f	b, m
Greater Glider	*Petauroides volans*	Vic (2), NSW (6), Qld (4)	f	b
Yellow-bellied Glider	*Petaurus australis*	Vic (3), NSW (3), Qld (8)	f	b
Sugar Glider	*Petaurus breviceps*	Vic (25) NSW (9), Qld (44)	f, c	b
Squirrel Glider	*Petaurus norfolcensis*	Vic (24), NSW (12), Qld (5)	f	b
Sugar or Squirrel Glider	*Petaurus sp.*	Vic (12) NSW (1)	f	b
Mahogany Glider	*Petaurus gracilis*	Qld (5)	f	b
Brush-tailed Bettong	*Bettongia penicillata*	Qld (1)	f	b
Tasmanian Pademelon	*Thylogale billardierri*	Tas (1)	f	b
Grey-headed Flying-fox	*Pteropus poliocephalus*	Qld (4), NSW (3)	f, c	b
Little Red Flying-fox	*Pteropus scapulatus*	Qld (666^), NSW (5), NT (6), WA (1)	f, c	b
Black Flying-fox	*Pteropus alecto*	Qld (23), NSW (81), NT (20)	f, c	b
Spectacled Flying-fox	*Pteropus conspicullatus*	Qld (25)	f, c	b
Flying-fox	*Pteropus* sp.	NSW (4), Qld (2), NT (75)	f, c	b
Queensland Tube-nosed Bat	*Nyctimene robinsoni*	Qld (41)	f, c	b
Ghost Bat	*Macroderma gigas*	NT (1)	f	b
White-striped Freetail Bat	*Tadarida australis*	Vic (1)	f	b
Long-eared Bat	*Nyctiphilus* sp.	NSW (1)	f	b
Microchiropteran Bat	species unknown	NSW (1), Qld (2)	f	b
Grassland Melomys	*Melomys burtoni*	NSW (1)	f	b
Red Fox	*Vulpes vulpes*	Vic (1)	f	b
Birds				
Southern Cassowary	*Casuarius casuarius*	Qld (1)	f	b
King Quail	*Coturnix chinensis*	NSW (2)	f	b
Australian Wood Duck	*Chenonetta jubata*	Qld (1)	f	b
Pacific Black Duck	*Anas superciliosa*	NSW (3), Qld (1)	f	b
Hoary-headed Grebe	*Poliocephalus poliocephalus*	Vic (1)	f	b
Short-tailed Shearwater	*Puffinus tenuirostris*	Vic (<5)	f	b
Australian Pelican	*Pelecanus conspicillatus*	Vic (1)	f	b
White-faced Heron	*Egretta novaehollandiae*	Vic (1), NSW (3)	f	b
White-necked (Pacific) Heron	*Ardea pacifica*	Vic (1)	f	b
Nankeen Night Heron	*Nycticorax caledonicus*	NSW (1)	f	b
Royal Spoonbill	*Platalea regia*	Qld (2)	f	b
Wedge-tailed Eagle	*Aquila audax*	Vic (1)	f	b
Brown Falcon	*Falco berigora*	NSW (1)	f	b
Australian Hobby	*Falco longipennis*	NSW (1), Vic (1)	f	b
Peregrine Falcon	*Falco peregrinus*	Vic (1)	f	b
Sarus Crane	*Girus antigone*	Qld (1)	f	b
Buff-banded Rail	*Gallirallus philippensis*	Qld (4)	f	b
Little Button-quail	*Turnix velox*	NSW (2)	f	b
Red-chested Button-quail	*Turnix pyrrhothorax*	NSW (1)	f	b
Lathams Snipe	*Gallinago hardwickii*	NSW (1)	f	b
Bush Stone-curlew	*Burhinus grallarius*	Qld (2)	f	b
Black-fronted Dotterel	*Charadrius melanops*	Vic (1)	f	b
Masked Lapwing	*Vanellus miles*	Vic (1), Qld (1)	f	b
Silver Gull	*Larus novaehollandiae*	Vic (<5)	f	b
Little Corella	*Cacatua sanguinea*	Qld (1)	f	b
Sulphur-crested Cockatoo	*Cacatua galerita*	Qld (1)	f	b
Red-rumped Parrot	*Psephotus haematonotus*	Vic (1)	f	b
Southern Boobook	*Ninox novaeseelandiae*	NSW (1), Qld (1), Vic (3)	f	b
Masked Owl	*Tyto novaehollandiae*	NSW (2)	f	b
Barn Owl	*Tyto alba*	NSW (2), Qld (1), Vic (3)	f	b
Grass Owl	*Tyto capensis*	Qld (1), SA (1)	f	b
Tawny Frogmouth	*Podargus strigoides*	Qld (2), SA (2), Vic (4)	f	b
Australian Owlet-nightjar	*Aegotheles cristatus*	Vic (1)	f	b

Table 3 continued.

Species	Scientific name	State (Number of individuals)	Fence type	Wire type
Laughing Kookaburra	*Dacelo novaeguineae*	NSW (2), Vic (1)	f	b
Dollarbird	*Eurystomus orientalis*	Qld (1)	f	b
Eastern Spinebill	*Acanthorhynchus tenuirostris*	NSW (1)	f	b
Magpie-lark	*Grallina cyanoleuca*	Vic (1)	f	b
Willie Wagtail	*Rhipidura leucophrys*	Qld (1)	f	b
Australian Magpie	*Gymnorhina tibicen*	ACT (1), Qld (2), SA (2), Vic (1)	f, c, na	b
Silvereye	*Zosterops lateralis*	Vic (1)	f	b
Common Starling	*Sturnus vulgaris*	Vic (1)	f	b

^ = Includes records of 200 individuals (Jon Luly *pers. comm.*) and 450 individuals from Ravenshoe district, north Queensland Fence type: f = standard height farm fence, c = 6 to 8 foot cyclone wire mesh fence, na = not assessed Wire type: b = barbed wire, m = mesh.

of their bodies to pass through or retreat. Goats were reported to become entangled with mesh fencing as their horns prevent them from removing their heads from the wire mesh once pushed through. Electrified strands of wire too close to the ground may electrocute Short-beaked Echidnas *Tachyglossus aculeatus* if they attempt to push underneath the wire. Fatal collisions by various bird species with mesh fencing was frequently recorded.

Wildlife also became entangled with wire in non-fence situations; a Kookaburra *Dacelo novaeguineae* was found impaled on a protruding wire on a tree-guard, five White-throated Needletails *Hirundapus Caudacutus* and Black Swans *Cygnus atratus* were observed dead on overhead powerlines and a small insectivorous bat was impaled by a piece of wire on the top of a shed.

Records of fauna entangled with barbed wire were received from across the Australian continent. Wildlife were entangled with barbed wire fences in a wide range of habitats, including arid and semi-arid rangelands, temperate woodlands, forests, rainforest, wetlands, urban areas and the rural-urban interface.

Discussion

A localised and widespread problem

The most commonly encountered species entangled with barbed wire in the Euroa area was the Squirrel Glider. In parts of the study area, roadside vegetation supports high densities of the Squirrel Glider and other arboreal marsupials (van der Ree, *unpubl. data*). The total number of Squirrel Gliders that became entangled with barbed wire is probably much greater than that reported here because many carcasses could not be reliably identified. Moreover, this report only includes those individuals that have been found and reported. In Victoria, the Squirrel Glider is present in only a few large reserves (e.g. Chiltern National Park, Killawarra State Park) and is largely restricted to small patches of woodland habitat or linear reserves along roads and streams. This species has undergone a significant decline in abundance and in Victoria is classified as vulnerable to extinction (CNR 1995). The additional threat of mortality from barbed wire fences for small and isolated populations may be detrimental to their long-term persistence.

The records collated from across Australia indicate that the problem is widespread. Records were collected from all states of Australia, with most originating from the eastern mainland states. The absence of records from many areas may be due to a paucity of observers and entanglements going unreported rather than an absence of entanglements. As many entanglements undoubtedly go unobserved and unreported, the results of this study must be considered an underestimation. To realise the full extent of the problem, observations of entanglements need to be reported and systematically collated. Of the data-bases interrogated, only the New South Wales Wildlife Atlas was able to easily retrieve records of wildlife entangled with fences. It would be useful for other data-bases to include a specific code for records that originate from such entanglement so that in future the extent of the situation can be accurately described.

Wildlife behavior

In the Euroa area, 85% of remnant vegetation occurs along roads and streams, and the remaining 15% as small patches. The practice of fencing on both sides of roads, streams and around patches places wildlife at risk of encountering a fence. The movement patterns and behaviour of Squirrel Gliders (as revealed by radiotelemetry) in the Euroa area (van der Ree, *unpubl. data*) may increase the risk of becoming entangled with barbed wire fences. Squirrel Gliders, and probably other gliders, risk entanglement with barbed wire fencing when gliding to and from woodland vegetation in paddocks and along roads and streams. Gliders also glide diagonally across corners at 90° intersections to minimise travel distance and energy demands. These behaviours require the glider to regularly cross fencelines. The potential for entanglement also increases as gliding distance increases; the longer the glide, the lower the animal will land on its target tree and the closer it is to the height of the barbed wire fence.

The placement of barbed wire fences in activity paths of other species may also increase the rate of entanglement. In north Queensland, barbed wire fences in fruit bat flight paths regularly cause the entanglement and mortality of at least five species of fruit bat. Removal of bats from barbed wire fences may place humans at risk of infection with bat viruses, and extreme care should be taken when removing these animals[1]. New fencing erected in existing wildlife travel paths can cause the entanglement and death of many individuals. Many respondents reported that kangaroos appear to be highly susceptible to entanglement in new fencing, and that consideration to wildlife movements when designing fences can minimise the problem.

There were insufficient data to determine whether mortality by collision and entanglement with barbed wire is specific to age or sex in any group of species.

[1] Guidelines on how to handle bats are given at the following web address: http://www.bushnet.qld.edu.au/~melissa/ffnff/

Management implications

Habitat restoration and revegetation is a goal of many government agencies, conservation groups and landholders. Fencing is essential to control stock access in order to protect native vegetation and allow for natural regeneration of palatable species. Wildlife populations in many rural areas have already undergone considerable declines, and often exist in small isolated patches of habitat. The loss of individuals by entanglement with fencing is an avoidable and unnecessary additional threat. All fencing that utilises barbed wire to conserve or protect vegetation may conceivably place the fauna using that habitat at risk of local extinction.

High risk areas

It appears from these results that areas of potentially high risk can be identified:

- Highly fragmented areas where animals must regularly cross barbed wire fences to reach different parts of their habitat. This is particularly apparent in the Euroa study area and is probably true for many agricultural areas.
- Regular flight paths for bats and birds, and movement paths for mammals that may include areas of fragmented and continuous habitat.
- Areas with high density populations of species vulnerable to entanglement such as marsupial gliders in the Euroa case study and fruit bats in north Queensland.
- Wetland areas where barbed wire is exposed above the water level.

Fencing alternatives

For an alternative fencing style to be adopted, it must be of equal or greater benefit for stock management. Depending on the farming enterprise, a number of alternatives to barbed wire are available:

- Plain high-tensile fencing wire, if tensioned correctly, can contain most stock. When a fence is being constructed with new materials, consider using multiple strands of high tensile plain wire or plain wire and ringlock mesh (but beware using fine mesh which may also entrap animals or act as a barrier to movement).
- If additional security is required, investigate the option of electric fencing instead of barbed wire. However, beware of the potential risk of electrocution of wildlife.

- If using existing fenceposts, consider removing the existing strands of barbed wire and replacing them with plain wire. In addition, consider adding an electrified strand to the fence for increased security.
- If a plain wire or ringlock mesh option does not offer sufficient security, an electrified strand is not feasible, and the use of barbed wire can not be avoided, then consider avoiding barbed wire on the top two or three strands of the fence – this will reduce, but not eliminate the risk. In high-risk areas, use plain wire or sheath the barbed wire inside poly-pipe to protect animals from the barbs.
- Design the fence to avoid right angles where marsupial gliders may cross diagonally across the corner (Fig. 3), such as at the intersection of two road reserves. This would benefit other wildlife by creating extra habitat as well as reducing fencing costs.

Future investigation should consider:

- Documenting the extent of the problem more fully by government agencies and wildlife rehabilitation organisations through wildlife databases by specifically including 'entanglement with barbed wire' as the cause of death.
- Investigating alternative fence designs that contain stock, are cost-effective to erect and maintain, and do not pose a threat to wildlife.
- Education programs to ensure land managers are aware of the potential risk to wildlife and are able to identify high risk areas or 'hot spots'.

Government agencies and other bodies providing funds for fencing and revegetation projects should consider these findings and encourage the use of non-barbed wire alternatives as a condition for receiving funding. This will reduce the amount of barbed wire fencing being erected, and as old fences are gradually replaced with non-barbed wire alternatives, the loss of fauna to barbed wire fencing will be greatly reduced.

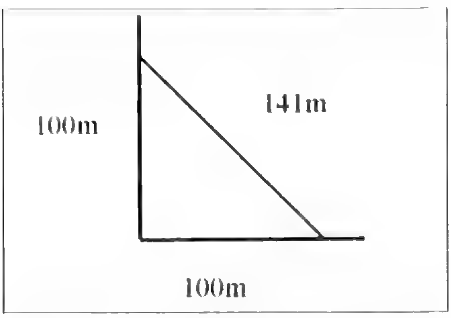

Fig. 3. Fencing diagonally at a 90° corner reduces the amount of fencing materials required, provides additional habitat for wildlife, and potentially minimises the risk of entanglement by wildlife.

Acknowledgements

This is a contribution from the Landscape Ecology Research Group, Deakin University. The financial support of the Holsworth Wildlife Research Fund is gratefully acknowledged. I thank the 120 plus people who provided me with their observations on wildlife mortality associated with fencing and for discussions about fencing requirements. Thanks also to the landholders and residents of the Euroa district who initially alerted me to the problem and gave generously of their time and local knowledge. I thank Andrew Bennett, Jenny Wilson and Sally Kimber and an anonymous reviewer for comments on the manuscript.

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One Hundred Years Ago

THE BLACKFISH Some interesting notes on the habits of the Blackfish, *Gadopsis gracilis*, McCoy, appear in the *Australasian* of 25th November, which, though written from an angling point of view, are worthy of attention, and possibly criticism, especially by country naturalists. Blackfish can almost be claimed as purely Victorian fish, and even here are nearly confined to the southern streams. The only other habitat of the genus is Northern Tasmania. Professor McCoy recognizes three species, and remarks, in "The Prodromus of Victorian Zoology", vol. i., p.39, that the colour is very variable.

Large Blackfish are undoubtedly scarce, owing to the many enemies they now have to encounter, and are only to be found in the upper reaches of the streams in the most unfrequented portions of the colony. In the early days of Melbourne fish of 6 lbs. to 8 lbs. in weight were of common occurrence, but one hears of such fish but seldom now. One was taken in the Cockatoo Creek, near Seville, in January last, which weighed 7¼ lbs., and it is on record that some twenty years ago a fish was caught in the Ringarooma River, Tasmania, which turned the scale at 13 lbs. 4 oz. In seeking for Blackfish the size of the stream does not seem to matter; in fact, fine fish are often obtained in the smallest streams. They are very shy fish in daylight, seeking the shelter of sunken logs, stones, &c., and though with great care they may be caught in the daytime, especially if the water be discoloured by rain, the best time to secure them is in the brief period between sunset and darkness. They can sometimes be taken all night, but another good time is at just before or at daybreak. The writer, though in favour of protection for the Blackfish, states that the present close season, from 31st August to 15th December, is of no practical use, as in the first place it is rarely observed, and secondly his experience leads him to believe that Blackfish spawn nearly all the year round, as he has taken the fish containing spawn in January, February, March, and April. He suggest that instead of a close season a minimum weight of half a pound should be adopted, and so give the small fish a chance to grow and provide sport worthy of the fisherman.

From *The Victorian Naturalist* **XVI**, p. 130-131, December 1899.

New Assistant Editor

I am pleased to welcome Alistair Evans as Assistant Editor for *The Victorian Naturalist*. Alistair has worked on the journal every week for almost three years as a desk-top publisher, preparing articles for the printer. He has also been a regular proof-reader during this time.

Alistair is a PhD student at Monash University, where his field of research is the functional morphology of teeth and cranial features in microchiropteran bats.

I am looking forward to working with Alistair on your journal, where his expertise in computing, desk-top publishing and statistics will be welcome.

Merilyn Grey

Recent Foraminifera and Ostracoda from Erith Island, Bass Strait

K.N. Bell[1] and J.V. Neil[2]

Abstract

The foraminiferal and ostracodal faunas from a sample at 15 m depth at Erith Island, Bass Strait, are described. The foraminiferal fauna consisted of 38 species; notable live species are *Cribrobulimina polystoma* (Parker and Jones), *Rosalina irregularis* (Rhumbler) and a spicular test form of *Haplophragmoides pusillus* Collins. There were 37 species of ostracodes present; notable species include *Papillatabairdia elongata* McKenzie, Reyment and Reyment, *Pterygocythereis* sp. aff. *P. velivola* (Brady) and a new species of *Eucythere (Rotundracythere)*. The fauna has some similarities to that found on the Victorian coast. (*The Victorian Naturalist* **116** (6), 1999, 218-227.)

Introduction

Although the foraminiferal fauna of the Victorian coastline is fairly well known, little research has been undertaken on the faunas of Bass Strait or of the surrounds of the Bass Strait Islands. The fossil ostracode faunas of the coastline have recently been the subject of a number of papers (McKenzie *et al.* 1990, 1991, 1993; Neil 1994), but the living faunas have received limited attention (Bell *et al.* 1995; Neil 1993; Yassini and Jones 1995).

The Kent Group (39°29' S, 147°20' E), which consists of three main islands (Deal, Erith and Dover) and two smaller isolated ones (North East and South West Islands), lies approximately halfway between Wilsons Promontory and Flinders Island in Bass Strait (Fig. 1). The group lies on the Bassian Rise in water depths of about 54-64 metres (30-35 fathoms) (Jennings 1959). The immediate seafloor surrounding the islands is mainly barren sand swells but in the more protected areas near the islands there is a rich growth of algae, sponges, ascidians, sea urchins and encrusting and solitary corals (Kuiter 1981; Wiedenmeyer 1989). Some aspects of the history, plants, animal life and general environments of the Kent Group are given by Jones *et al.* (1970), Marginson and Murray-Smith (1969) and Mullet and Murray-Smith (1967).

During late March, 1981, a small expedition of SCUBA divers visited the Kent Group to study the marine fauna (Kuiter 1981). One sample of bottom sediment from 15 metre depth in West Cove, Erith Island, collected by this group, was available for study. It consisted of a fine sand with only a small amount of silt-sized particles and with some algal fragments, broken bryozoa, small gastropods, foraminiferans and ostracodes. The sample had been preserved in 70% alcohol upon collection.

This note deals with the foraminiferans and ostracodes found near Erith Island in the Kent group; responsibility for the various taxa lie with KNB for the foraminiferans and JVN for the ostracoda.

Results

Foraminiferans

After staining with Rose Bengal (a protoplasmic stain) and washing, a total fauna of 32 species of live foraminiferans and 6 species as dead specimens was found (Table 1, dead species marked *). With the exception of *Carterina spiculotesta* (Carter), the other species have been previously recorded from shallow waters around the Victorian coastline (Apthorpe 1980; Bell and Drury1992; Collins 1974; Parr 1932, 1945). Comparison with Tasmanian coastal faunas is not possible as the Recent Tasmanian faunas have not, as yet, been studied although the faunas from Port Dalrymple and the River Tamar are similar to those of the Victorian coast (Bell 1996).

As species descriptions and illustrations can be found in the above cited references, and in Albani (1979), only selected species are commented upon here.

Haplophragmoides pusillus Collins, 1974 (Fig. 2A, B).

This species has been previously recorded from Port Phillip Bay (Collins, 1974),

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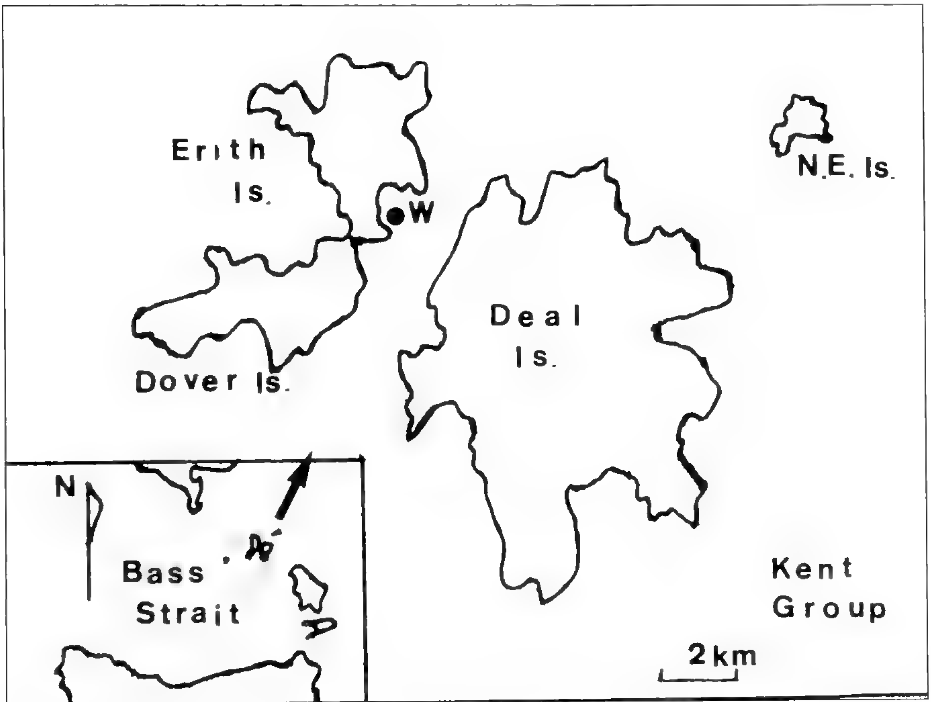

Fig. 1. Locality map showing position of the sample studied (W) from Erith Island.

Mallacoota Inlet (Bell and Drury 1992) in Victoria, and the River Tamar, Tasmania (Bell 1996). The specimens from Erith Island (although similar in size, shape and chamber arrangement to typical specimens from these other localities) differ in wall composition in that the wall is composed of fine quartz grains with various sized needle-like sponge spicules arranged roughly parallel to the coiling direction (Fig. 3B). The test surface is fairly smoothly finished. The difference in wall construction may be a reflection of the large sponge fauna in the area (Wiedenmeyer 1989). This spicular form of *H. pusillus* seems to be identical to that described from shallow water off the Xisha Islands, Guangdong Province, China, by Zheng (1979: 201, pl. 1, figs 10, 11) as *Cribrostomoides spiculotesta.*

Haplophragmoides australensis Albani, 1978.

Rare dead specimens were found in the sample. This species differs from *H. pusillus* in having a coarsely agglutinated test. It has previously only been reported from New South Wales (Albani 1978; Yassini and Jones 1995).

Textularia sp. (Fig. 3F).

Many specimens of a small, ovate, compressed, biserial textulariid were present. In side view the periphery is either smoothly tapered or zigzag due to slightly protruding chambers. It appears to be an undescribed species. This taxon differs from *T. tubulosa* Zheng in not having the overhanging chambers or the domed apertural face of that species (as figured by Loeblich and Tappan (1994)), and they are not as fistulose as *T. horrida* Egger. It is to be described in full in a forthcoming paper on the agglutinated foraminiferan fauna of the Victorian deeper waters.

Siphotextularia sp. cf. *S. mestayeri* Vella, 1957.

Several small (0.3 mm long) but typical specimens of this taxon are described here. The test is compressed, tapering with flat lateral faces and square edges; the walls are finely agglutinated and the aperture is a short slit perpendicular to the final suture. Vella (1957) described the species as having an oblique apertural slit but Loeblich and Tappan (1994) figured specimens from the Sahul Shelf which have a perpendicu-

Table 1. List of foraminiferans found at Erith Island (* indicates species found only as dead specimens); % given as percentage of live foraminiferan fauna; P, indicates presence but percentage < 2%

Haplophragmoides pusilla Collins, 1974	P
H. australensis Albani, 1978*	
Cribrobulimina polystoma (Parker and Jones, 1865)	15%
Clavulina multicamerata Chapman ,1909	12%
Textularia agglutinas d'Orbigny, 1839	P
T. sagittula Defrance, 1824	P
T. sp.	15%
Siphotextularia sp. cf. *S. mestayeri* Vella, 1957	P
Gaudryina convexa(Karrer, 1865)	P
Trochammina sorosa Parr, 1950	P
Tritaxis sp.	P
Spiroloculina antillarum d'Orbigny, 1826*	
Quinqueloculina moynensis Collins, 1953	P
Q. poeyanum victoriensis Collins, 1974	3%
Q. subpolygona Parr, 1945	P
Triloculina oblonga (Montagu, 1803)	P
T. sabulosa Collins, 1974	P
T. trigonula Lamarck, 1804	7%
Miliolinella australis Parr, 1932	8%
M. labiosa schauinslandi (Rhumbler, 1906)	P
M. oceanica (Cushman, 1932)	P
Spirillina vivipara Ehrenberg, 1843	P
Buliminella elegantissima (d'Orbigny, 1839)	P
Bulimina marginata d'Orbigny, 1826*	
Bolivina sp. cf. *B. pseudoplicata* Heron-Allen and Earland, 1930	5%
Brizalina cacozela (Vella, 1957)	P
Rugobolivinella pendens (Collins 1974)*	
Elphidium macellum (Fitchel and Moll, 1798)	6%
Planulina bassensis Collins, 1974	5%
Patellinella inconspicua (Brady, 1884)	P
Glabratella patelliformis (Brady, 1884)	P
Lamellodiscorbis dimidiatus (Jones and Parker, 1862)	P
Rosalina anglica (Cushman, 1931)	3%
R. irregularis (Rhumbler, 1906)	5%
Cymbaloporetta bradyi Cushman 1915*	
Acervulina inhaerens Schultze, 1854	P
Cibicidella variabilis (d'Orbigny, 1826)*	
Carterina spiculotesta (Carter, 1877)*	

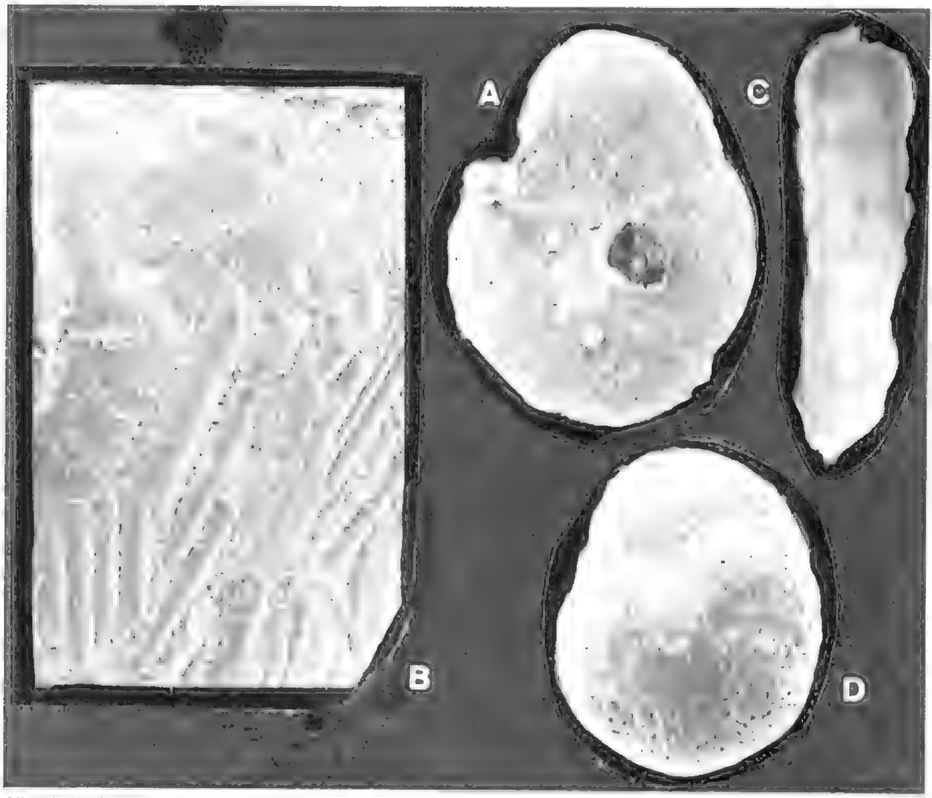

Fig. 2. A, B. *Haplophragmoides pusillus*, A ×120, B ×600. **C.** *Clavulina multicamerata*, ×45. **D.** *Planulina bassensis*, ×150.

lar slit. Until this point is clarified I have not made a definite specific identification.

Trochammina sorosa Parr, 1950 (Fig. 3E).

This species was described by Parr (1950) from off Maria Island, east coast of Tasmania, in depths of 122-155m. Hedley *et al.* (1967) have reported it from the intertidal zone in New Zealand, and it is known from Mallacoota Inlet, Victoria (Bell and Drury 1992). The present specimens are somewhat flattened compared with the more typical conical form.

Cribrobulimina polystoma (Parker and Jones, 1865) (Fig. 3A).

This is a common live species in the fauna, with both the megalospheric and microspheric generation forms present. In many cases the aperture was found to be covered with sand and algal fragments which may represent collapsed feeding cysts. Later chambers may cover all of the earlier test so giving rise to a flattened, subglobular shape.

This species has an interesting distribution: it has not been reported from Victorian shallow waters but is found in shallow waters of Spencer and St. Vincent Gulfs, South Australia, [Cann and Gostin 1985; Cann and Murray-Wallace 1986; Cann *et al.* 1993; who all refer to it as *C. mixta* (Parker and Jones)]; in shore sands at Glenelg and Hardwicke Bay, South Australia (Parr 1932); from sediments of 550 m depth off Cape Nelson, Victoria (Parr 1932); and in the Great Australian Bight (Chapman and Parr 1935) in depths less than 165 m. However, none of these reports distinguish living from dead specimens. *C. polystoma* is also known from the Holocene of northern Spencer Gulf (Cann and Murray-Wallace 1986; as *C. mixta*) and the Pliocene of the Adelaide Plains bore at Cowandilla, South Australia (Howchin 1936). It has also been found in the Upper Pliocene beds at Tailem Bend, South Australia (pers. obs.). Parr (1932) has discussed this species in detail and showed that *mixta* represents the megalospheric generation and *polystoma* the microspheric generation of the same species.

Gaudryina convexa (Karrer, 1865) (Fig. 3B).

A common species in the sample; specimens show quite variable chamber shape and overlap of chambers. This species ranges from the Upper Eocene to Recent in the Australasian region (Burdett *et al.* 1963). The 'Challenger' expedition recorded it from East Moncouer Island, Bass Strait (Brady 1884).

Clavulina multicamerata Chapman, 1909. (Fig. 2C).

This is a common species in the sample and growth stages from just the initial triangular section up to large specimens with nine linear chambers are present. Records of this species are from shallow waters along the Victorian coast and the River Tamar (Chapman 1907; Parr 1932; Collins 1974; Bell 1996).

Miliolinella labiosa var. *schauinslandi* (Rhumbler, 1906).

Rare specimens of this variable growing form of *M. labiosa* occurred. Initially the chambers resemble *M. labiosa* but the later chambers are straight or curved in a series of irregular chambers. It has been recorded from Victorian waters (Parr 1932, 1945).

Miliolinella oceanica (Cushman, 1932) (Fig. 3L).

Typical specimens of this widespread Pacific and Indian Ocean shallow water species were present. Collins (1974) recorded it from Bass Strait and Port Phillip as *Quinqueloculina baragwanathi* Parr 1945, but Ponder (1974) has shown *Q. baragwanathi* to be a synonym of *M. oceanica.*

Quinqueloculina moynensis Collins, 1953.

Rare specimens of this small, quadrate *Quinqueloculina* occurred. It is common in Victorian Bass Strait beach sands (Collins 1974).

Quinqueloculina poeyanum victoriensis Collins, 1974.

This subspecies is characteristic of high energy environments (Collins 1974). It differs from the low energy, sheltered environment form, *Q. poeyanum poeyanum*, in having narrower, straighter chambers and in the narrow aperture with a long, straight tooth.

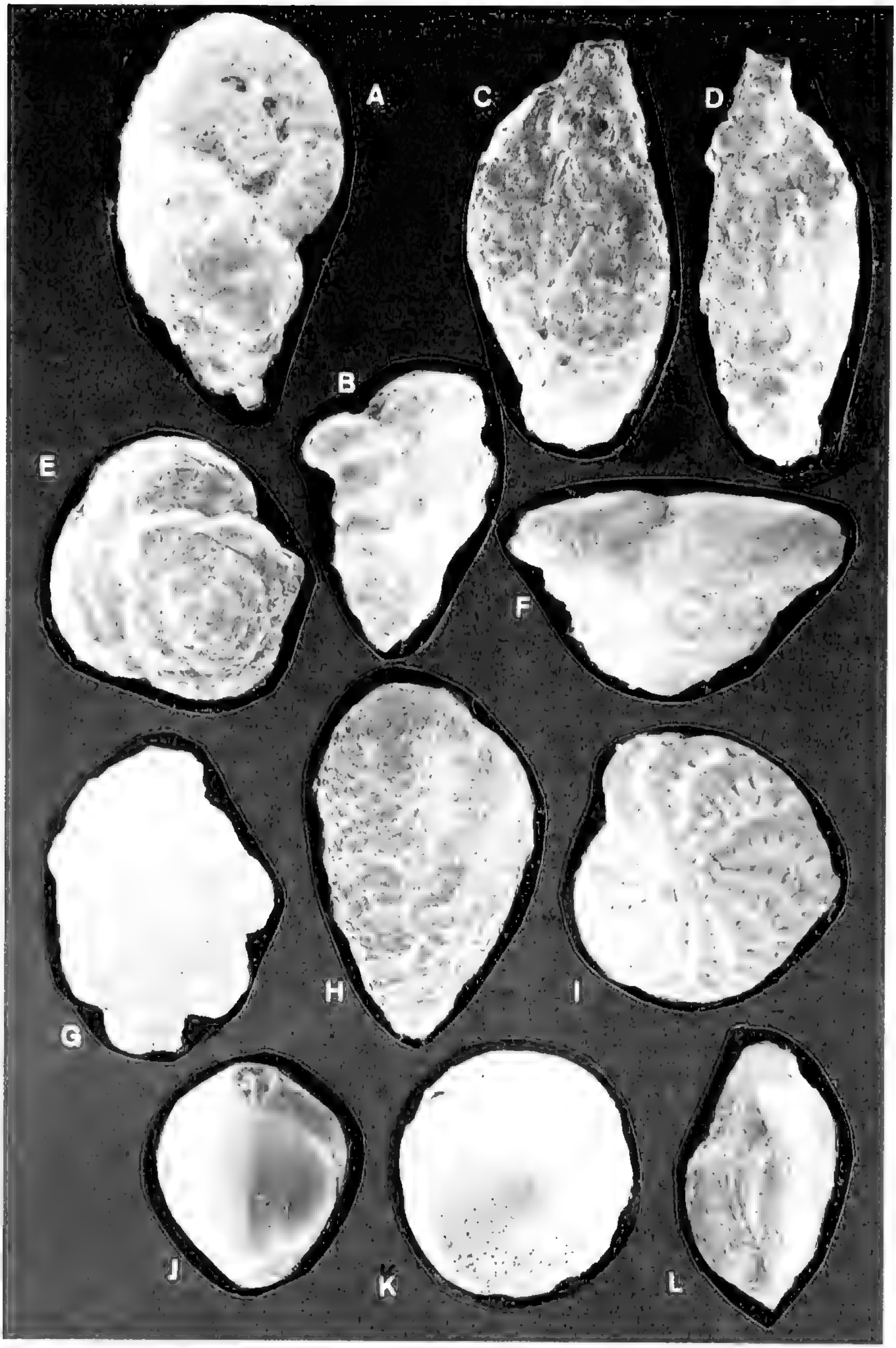

Fig. 3. A. *Cribrobulimina polystoma*, ×45. **B.** *Gaudryina convexa*, ×45. **C, D.** *Triloculina sabulosa*, C ×180, D ×120. **E.** *Trochammina sorosa*, ×180. **F.** *Textularia* sp., ×110. **G.** *Acervulina inhaerens*, ×42. **H.** *Bolivina* sp. cf. *B. pseudoplicata*, ×180. **I.** *Elphidium macellum*, ×90. **J.** *Triloculina trigonula*, ×42. **K.** *Rosalina irregularis*, ×90. **L.** *Miliolinella oceanica*, ×75.

Table 2. List of ostracoda found at Erith Island.

Arcacythere hornibrooki Yassini & Jones, 1995	*Mckenzieartis portjackonensis* (McKenzie, 1967)
Baltraella keiji Yassini & Jones, 1995	*Microcythere dimorpha* Hartmann, 1980
Bythocypris reniformis Brady, 1880	*Munseyella puncata* Yassini & Jones, 1995
Callistocythere bermaguiensis Yassini & Jones, 1995	*Neonesides* spp.
Callistocythere dorsotuberculata Hartmann, 1982	*Orlovibairdia* sp.
Callistocythere hieroglypica Yassini & Jones, 1995	*Papillatabairdia elongata* McKenzie, Reyment & Reyment, 1990
Callistocythere keiji (Hartmann 1978)	*Paradoxostoma crustaecolum* Hartmann, 1980
Callistocythere puri McKenzie, 1967	*Paradoxostoma geraldtonense* Hartmann, 1978
Cypridina sp.	*Paradoxostoma horrocksense* Hartmann, 1978
Cytheretta sp.	*Paradoxostoma schornikovi* Yassini & Jones, 1995
Cytherura sp.	*Paranesidea sinusaquilensis* (Hartmann, 1979)
Eucythere (Rotundracythere) sp. nov.	*Procythereis (Serratocythere) densuireticulata* Hartmann, 1981
Hemicytherura seaholmensis McKenzie, 1967	*Pseudohemicytherideis ornatissima* Yassini & Jones, 1995
Kangarina sp. cf. *K. radiata* Hornibrook, 1952	*Pterygocythereis* sp. aff. *P. velivola* (Brady, 1880)
Keijcyoidea keiji (McKenzie, 1967)	*Semicytherura tenuireticulata* McKenzie, 1967
Leptocythere generodubia (McKenzie, Reyment & Reyment, 1990)	*Tasmanocypris dietmarkeyseri* (Hartmann, 1979)
Loxoconchella pulchra McKenzie, 1967	*Xestoleberis cedunaensis* Hartmann, 1980
Loxoconcha australis Brady, 1880	
Loxoconcha cumulus (Brady, 1880)	
Loxoconcha gilli McKenzie, 1967	

Triloculina sabulosa Collins, 1974 (Figs 3C, D).

The small specimens placed in this taxon are more slender than the typical Port Phillip specimens and also the test usually has fewer larger grains in its construction. The length of the neck is variable which may be an age characteristic.

Rosalina irregularis (Rhumbler, 1906) (Fig. 3K).

The specimens present at Erith Island are very similar to those figured by Rhumbler (1906) and Hedley *et al.* (1967) from the New Zealand intertidal zone, in having normal, regular 1-2 whorls and then irregularly arcuate, flattened chambers with a narrow, thin peripheral rim. The rim is quite fragile and often broken producing a ragged edge to the test. Parr (1945) had specimens, from sands at Barwon Heads, which he referred to *Discorbis globularis* var. *anglica* Cushman but which are very similar to *R. irregularis* from Erith Island..

Rosalina anglica (Cushman, 1931).

The tests are usually deformed by having grown about a stem or leaf of alga or seagrass. As used here *R. anglica* is restricted to specimens which have 1-2 regular whorls and then a series of grossly deformed chambers, usually also slightly inflated. These later chambers are opaque whereas in *R. irregularis* they are transluscent. Parr (1950) has suggested that *R. angelica* is only a growth form of *R. globularis* and should possibly not be separately distinguished. Collins (1974) recorded it from Port Phillip Bay and nearby Bass Strait.

Planulina bassensis Collins, 1974 (Fig. 2D).

This small species is very common in the sample, and is easily identified by its slightly convex/concave shape and evolute whorls; most specimens have a white last chamber with other chambers pale brown. It was originally described from the entrance to Port Phillip Bay (Collins 1974).

Rugobolivinella pendens (Collins, 1974).

Only dead specimens were found in the sample. Originally described from Port Phillip, this species is now known to be widespread along the southern Australian coast, ranging from Eucla, Western Australia, to Port Phillip Bay (Hayward 1990) and from the River Tamar, Tasmania (Bell 1996).

Acervulina inhaerens Schultze, 1854 (Fig. 3G).

This is a common species frequently found attached to seagrass fronds and so shows a variety of shapes.

Bolivina sp. cf. *B. pseudoplicata* Heron-Allen and Earland, 1930 (Fig. 3H).

Although the test surface of the specimens from Erith Island show a randomly reticulate pattern they do not clearly show the characteristic two longitudinal ridges of *B. pseudoplicata*. The figured specimen shows incipient ridges on the final two chambers only.

Carterina spiculotesta (Carter, 1877).

One specimen of this unusual species was recovered but, as internally it only stained a pale pink, was questionably alive when collected. The specimen has only seven chambers. The wall of the chambers show the typical elliptical, parallel arranged, secreted particles, but no evidence of the flat spreading apron as described by Loeblich and Tappan (1955). Previous records are all tropical subtropical (Loeblich and Tappan 1964). Collins (1958) recorded it from the Great Barrier Reef.

Ostracodes

No distinction between live and dead specimens was possible with the ostracodes in the sample, though the one large specimen of *Cypridina* sp. is stained and includes the soft parts. A total of over 400 specimens was picked. Carapaces and separated valves were counted as individual specimens. Only identifiable broken specimens larger than 50% of a whole valve were counted. The fauna comprised 37 species from a total of 28 genera (Table 2). There was a very high proportion of carapaces (over 75%). Detailed comparisons with faunas from the northern Tasmanian coast and the south-eastern coast of New South Wales are not possible here, but such a comparative study is in preparation.

The fauna is typical of a shallow marine to inner shelf environment, with a few unusual characteristics. The dominant species are *Xestoleberis cedunaenis*, *Eucythere (Rotundracythere)* sp., *Neonesidea* sp. and *Loxoconcha cumulus*. The species of *Eucythere (Rotundracythere)* is new, and it is unusual to find such large numbers of this genus in a fauna in this region. Other features of the fauna include the variety of paradoxostomatid species; the presence of the species *Pterygocythereis* sp. aff. *P. velivola* which was described from the Gulf of Carpentaria (Yassini *et al*. 1993) and quite a variety of callistocytherids. There are very few cytheropteronids as is characteristic of shallow marine and inner shelf assemblages. On the other hand, there is a complete absence of hemicytherids and trachyleberidids which are often very numerous in fossil faunas from these environments.

A detailed analysis of the ecological implications of the fauna, and a description of the new species of *Eucythere (Rotundracythere)* is being prepared, to accompany the comparisons with assemblages from the beach at Wynyard (Fossil Bluff), Tasmania, and at Twofold Bay, New South Wales.

Papillatabairdia elongata McKenzie, Reyment and Reyment, 1990 (Fig. 4E).

This species is characteristic of an estuarine to inner shelf environment. It was recorded by Hartmann (1978) from a deposit of coral debris in a pool on the reef off Heron Island, Queensland (one specimen) as *Bythocypris* sp., and initially described by McKenzie *et al*. (1990) from the Pleistocene deposits of Goose Lagoon Drain in southwest Victoria. Yassini and Jones (1995) record it from Lake Macquarie and Broken Bay in New South Wales. Its occurrence in the Erith Island fauna suggests its persistence in a cooler environment, in spite of its origin in warmer Pleistocene waters and Recent occurrences in warm temperate and subtropical locations. Only one specimen was found.

Xestoleberis cedunaensis Hartmann, 1980.

This is the most common species in the fauna. It has been recorded by Hartmann (1980); Yassini and Jones (1987, 1995) from saline lakes, lagoons and the intertidal zone. Its abundance in this fauna is somewhat unusual because of the more marine aspect of the assemblage though it may have been transported from the intertidal zone in the Kent Group.

Procythereis (Serratocythere) densuireticulata Hartmann, 1981 (Fig. 4I).

This species is found typically in the intertidal zone of sheltered embayments and the entrance channels of coastal lagoons. Only four specimens were found but this occurrence reinforces the inner shelf signal of the fauna.

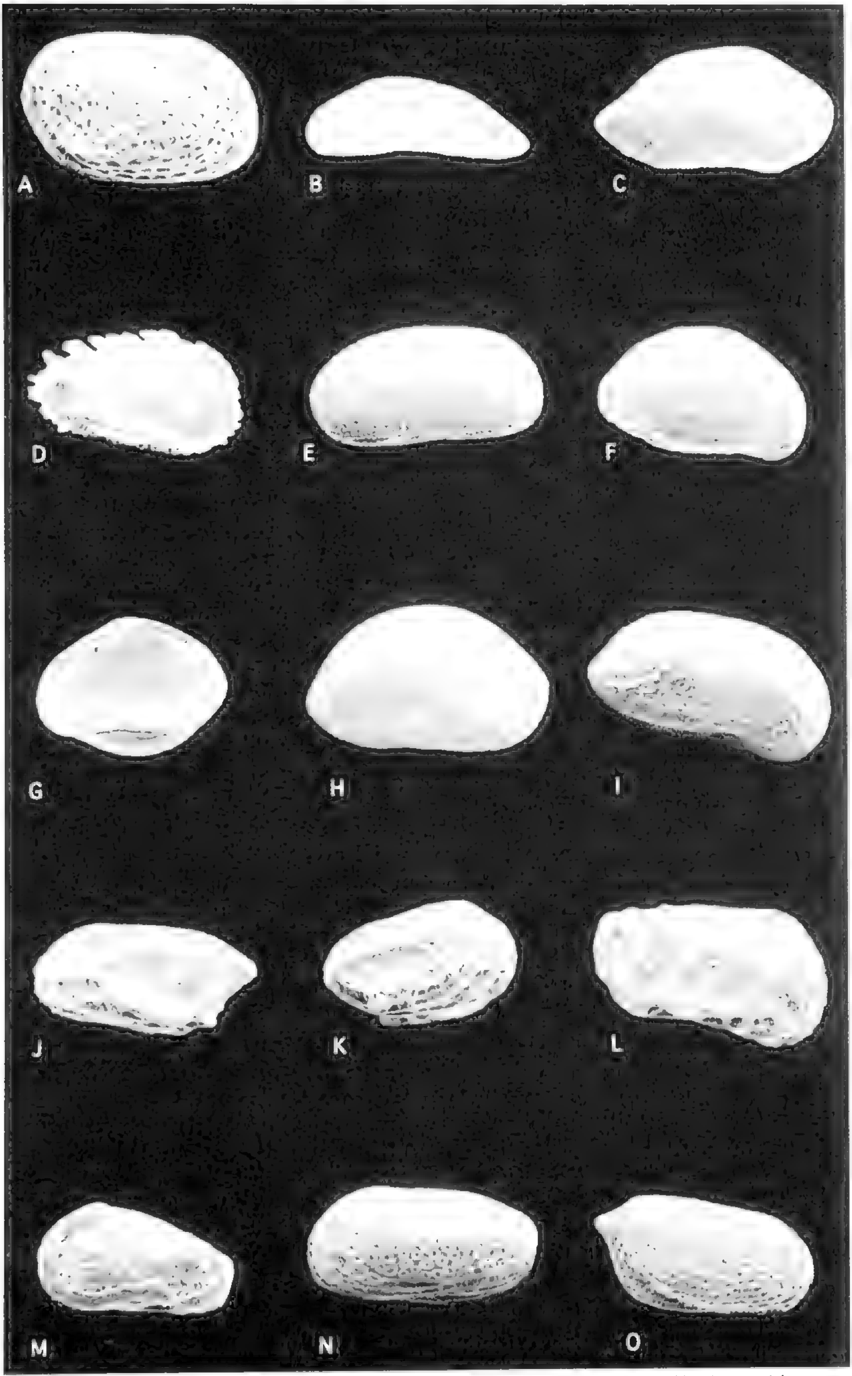

Fig. 4. A. *Loxoconcha cumulus*, ×55 **B**. *Tasmanocypris dietmarkeyseri*, ×26 **C**. *Neonesidea* sp., ×33 **D**. *Pterygocythereis* sp. aff. *P. velivola*, ×44 **E**. *Papillatabairdia elongata*, ×44 **F**, **G**. *Eucythere (Rotundracythere)* n. sp., ×66 **H**. *Paranesidea sinusaquilensis*, ×44 **I**. *Procythereis (Serratocythere) densireticulata*, ×44 **J**. *Semicytherura illerti*, ×66 **K**. *Loxoconcha gilli*, ×55 **L**. *Callistocythere keiji*, ×55 **M**. *Munseyella punctata*, ×66 **N**. *Arcacythere hornibrooki*, ×58 **O**. *Cytherura* sp., ×55.

Eucythere (Rotundracythere) n. sp. (Fig. 4F, G).

The second most abundant species in the fauna, *Rotundracythere* n. sp. differs from the only other Recent species of this genus, *R. bassiana* Yassini and Jones 1995, in being more strongly ornamented and having a more rounded dorsal margin. *R. bassiana* is described as being 'rare in Bass Strait' (Yassini & Jones 1995). Two species of this genus from the Eocene and Oligocene are figured by McKenzie *et al.* (1991, 1993). The presence of the genus usually suggests shallow, open, marine conditions, rather than the intertidal zone favoured by many other species in the assemblage.

Neonesidea spp. (Fig. 4C).

Although there are 25 specimens of this genus in the fauna, they probably represent more than one species, of which *N. australis* (Chapman 1914) is the most common. The genus is generally representative of shallow, open marine conditions.

Loxoconcha cumulus (Brady, 1880) (Fig. 4A).

Loxoconcha cumulus is the most common of the three species of the genus in the fauna. The others are *L. australis* Brady 1880, and *L. gilli* McKenzie 1967 (Fig. 4K). Of the range of environments favoured by *Loxoconcha* in this region, *L. cumulus* is generally found in estuaries in association with seagrasses. *Loxoconcha gilli*, which favours an open marine environment, and *L. australis*, lagoons, estuaries and the shallow shelf, are both quite rare in this assemblage.

Pterygocythereis sp. aff. *P. velivola* (Brady, 1880) (Fig. 4D).

Only one specimen occurs in this assemblage. It has close affinities with the specimens figured by Yassini *et al.* (1993) from the Gulf of Carpentaria. This genus has not been identified previously in fossil or Recent faunas from southern Australia.

Callistcytherids (four species) form a significant proportion of the assemblage. This genus is generally indicative of shallow marine conditions. The Paradoxostomatids present (four species), although not numerically common, also give a clear indication of this kind of environment.

Discussion

It is not customary to present data from just one sample. However, we feel that the dearth of knowledge of the microfauna of Bass Strait and some of the interesting ostracod and foraminiferan occurrences in this sample from Erith Island warrants reporting.

Although the Victorian shallow marine foraminiferal fauna is fairly well documented that of the Tasmanian side of Bass Strait is almost totally unresearched but with the exception of *C. polystoma*, the other species occur widely in Victorian shallow marine faunas (see references already given); *C. polystoma* has never been reported in Victorian shallow waters nor from Bass Strait so its occurrence is significant. It may be that currents flowing from the Great Australian Bight eastwards (Gibbs et al. 1986; Tomczak 1985) transport specimens from the South Australian Gulfs into Bass Strait and they there find suitable habitats near the Bass Strait Islands (it was not found at East Moncouer Island by the 'Challenger' expedition (Brady 1884)). This point warrants further sampling in the shallow areas about other Bass Strait Islands.

The ostracode fauna is characteristic of a cool-water, shallow marine, or intertidal environment. Most of the commonly occurring species of *Neonesidea* and *Callistocythere* are cosmopolitan and do not reflect narrow environmental constraints. However, *Xestoleberis cedunaensis*, although found in the intertidal zone, favours estuarine or lagoonal conditions and *Procythereis (Serratocythere) densuireticulata* has similar preferences. *Loxoconcha cumulus*, which is common in the assemblage, is another species favouring estuarine conditions in association with seagrasses. This range of conditions suggested by the species of the fauna is consistent with the location of the sample.

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Bizarre Encounters with Wildlife: Observations from Around Wattle Glen

Different animal species using the one nest hollow

Stagwatching a tree with a large tree hollow with obvious scratchings around it, led to the discovery of a couple of possum species using this tree. The tree, which is a large senescing Red Stringybark *Eucalyptus macrorhyncha* was found to be home to a Brushtail Possum (in the hollow described) and a colony of Sugar Gliders in another hollow. This tree is also home to a colony of feral European Honeybees. Regularly watching this tree at dusk, I was surprised to discover that the Brushtail's hollow was used annually by a pair of nesting Kookaburras (I observed this for three consecutive years). Presumably they kick the Brushtail out. This leads to a number of questions. Where does the Brushtail Possum go? Must it find another tree hollow or does it sleep out for the summer? How often do birds, which use tree hollows for nesting, evict arboreal mammals during their breeding season? Is this the Kookaburras' preferred tree hollow or is it an indication of lack of suitable tree hollows in the area? Have any field naturalists observed similar events?

An even more bizarre encounter with a Black Wallaby

While walking in bushland close to home I realised our two knee-high (kind of fox looking) dogs had sneakily followed me. I didn't send them home. They continued on with me into the base of a gully which drains into a dam. It was here that we stimulated some uncharacteristic behaviour in a Black Wallaby. The Black Wallaby rapidly and repeatedly circled us (at a radius of approximately 30 m). It occasionally stopped and took a series of deep breaths (as if smelling the surroundings). My initial thought was that there was a young wallaby around, but I couldn't see it. The Black Wallaby continued this behaviour, giving no indication it was about to stop. In order not to continue the disturbance I decided to leave. While this was happening the dogs showed no interest in the Black Wallaby and continued sniffing around the tussock grasses *Poa labillardieri*. As we left the gully (I took a path which would have been about a 200 m walk up the ridge), the Black Wallaby followed behind. The circling behaviour of the Black Wallaby occurred on two separate occasions and the dogs were with me both times (the wallaby didn't follow us out the second time). I've walked this area many times and never experienced anything like it. Characteristically, as you would know, as soon as these animals are aware of your presence they take off.

So what does this mean? Is this typical behaviour or is this Black Wallaby a nut? Was it the same wallaby on both occasions (I'd suspect so but I couldn't be sure)? Has it had an encounter with dogs before which stimulated this behaviour? After thinking about it for a while I wondered whether the wallaby thought the dogs were foxes. Are foxes a threat to Black Wallabies? I've seen Eastern Grey Kangaroos and foxes within the one area and neither seemed interested in the other. Once again has anyone else had a similar encounter?

I'd be interested in other field naturalists describing their bizarre encounters with wildlife during their wanderings. I have no doubt they would be many and varied.

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Editor's note: Regarding the sharing of nest hollows, it has been reported that Sugar Gliders sometimes share a nest hollow with Galahs (*The Bird Observer*, no. 794, March 1999, p. 9). Thank you to Virgil Hubregtse for pointing this out.

Plant Collecting for the Amateur

by T. Christopher Brayshaw

Publisher: *Royal British Columbia Museum, Canada. ISBN 0-7718-9439-2, 44 pp., paperback., RRP $12.95.*
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Collecting plants is one of the most enjoyable experiences for any botanist, allowing the opportunity to get outdoors and seek out and examine interesting plants. The book, 'Plant Collecting for the Amateur' by T.C. Brayshaw (1996), provides a very basic yet informative guide on how to get started. It includes some very important aspects about collecting, what to collect, and how and when to collect. It discusses the types of information that should accompany any collection, which is of critical importance if collections are to retain some sort of meaning in the years to come. The chapter on mounting and filing specimens gives some valuable information on ensuring collections are timeless.

Brayshaw provides some good advice on pressing and drying plant specimens, including some wonderful ideas for building your own press and drying racks. It was good to see discussion of how to deal with pressing and drying some of the more tricky plant types, such as succulents and plant materials with large cones or fruits. I was also happy to see treatment on collection of non-vascular plants (mosses, liverworts and lichens), an often neglected area of botanical study. However, I don't recommend pressing lichens as their shape can be an important diagnostic feature. Unfortunately, Brayshaw did not cover fungi and algae (micro or macro) and these two groups can cause difficulty for interested amateurs.

Overall, Brayshaw has written a very readable and informative little book with all the information necessary on how to collect, preserve and file plant specimens for both personal and public herbaria. The only detraction being that the book contains potentially useful information on herbaria to send specimens to for identification, books to aid in identification and references to what is legal/illegal to collect - provided you live in British Columbia! For the Victorian naturalist, this aspect of the book is of limited practical value and perhaps relegates the book to the category of 'a really good book to borrow from the library'.

Out of interest, the Melbourne Herbarium generally charges $10 for each identification, and reserves the right to charge by the hour for particularly difficult specimens. Collectors should also remember that, in Victoria, permits are required to remove any plant material from national parks and state forests, which limits the range of material that may be available for collection.

Many plants are rare or threatened in Australia due to reductions in habitat. Some rare plants turn up in some very unexpected places, and, indeed, in many cases it has been the amateur collector that has drawn attention to these populations. However, for particularly interesting plants with limited distribution, the potential for viable populations to be 'collected out of existence' can be a real threat. I would question the need to collect apparently rare or non-abundant plants from an area, especially where the identity of the plant is unknown. Amateur collectors, being curious, yet eternally fond of our native bushland, should be able to find plenty of enjoyment in collecting and identifying the plants that appear numerous and abundant in an area.

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Phillips, A. and Watson, R. (1991). *Xanthorrhoea*: Consequences of 'horticultural fashion'. *The Victorian Naturalist* **108**, 130-133.

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