The Victorian Naturalist

Volume 110 (1) 1993 February

Box & Ironbark Woodland Conservation

Proceedings of the Victorian National Parks Association Conference

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FNCV Calendar of Activities

March	
Tues 2	Fauna Survey Group Meeting. Rediscovery of the Broad-Toothed Rat in Dandenong Ranges National Park – Dr. Rob Wallis. Annual General Meeting. Herbarium Hall 8 p.m.
Sat 6-Mon 8	VFNCA Camp. 'Kangaroobie', Princetown. Contact Dorothy Mahler, 435 8408.
Sat 6-Mon 8	Fauna Survey Group Labour Day Camp. Central Highlands. Contact Ray Gibson, 874 4408.
Tues 9	General FNCV Meeting. Preservation of Plants at the Zoo – John Arnott. Herbarium Hall 8 p.m. **Please note date. Library open 7.15 to 7.55 p.m.**
Thurs 11	Botany Group Meeting. An Unnatural Flora – Kim Robinson. Herbarium Hall 8 p.m.
Wed 17	Microscopy Group Meeting. Imaging of Live Cells – Prof Pickett-Heaps. **At Botany School, University of Melb 8 p.m.**
Wed 24	Geology Group Meeting. A General Introduction to the Geological Time Scale – Bob Dalgarno. Herbarium Hall 8 p.m.
Saturday 27	Botany Group Excursion. Courtenay Road, Lysterfield. Leader Margaret Corrick. Contact Joan Harry, 850 1347.
Sat 27-28	Fauna Survey Group Field Survey. Final trip to Mt Cole. Contact Russell Thompson, 434 7046.
April	
Sun 4	General FNCV Excursion. Pond Life at Jells Park. Leader Ian Endersby with help from Microscopy Group. Private transport. Contact Dorothy Mahler, 435 8408.
Mon 5	Annual General Meeting FNCV. **Astronomer's Residence 8 p.m. Library open 7.15 to 7.55 p.m.**
Tues 6	Fauna Survey Group Meeting. An Update on Leadbeater's Possum Research – David Lindenmayer. Herbarium Hall 8 p.m.
Wed 7	Geology Group Meeting. Herbarium Hall 8 p.m.
Fri 9-Mon 12	Fauna Survey Group Easter Camp. Pallister Reserve near Port Fairy. Contact Felicity Garde, 808 2625.
Sat 17	Fauna Survey Group Field Survey. Leadbeater's Possum Survey. Contact Ray Gibson, 874 4408.
Wed 21	Microscopy Group Meeting. Preparation of slides of insects and insect parts – Dr. Malipatil. Astronomer's Residence 8 p.m.
Fri 23-Sun 25	Fauna Survey Group Field Survey. Wilson's Promontory (post-fire ecology study). Contact Russell Thompson, 434 7046.
Sat 24	Botany Group Excursion. Bone Seed Pulling at Sea Winds. Contact Joan Harry, 850 1347.
Wed 28	Geology Group Meeting. Herbarium Hall 8 p.m.

Erratum

Cyanobacteria: A Problem in Perspective

We regret losing (f) from Fig. 1 p. 226 Vol. 109 (6) 1992. A replacement page is enclosed.

The Victorian Naturalist

F.N.C.V.

Volume 110 (1) 1993 February

Editor: Robyn Watson
Assistant Editors: Ed and Pat Grey

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Cover Photo: The Regent Honeyeater (*Xanthomyza phrygia*), drawn *by T. Coates.*

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The Box and Ironbark Communities of the Northern Slopes of Victoria

Malcolm Calder*

Introduction

The Box and Ironbark communities of the northern slopes of Victoria are in deep decline as a result of land clearing, gold mining, timber utilisation, grazing, changed regional hydrology and the problems of salinity, and the impact of introduced plants and animals. In making this statement I am not ascribing blame to any individual or group, but simply identifying the ecological facts which have led us to the present situation. The original forest and woodland communities of the northern slopes of Victoria have been largely cleared and those which remain are under stress. If we want the residual Box-Ironbark forest and woodland communities to survive it is essential that urgent action be taken to reverse the present decline. The conference is a major step towards achievement of the conservation objective; and it is important that all the interest groups get together and develop action strategies for the future.

My role was to provide the background mural, painting the broad picture to support the papers which follow. We need to establish the particular qualities of these communities and identify the environmental and managerial pressures to which they are subject. As a botanist, my starting point is that the communities which make up the Box-Ironbark forests and woodlands of the northern slopes have declined to a point where active conservation of all remaining examples is an imperative; we must save these communities as a part of our ecological heritage, we must save them also to protect rural landscapes and industries which are so important to the economic and social well being of Australia.

Botanists talk of the *Box-Ironbark Alliance,* which extends discontinuously along the northern foothills from east of Chiltern to Stawell in the west. Some, eg Dexter (1978), take a more expanded view of the Alliance and include some of the communities which border the Mallee Alliance. The communities are dominated by Red Box (*Eucalyptus polyanthemos*) or Grey Box (*E. microcarpa*), both of which are fairly widespread. In some regions or habitats, White Box (*E. albens*) and Yellow Box (*E. melliodora*) are found and, in the higher rainfall sites, Long-leaved Box (*E. goniocalyx*) grows. Red Ironbark (*E. tricarpa* and *E. sideroxylon*) are features of this Alliance, with *E. sideroxylon* only entering Victoria in the far north-east. Yellow Gum or White Ironbark (*E. leucoxylon*) is also an important component of the Alliance in Victoria west of the Goulburn, but does not extend into these communities in New South Wales.

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Climate and soils

Broad generalisations about soils and climate are only helpful to set the boundaries or limits of the distribution of different plant communities. Details of aspect, slope, exposure and the like, control the actual distribution. In Victoria there is a general understanding and agreement that the Box-Ironbark communities fall within the rainfall bands of 700 mm and 400 mm. Above 700 mm are the taller forests dominated by Peppermints, Stringybarks and Gums, and below 400 mm we move into the Mallee communities.

The Box-Ironbark Alliance is associated with Ordovician formations, which Patton describes as 'the home of the Box-Ironbark' but the Alliance is also found to a lesser extent on granites, newer basalts and recent sediments of the Murray floodplain. Soils derived from Ordovician sediments are shallow, well drained and contain reefs of quartz. At the other extreme are the deep clays of the Murray floodplain where drainage is poor and where in the winter and spring, surface water may lie for several weeks at a time. Here Grey Box is the most common dominant.

The vegetation

The characteristic structure of the Box-Ironbark communities is of close to widely spaced trees with an open canopy. There is usually a light shrub layer from 1-3 m comprising a range of sclerophylous Acacias, epacrids and composites as well as other shrub genera. On more exposed or drier sites the shrubs open out to allow the growth of grasses and a number of bulbous geophytes (lilies and orchids) which emerge in the winter, flower in the spring and die down in the summer.

The understorey varies floristically according to its locality and this variation leads to the observation that the Alliance as a whole is rather species rich. Trees associated with this Alliance include White Cypress Pine (*Callitris glaucophylla*) and Buloke (*Allocasuarina lehmanii*). In places *Exocarpos cupressiformis* and *Acacia pycnantha* can grow quite tall, but they do not reach the top of the canopy. Box mistletoe (*Amyema miquelii*) is common throughout, and in places reaches heavy levels of infestation.

Values and threats

The timber of the Box-Ironbark species is strong and durable. It has been used for pit props, fencing timbers, farm buildings and firewood. While market demand is now greatly diminished there is continuing pressure on timber supplies from these communities. Minor forest products such as honey have their own impact on the community. Hive bees compete with native nectar feeders for a resource which at times may be limited. Wild colonies of the honey bee generally occupy sites which would otherwise form the nesting hollows of native animals.

The clearing of land for agriculture is an historic fact which has vastly reduced the extent of the Box-Ironbark Alliance; this land clearing is socially, economically and ecologically irreversible. Nevertheless, previous land clearing makes more valuable the remnants of the Alliance and all of these must be protected and managed to ensure their survival. In this context, continued grazing under licence on public land is ecologically unacceptable. Domestic stock are selective grazers and browsers and the damage they cause when introduced in relatively large numbers is considerable.

Rabbits, foxes and cats are all alien to these communities and their presence is a threat to the survival of the balanced community. Management strategies must be put in place to control or eliminate them.

Botanically, these communities have suffered invasion from a range of alien plants. Often called environmental weeds, these plants compete with the local flora, frequently establishing their annual growth cycle ahead of the natives and so crowding them out in the struggle for existence. These plants are difficult to control since there is a continuous and effectively inexhaustible supply of seed available from the surrounding country, especially within the vegetation of road verges.

What needs to be done?

First, there needs to be a recognition at the local and state level that the Box-Ironbark communities have value in the terms of conservation, in terms of land management (including the management of regional watertables), and in terms of the characteristic rural landscapes of Victoria.

Secondly, there needs to be a commitment to environmental research, paying particular attention to the basic ecology of the plants and animals which make up these communities; the effects of grazing; and the development of strategies for the elimination of introduced plants and animals.

Thirdly, landholders and local government should collaborate in the development of 'Regional Vegetation Strategies' (ReVS). Continuation of current practices can only lead to the eventual loss of trees in the landscape, apart from the small islands of public land which in any case are vulnerable. In my view, each shire in the region should undertake the development of a ReVS whch would have the purpose of maintaining visual amenity, assisting the processes of land care, providing for the shelter of stock, and the maintenance of regional identity by using only local plants as the source of seed for regeneration.

Fourthly, all remnant communities of the Box-Ironbark Alliance must be identified and managed with the knowledge of the best ecological information available and with the objective of rebuilding them to typify the diversity of community types represented.

Lest We Forget to Forge

Doug Robinson*

Two major land issues confront all Australians today. The first and most important issue is that of aboriginal land rights. The second is that of land care. And knowing the tragic consequences caused by the failure of successive State and Federal governments to act on the issue of land rights, it is crucial that we do not likewise delay essential conservation actions in rural Australia and thereby abandon the land.

Many speakers at the conference stressed the fact that conservation of Box-Ironbark ecosystems involves us all, it is not the responsibility of just one agency. In a similar vein and in contrast to the memorial plaque at Thoona (the host town for Day 2 of the conference), which now reads 'Lest we forge', I propose the motto – 'lest we forget to forge'. As part of that process, this paper firstly reviews the major issues discussed at the conference. Secondly, it summarises the conservation actions proposed by participants, either during the conference or in subsequent communications with the VNPA.

The Box-Ironbark environment

What is Box-Ironbark woodland? While the title of the conference suggested one, broadly homegeneous vegetation community, various speakers clarified that the phrase 'Box-Ironbark woodland' is far too restrictive a term to describe the diversity of communities included therein. The Box-Ironbark lands of central-western NSW comprise at least eight different vegetation communities, including those of Poplar Box and Yellow Box, Brigalow, Carbeen, Myall, Belah and River Red Gum (Sivertsen). Elsewhere, there are communities of Blakely's Red Gum or White Box (Landsberg; Prober). In Victoria, Box-Ironbark ecosystems range from grassy woodlands/grasslands to forests with a shrub understorey (Baker-Gabb; Calder; Traill). They occur across a broad geographical gradient in which annual rainfall varies from approximately 275mm to 750mm and in which many different communities intergrade (Bennett). Each of these communities may support a distinctive fauna and Bennett discussed how animal distributions vary in Victoria's Box-Ironbark lands, firstly at a broad geographic scale according to landform and rainfall and secondly at a local scale in response to soil type, vegetation and configuration. The local distribution of Red Ironbark and Yellow Box, for example, seems critical to the distribution of several species of mammal and bird (Traill; Davidson).

Threatening processes

Notwithstanding the array of communities included within the notion of 'Box-Ironbark woodlands' speakers made it abundantly clear that all these ecosystems at least share a history of extensive loss. It was estimated that less than 15% of the original Box-Ironbark lands remain in Victoria (less than 3% of which are in

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conservation reserves, Baker-Gabb; Traill) and less than 25% in the Murray-Darling Basin (Scott), with vegetation still being lost at a rapid rate (Woodgate and Black 1988; Sivertsen).

The end result of this persistent clearing has been massive fragmentation of all Box-Ironbark communities and massive declines of wildlife. In an area of 65,000 square kilometres in central NSW, only 25% of the original woodland vegetation remains, scattered across the study area in 3,500 remnants, 90% of which are less than 5 sq km in area (Goldnay). And throughout the Box-Ironbark lands of eastern Australia, communities no longer form a connected mosaic of different forest and woodland types but stand as isolated and modified patches, with the loss of every 100 ha denoting the loss of some thousands of birds, skinks, grasses and so forth (Bennett).

Even those patches that do remain are not secure, due to degrading processes exacerbating the environmental consequences of fragmentation. Landsberg discussed the continuing and accelerating rate of rural dieback, often caused by nutrient enrichment of sites, either from sheep dung or fertilizer run-off. Traill noted how little fallen timber there is in Ironbark forest due to extensive collection of timber for firewood and showed slides of the Inglewood Flora Reserve being bulldozed for gold-mining. He also mentioned how Box-Ironbark production forests were extensively culled of large, old trees from 1930 to at least the 1960's to create a younger forest of 'pole' trees. As a result, those same forests are deficient in hollow-dependent fauna and populations of some nectarivores (Traill).

Many speakers noted the impact of grazing by domestic stock, rabbits and even kangaroos on native vegetation communities. It was made clear that any sustained grazing by domestic stock will cause the disappearance of some native plant species from particular communities and that as grazing intensity increases, more and more species will disappear until the point where just a few unpalatable species remain (Sivertsen; Prober). In addition, grazing by stock and rabbits prevents the regeneration of young trees and shrubs, thereby hastening the demise of remnant patches of native vegetation (Sivertsen).

None of these processes is unique to Box-Ironbark systems – land degradation is occurring throughout Australia and the world and affects all taxa of plants and animals (Blakers; Sivertsen). The rate of loss of communities and taxa from Box-Ironbark systems, however, makes their nature conservation critical. For example: less than 0.01% of the White Box community remains intact (Prober); many other plant communities are threatened (Sivertsen; Baker-Gabb); 21 of the 22 extinct species of mammal and 31% of now-threatened vertebrates in Victoria occur/occurred in the grassy woodland components of the Box-Ironbark lands (Baker-Gabb); and 46 species of landbird that are declining throughout their range, but which are not listed as threatened, occur in Box-Ironbark (Robinson and Bennett in prep.). Given that so many threatened taxa and vegetation communities occur there, we need to act now to develop long-term conservation strategies for these lands. Equally, though, we must recall that the same processes of habitat loss, fragmentation, degradation and decline are occurring throughout rural Australia, for much the same reasons (Beale and Fray 1990). Any proposals for nature conservation in the Box-Ironbark lands therefore should be broad enough to encompass the conservation of ecosystems in other parts of rural Australia.

Proposed conservation actions

Nature conservation is especially complicated in rural Australia because we are dealing with fragments of native vegetation on public and private land and the degrading process may be different on each. Thus a coherent regional strategy will require consultation and cooperation between government agencies, landholders, local shires, local fire authorities, local water boards and so forth, as opposed to the (relatively) simple process of nature reserve proclamation and management by a single public authority as is possible where large blocks of native vegetation remain.

In the past, conservation actions in rural lands have been ineffective because we have tended to develop strategies in terms of land ownership – one strategy for public lands, one strategy for private land (Blakers). If we want an adequate conservation system in Box-Ironbark, we need to progress beyond this point and develop coherent strategies that focus firstly on nature conservation, and only secondly on who owns the land (Blakers), thereby leading to 'sustainable wildlife conservation' throughout the region (Bennett).

Similarly, rather than trying to assign responsibility for nature conservation to particular groups, we have to realise that everyone is responsible (Baker-Gabb; Bennett; Davidson). For example, government agencies have liked to argue that conservation on private lands is primarily the responsibility of the farmer. Tom Lee, though, recounted how his father, now in his seventies, chuckles as he helps Tom to plant trees. The reason? The government department that provides Tom with financial incentives to replant some trees is the same department that provided his father with incentives to clear the land. Likewise, among urban conservationists lamenting the clearing of native vegetation there are doubtless many who help to burn the 230,000 cubic metres of firewood consumed annually in Victoria and the 80,000 tonnes burnt each year in the ACT. We all are responsible for nature conservation in rural Australia, and all need to be involved in the restoration of the Box-Ironbark lands.

What can be done then?

In the long-term, there are going to be many changes in land use and ownership in rural Australia. There will be more people, more rural subdivision, less money from sheep and wheat and less government money directed into rural economies (Blakers). We need to think about the environmental consequences of those changes and begin planning now. For example, will changes from pastoral to other land uses increase the threats to nature conservation in the Box-Ironbark lands? If farmers are forced to leave their land because of global trade wars, will the loss of experienced land managers be a disadvantage to nature conservation? Might it be better to offer an annual salary to those farmers so that they continue to kill foxes and rabbits? Or, as proposed by Tom Lee, perhaps the Government should enter into covenant agreements with landholders to manage portions of their land for nature conservation. The landholder could then receive an annual payment for managing the land accordingly.

What is the long-term future for timber-harvesting in Box-Ironbark forests? Although forest managers are now trying to increase the average size of the trees in production forests (Young), is it reasonable to continue harvesting when only 3% of the forest is protected in conservation reserves? Some regions are already encouraging firewood collection from plantations rather than from native forests (Young). Several companies now manufacture fence posts from materials such as concrete and recycled plastic rather than from hardwood. Given that there are alternative supplies of firewood, poles and posts, surely we should manage the remaining Box-Ironbark forests for nature conservation rather than for timber production.

Irrigation was identified as a major threat to Box-Ironbark systems. What is the ecological sustainability of irrigation farming? Of the 530,000 ha of irrigated pasture in Victoria, 89% is suffering severe soil structure damage. In the Kerang/North West Lakes area, 60% of the irrigated pasture lands (347,000 ha) are affected by soil salinity, 24% severely so (OCE 1991). At the same time, 21 of 40 sampled wetlands in the area have declined in condition since 1975 and some wetlands listed as being of global significance for waterbirds have become so hypersaline that they support few birds (OCE 1991). Clearly, then, irrigation farming is not ecologically sustainable and conservation land managers need to develop long-term strategies for better land use in these districts. For example, in the Shepparton Irrigation District (280,000 ha), the cost of implementing a 30 year salinity management plan is estimated to be $295 million (OCE 1991). What if we suggested that irrigation farming will be discontinued after the next ten years and that farmers can either shift to dryland farming practices, be employed solely for habitat restoration works or leave the land. For the same $295 million, $40,000 could be offered to each of the 7300 landholders to make the transition, or the money could be used to compensate those landholders who decide to leave, the remainder being spent on broadscale nature conservation programs. Surely this would be a wiser use of money designated for land protection than its current use to support the continuation of an environmentally damaging practice.

Obviously, such decisions will have major ramifications for everyone concerned and will take time to develop so that all groups concerned believe that their needs are met. In the meantime, though, many short-term actions were proposed at the conference.

First, it is clear that we need to act immediately to establish better nature conservation reserve systems in every State in order to protect the remaining Box-Ironbark woodlands. These may comprise small, high-quality sites for populations of plants and invertebrates, and larger, perhaps more degraded sites for most species of vertebrates (Prober; Baker-Gabb). To identify those biologically significant sites we urgently need surveys throughout the Box-Ironbark lands. Several speakers also noted that we have to think in terms of networks of interlinked reserves, rather than focus solely on the conservation merits of individual reserves (Baker-Gabb; Prober; Bennett).

Likewise we need to think about nature conservation priorities regardless of who owns the land. In Victoria, the Government is committed to conservation of representative samples of all vegetation communities. Accordingly, given that we have lost more than 85% of the Box-Ironbark lands, government agencies need to acknowledge the huge significance of the blocks of public land containing woodland and forest that do remain. These blocks should be considered as conservation reserves rather than as surplus land to be used for gravel dumps, timber cutting or whatever. Grazing should be excluded from them unless for specific biological reasons. Organisations such as the VNPA should lobby to have major streamside reserves declared as conservation reserves.

Where particular vegetation communities or wildlife populations occur only on private land it must be the responsibility of government agencies to provide materials and assistance for the protection of those sites. If our government agencies are serious about nature conservation in rural lands they could establish fencing crews for nature conservation projects to assist landholders to fence remnants or to fence parcels of public land. As discussed by Howell, Willett and Lee, there are many farmers keen and willing to donate land, labour and time to conservation projects, but they want some real support, not just brochures on when to plant trees. We therefore need more direct assistance from government agencies to assist with conservation projects on private land.

Equally, the government agencies must more clearly determine how they will spend money. In 1991 in the Goulburn Broken River catchment area (2.3 million ha), public money subsidised the planting or protection of 18 ha of native vegetation regeneration, 87 ha of lucerne, 1031 ha of improved pasture and 433 ha of trees on recharge sites. Further, one of the supposed achievements of the year was an increase in incentives to plant improved pastures on recharge sites – from $30/ha to $60/ha. The provision of such an incentive runs counter to any nature conservation ethic. Just as the Land Improvement Scheme and

Phosphate Bounty encouraged landholders to clear their land and fertilise the paddocks, so this incentive scheme is encouraging landholders to plant an invasive weed. Conservation Departments should only provide grants to landholders willing to fence remnants of native vegetation, or should require that any grants for tree planting be matched by funding for fencing areas of native vegetation. Tree planting grants should specify that understorey species be included in the planting. Grants for corridor planting projects should require that corridors be at least 50 m wide and give priority to corridor projects that aim to fence out or widen existing corridors.

Overall, the removing of grazing from public land is the most effective action that conservation land managers can take to improve the long-term survival of remnants of native vegetation in the Box-Ironbark lands. In Victoria, 1.4 million hectares of public land (some 11% of all agricultural land) is grazed by domestic stock. And in some regions encompassing the Box-Ironbark communities, 30-35% of all public land is leased for grazing, with the consequence that most streamsides and roadside corridors have become degraded. If we removed grazing from these areas, we would gain an area of ungrazed *public* land slightly larger than the total area of land now contained in conservation reserves in Victoria – a vast gain for the *public* of Victoria. What would it cost to fence streamside sites, should we have the courage to do so? In the Department of Conservation and Natural Resources (DCNR) Benalla Region, as an example, there are c. 3500 ha of leased waterfrontage. To fence all those sites would cost about $3 million and would secure long-term conservation of the most important natural corridors that remain in northern Victoria.

Bennett discussed the perils of small patch size and habitat fragmentation for local populations of wildlife. To increase the long-term chances of survival for these populations, we need to restore 'islands' of habitat across the rural landscape, increase the size of remnants and improve connectivity between the remnants. What if we tried to fence against stock and restore, say, 5 ha of woodland blocks at the rate of one per 300 ha of land across the landscape. Within the DCNR Benalla Region (c. 1 million ha) there are some 200 such remnants on private land. To fence out those remnants would cost about $4 million in materials, with additional recurrent costs for their management by landholders. Another example: there are 154 Box-woodland reserves in the DCNR Benalla Region, the average size of which is 9 ha but many of them less than 2 ha in area. If, with permission, we fenced off 2 ha triangles on the private block corners adjoining all of those reserves it would cost just $87,000 and, in some cases, would double the size of existing reserves.

Many of these suggestions may sound daunting in scale. In truth, we simply need agreement that nature conservation is a priority in the Box-Ironbark lands and that landholders and government agencies must work together to find solutions, regardless of who owns the land. Note, for example, the two wonderful cases of local landholders giving time, labour and care to habitat protection works for Regent Honeyeaters and Superb Parrots (Willett; Davidson). Nature conservation in rural Australia can be achieved, but only if we remember to forge. We need to develop strategies that can incorporate protection of high quality sites on private land, protection of as many remnants as possible on public land and a shift towards lower stocking rates or practices which are more complementary to nature conservation on rural land. Only then is there a possibility of long-term survival of either wildlife or agriculture in the Box-Ironbark lands.

References

Beale, B. and Fray, P. (1990). 'The Vanishing Continent: Australia's Degraded Environment'. (Hodder and Staughton: Sydney).

Office of the Commissioner for the Environment (1991). 'Agriculture and Victoria's Environment'. (Office of the Commissioner for the Environment: Melbourne).

Robinson, D. and Bennett, S. (in prep). Patterns of decline among landbirds in southeastern Australia.

Woodgate, P. and Black, P. (1988). 'Forest Cover Changes in Victoria, 1869-1987'. (Dept of Conservation, Forests and Lands: Melbourne).

Forestry, Birds, Mammals and Management in Box and Ironbark Forests.

B.J. Traill*

Introduction

For two decades there have been bitter controversies over the effects of forestry operations on the flora and fauna of the mountain and coastal forests of eastern Australia. These disputes have led to the completion of a wide range of studies on the effects of logging in these forest types. However, the drier Box and Ironbark forests and woodlands have been largely ignored by groups on both sides of the debate. Yet these forests are in a far poorer state of conservation than most vegetation communities in the wetter forests (Frood and Calder 1987) and have been managed far more extensively, and intensively, for timber production (eg. Newman 1961).

In this paper I discuss the effects on fauna of forestry practices in Box and Ironbark forests and recommend changes needed to adequately conserve the vertebrate fauna of Box and Ironbark in timber production areas. Unless otherwise stated my comments in this paper specifically relate to Victoria but all discussions I have had with people working in New South Wales indicate that similar problems occur in that state.

History

In Victoria approximately 85% of the Box and Ironbark country has been totally cleared (Woodgate and Black 1987). With the possible exception of some small areas in East Gippsland, all the remaining country has been degraded in some way by mining, logging, grazing or combinations of all three. The clearing occurred mostly in the Grey Box *Eucalyptus microcarpa,* White Box *E. albens,* Yellow Box *E. melliodora* and Yellow Gum *E. leucoxlyon* communities on the more fertile soils. The vegetation associations in the remaining larger blocks are typically on poorer soils and are mostly Ironbark *E. sideroxylon* and *E. tricarpa,* and some Grey Box, communities (Frood and Calder 1987).

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These remaining larger blocks ('large' here means approximately 300 ha or more) have been used for timber production since gold-rush days in the 1850's. Initially there was uncontrolled cutting for mining timbers and fuel. Regrowth of trees from this early exploitation has been intensively managed for timber production. This included the systematic removal of mature trees in the 1930's and 1950's to improve the growth of younger 'pole' aged trees (Newman 1961). Mature refers here to ecological maturity, not silvicultural maturity as is used by foresters. An ecologically mature tree is one which has ceased net growth and is likely to have a large crown and dead wood and hollows of value to many species of wildlife.

The structure of the forest has changed from that of open stands of probably 30-40 trees per ha of mostly large, mature trees of greater than 1 m diameter at breast height, to the current structure of much denser stands of immature trees (Newman 1961; Kellas 1991). In most areas very little standing or fallen dead timber remains due to continual collection for firewood. Changes in the floristics of the forests since European settlement do not appear to be known.

Effects on fauna

At least two key wildlife resources are likely to have been affected by these changes: Tree hollows and nectar.

Tree Hollows

As in other forest types in Australia, a large proportion of birds and mammals in Box and Ironbark forests (about 40 species, around 30% of all resident birds and mammals) require tree hollows for nesting or roosting. Such hollows are usually provided by mature trees when the branches begin to die back and fungus or termites enter the tree (eg. Mackowski 1984). In Box and Ironbark forests such mature trees are rare or absent over large areas due to past silvicultural treatment.

Studies in the Chiltern State Park (146° 35' E., 36° 10' N.) in north-eastern Victoria indicate that a lack of hollows is affecting the distribution and densities of many species dependent on hollows. Meredith (1984) found significantly higher densities of arboreal mammals in parts of Chiltern with higher numbers of mature trees. I found that birds and mammals which required types of hollows found only in mature trees (eg. Powerful Owl, Barking Owl, Sacred Kingfisher, Australian Owlet-nightjar and Common Ringtailed Possum) were absent or very rare in areas lacking mature trees (Traill 1991).

Other hollow-dependent species such as Brush-tailed Possums, Brush-tailed Phascogales, Brown Treecreepers, and Squirrel and Sugar Gliders were found to use stumps and 'coppice hollows'. Coppice hollows are formed at the rotting base of trees that have regrown from coppicing stumps.

The two hollow types are widespread throughout Box and Ironbark forests but they are not abundant (pers. ob.) At sites which had these hollows but lacked mature trees, there was a high rate of use by these animals of artificial nest-boxes and a high degree of inter-specific overlap in the use of the available natural hollows (pers. ob.; T. Coates and T. Soderquist pers. comm.). This indicates that lack of suitable hollows may also be limiting populations of the animal species that can use stumps and coppice hollows.

Nectar

Eucalypt nectar (and possibly pollen) is an extremely important winter and spring food resource for birds and mammals in Box and Ironbark forests. Nearly 20% (25 species) of all resident Box and Ironbark birds and mammals feed on nectar. Ironbark *E. sideroxylon*, White Box *E. albens*, Yellow Box, Yellow Gum and Ironbark *E. tricarpa* are the important trees for nectarivorous vertebrates (Webster and Menkhorst 1992; Franklin *et al.* 1989; pers. ob.; T. Soderquist pers. comm.). The importance of the flowering is exemplified by what happens when flowering fails. At Chiltern in those years of poor flowering the normally resident and abundant Fuscous Honeyeaters disappeared from the forest and Squirrel Gliders and Sugar Gliders made unusually long daily movements to reach isolated flowering trees (pers. ob.). In good flowering years of White Box and Ironbark, very large numbers of nectarivorous honeyeaters and lorikeets may move into those areas. At Chiltern from transect counts, density estimates of up to 140 honeyeaters per ha have been recorded (pers. ob.).

Several pieces of evidence indicate that the loss of mature trees in Box and Ironbark would have reduced the availability of nectar. Apiarists report that larger trees produce more nectar (B. Kirkwood pers. comm.) and studies on nectarivorous vertebrates support this. Webster and Menkhorst (1992) found Regent Honeyeaters selected the largest trees within forest stands and preferred these for nectar feeding. Studies on Squirrel Gliders and Brush-tailed Phascogales also found that larger flowering trees were preferred (pers. ob.; T. Soderquist pers. comm.). Given that there has been a widespread reduction in the number and size of large mature trees then nectar production in the remaining Box and Ironbark forests may have been greatly reduced.

Other effects

There is little or no direct evidence of other effects of forestry operations on fauna in Box and Ironbark forests. However, it is worth strongly emphasising that lack of evidence indicates only a lack of studies not an absence of other deleterious effects.

One obvious change has been the widespread removal of dead timber for firewood. Extrapolation from studies in wetter Australian forest types indicates that in Box and Ironbark forests, the lack of dead fallen timber could severely affect amphibians, reptiles and ground mammals through loss of cover and foraging habitat (Dickman 1991, Scott 1991). The loss of standing dead timber may affect species such as the Varied Sittella and the Brush-tailed Phascogale which have a preference for foraging on dead timber (Noske 1985; Traill and Coates in press).

The changes in forest structure are likely to have affected factors such as the percentage of canopy cover and soil moisture and nutrient levels. The effects of any such changes on the abundance and distribution of herbaceous and understorey plants are not known. Any changes in floristics could lead to major changes in the vertebrate fauna.

Recommendations for future management

Currently most of the large blocks of Box and Ironbark in Victoria are designated for timber production. Up until the last two years habitat prescriptions (practices aimed at helping to buffer flora and fauna from the effects of logging) for these forests appear to have been adapted from those developed for the very different foothill forests, and they have, at best, been haphazardly applied (pers. ob.).

Given below are recommendations for habitat prescriptions and other actions to improve the conservation management of the remaining large blocks of Box and Ironbark. They are intended to provide a starting point and not a complete list of recommended actions. They are not listed in any order of priority.

1. *A review of the conservation reserve system in the Box and Ironbark country to systematically determine what additions are required.* Currently less than 3% of the original area of Box and Ironbark country is in conservation reserves. This is very likely to be too small and patchy to maintain the wide range of plant and animal communities in this ecosystem. The current reserve system in the area appears to have evolved haphazardly without examination of the ecosystem as a whole. This has perhaps been partly due to the lack of information of where species are, and which ones are threatened. Work in recent years has improved the knowledge of fauna and the Victorian Wildlife Atlas database now has reasonable distributional information, at least for birds and mammals in the area. However, there remains an urgent requirement for botanical surveys. Hopefully a beginning has been made this year with the start of a Goldfield's botanical survey by the Department of Conservation and Environment.
2. *In areas that continue to be used for timber production pre-logging biological surveys need to be carried out to determine sites of biological significance.* Currently sites known to have species listed as threatened under the Flora and Fauna Guarantee are still being logged, with no specific controls for determining the effects of logging on the species involved.
3. *The permanent retention of at least 10 large ('habitat') trees per hectare in remaining timber production areas.* Bendigo and Benalla Regions have apparently already begun implementing this, but state-wide prescriptions are required. In choosing habitat trees the largest available trees and those with existing hollows should be selected.
4. *Total ban on removal of all standing dead timber.* This will help the shortfall in production of tree hollows until the retained habitat trees begin producing hollows in the longer term.
5. *Ceasing the current practice of allowing random removal of fallen timber by firewood collectors.* Bendigo Region has apparently begun phasing out this practice and only allowing cutters to areas with a known resource from thinning or logging operations. This change should be implemented across the state.
6. *Ceasing the practice of allowing tree species with preferred timber quality (typically Ironbark) to form the larger*

'standard' trees, while keeping other tree species at a more immature level by frequent cutting for smaller sized timbers. This is against the spirit of the recommendation of the Victorian Timber Industry Strategy, that the natural composition of tree species should be maintained in timber production areas. Maintaining some species as saplings and shrubs does not constitute maintaining the natural ecological composition of the forest. In New South Wales the removal of Box species to favour the *Callitris* sp. is apparently a widespread management practice (B. Williams pers. comm.) with possibly severe consequences for the many animal species which depend on eucalypts for foraging and shelter.

7. *Ceasing of the unrestricted poisoning of* Dodder-laurel *Cassytha melantha.* Dodder-laurel is a parasitic creeper which has affected areas with coppice regrowth. Poisoning has occurred in some forest areas without any investigation of the effects of herbicides on other plant species. Problems with Dodder-laurel appear to arise as a result of logging practices which produce areas of young coppice growth (Pederick and Zimmer 1961). Any control work done should not use persistent herbicides and areas treated should first be surveyed for the presence of any significant vegetation.
8. *Examine the advantages of thinning coppice growth in conservation reserves.* Kellas *et al.* (1972) found increased growth rates in the remaining trees when thinning of surrounding growth occurred in a Bendigo Ironbark forest. Currently a large proportion of conservation reserves have dense stands of immature coppice growth. Thinning of some smaller trees could help to increase the speed at which large mature trees are restored to these areas.
9. *Work out sustainable yield in Box and Ironbark forests.* Currently the sustainable yield is not known. Until it is, the effects of logging on fauna will be very difficult to manage effectively in more than the short term.

References

Dickman, C. (1991). Use of trees by ground-dwelling mammals: implica-tions for management. *In* 'Conservation of Australia's Forest Fauna'. Ed. D. Lunney, pp. 125-136. (Royal Zoological Society: Sydney).

Frood, D. and Calder M. (1987). 'Nature Conservation in Victoria'. (Victorian National Parks Association: Melbourne).

Kellas, J.D. (1991). Management of the Dry Sclerophyll Forests in Victoria. 2. Box-ironbark forests. *In* 'Forest Management in Australia'. Ed. F.H. McKinnell, E.R. Hopkins and J.E.D. Fox, pp. 163-169. (Surrey Beatty: Sydney).

Kellas, J.D., Owen, J.V. and Squire, R.O. (1972). Response of Eucalyptus sideroxylon to release from competition in an irregular stand. *Forests Commission of Victoria Technical Note.* **No. 29.**: 33-36.

Mackowski, C. (1984). The ontogeny of hollows in Blackbutt *(Eucalyptus pilularis)* and its relevance to the management of forests for possums, gliders and timber. *In* 'Possums and Gliders'. Ed. A. Smith and I. Hume, pp. 553-567. (Surrey Beatty and Sons: Sydney).

Meredith, C. (1984). Possums or Poles? — the effects of silvicultural management on the possums of Chiltern State Park, northeast Victoria. *In* 'Possums and Gliders'. Ed. A. Smith and I. Hume, pp. 575-577. (Surrey Beatty and Sons: Sydney).

Newman, L.A. (1961). The Box-Ironbark forests of Victoria, Australia. *Bulletin of the Forest Commission of Victoria,* **No. 14.**

Noske, R.A. (1985). Habitat use by three bark-foragers of eucalypt forests. *In* 'Birds of eucalypt forests and woodlands: ecology, conservation, management'. Eds. A. Keast, H.F. Recher, H. Ford and D. Saunders, pp. 193-204. (Surrey Beatty and Sons: Sydney).

Pederick L.A. and Zimmer, W.J. (1961). The parasitic forest Dodder-laurel *Cassytha melantha. Bulletin of the Forests Commission of Victoria,* **No. 12.**

Scotts, D. (1991). Old-growth forests: their ecological characteristics and value to forest-dependent vertebrate fauna of south-east Australia. *In* 'Conservation of Australia's Forest Fauna'. Ed. D. Lunney, pp. 147-160. (Royal Zoological Society: Sydney).

Traill, B.J. (1991). Box-Ironbark forests: tree hollows, wildlife and management. *In* 'Conservation of Australia's Forest Fauna' Ed. D. Lunney, pp. 119-124. (Royal Zoological Society: Sydney).

Traill, B.J. and Coates T.D. *in press.* Field observations on the Brush-tailed Phascogale *Phascogale tapoatafa. Australian Mammalogy.*

Woodgate, P. and Black, P. (1988). 'Forest cover changes in Victoria 1869-1987'. (Victorian Department of Conservation and Environment: Melbourne).

Fauna Conservation in Box and Ironbark Forests: A Landscape Approach

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Abstract

Box and Ironbark forests in south-eastern Australia have experienced profound changes over the past 150 years. Landscapes that formerly were continuous forest and woodland cover are now mosaics of modified natural forests amongst cleared land. Changes to the spatial pattern of forests, changes to temporal patterns (time-related processes), and the introduction of new species to the flora and fauna, have each had, and continue to have, important consequences for the conservation of wildlife that depend on these forests. A landscape approach to wildlife conservation emphasises the need for understanding the structure and function of patchy environments, and for integrating natural resource management across broad areas that may include a range of differing land-uses.

Introduction

Landscape ecology is the study of land mosaics – their structure, function and change (Forman and Godron 1986). In recent years, there has been a growing interest in landscape ecology as a conceptual framework for land-use planning and the development of conservation strategies (e.g. Harris 1984; Noss and Harris 1986; Saunders 1990; Hanssen and Angelstam 1991; Hobbs *et al.* in press). This arises from a recognition that all environments, whether natural or modified, are mosaics of different elements.

Box and Ironbark forests in south-eastern Australia now comprise a complex patchwork of forest habitats of differing composition, size, shape, and degree of disturbance; interspersed with lands committed to agriculture and urban development. The patterns of occurrence of fauna within these different landscape components varies greatly. Effective conservation and land-use planning in such mosaics must recognise the characteristics and values of the different landscape components, the interactions between these components, and their changes through time. This requires that research, planning and management are carried out at an appropriately broad spatial scale. The need for a large scale is further highlighted by the complex movement patterns of animals within and beyond this forest system; by the size of natural areas that are required to sustain viable populations of all species (especially large predators); and by the geographic scale at which disturbance processes operate in these environments (e.g. fires, floods, rising saline groundwater).

The last 150 years of settlement have brought about profound changes to the pattern and structure of Box and Ironbark forest landscapes. The distribution and abundance of many species of animals that depend upon these forests has also changed markedly. In this contribution, I discuss from a landscape perspective, the types of changes that have occurred to Box and Ironbark forests, and the consequences that these changes have had on faunal populations. This approach provides a different, and complementary, perspective on wildlife conservation to that traditionally derived from surveys or the study of selected threatened species.

Box and Ironbark forest landscapes

Box and Ironbark forests, in the present context, refer to the broad zone of forests and woodlands along the inland slopes of the Great Dividing Range and adjacent plains, that are dominated by eucalypts known as Ironbarks (e.g. Red Ironbark *Eucalyptus sideroxylon*) or Box species

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(e.g. Yellow Box *E. melliodora,* Grey Box *E. microcarpa,* White Box *E. albens,* Red Box *E. polyanthemos*). Little information is available on the natural structure and composition of Box and Ironbark forests prior to European settlement. Recent descriptions of these forests in Victoria are provided by Newman (1961), Land Conservation Council (1978, 1983, 1984) and Frood and Calder (1987). Box and Ironbark forests comprise a mosaic of different forest types, varying in floristic composition, structure and productivity. This diversity arises from variation in topography, geology, soil structure and fertility, and moisture regimes. In turn, the forest mosaic provides habitats that differ in the quality and quantity of resources (e.g. food, shelter, nest sites) that are available to animals.

A useful distinction can be made between the forest landscapes of the inland slopes and foothills of the Great Dividing Range and those on the inland riverine plains. The slopes and foothills are of Paleozoic origin, and their variable topography (ridges, slopes, valleys) results in higher spatial diversity of forest types than on the plains (i.e. there is a greater range of forest types within a defined area). The composition of these forests generally includes two or more dominant eucalypts, and sclerophyllous shrubs are prominent in the understorey. Typical Ironbark forests dominated by Red Ironbark and Grey box occur in these landforms.

In contrast, the plains have a more recent origin in the Quaternary period. Topographic relief is limited and the spatial diversity of habitats is lower than in the foothills. Woodlands on the plains are often dominated by a single species of eucalypt (e.g. Yellow Box, Grey Box, Black Box *E. largiflorens*), and the understorey is generally dominated by grasses and herbs.

Natural forests and woodlands of the plains and foothills were extensive in size, and essentially comprised large continuous areas with few natural barriers to the movement of forest-dependent animals. They were also continuous with habitats in other biogeographic regions; in the south and east with wetter forests of the Dividing Range, and in the north and west with *Casuarina* woodlands, mallee shrublands and chenopod shrublands.

Changes to Box and Ironbark forest landscapes

Three major types of change to the natural landscape can be recognised: changes to spatial patterns in the landscape; changes to temporal patterns in the landscape and the introduction of new species to the landscape. These are each discussed briefly, together with the consequences that they can have for animal populations.

Changes to spatial patterns in the landscape

The main aspects of the spatial pattern of habitats in a landscape are: the **amount** of each habitat type, **where** it is located, and **how** it is arranged. Here, these aspects are considered in relation to remnant forest vegetation amongst cleared land.

Amount of natural habitat

The riverine plains and inland slopes and foothills were among the most attractive lands for pastoral settlement in the 19th Century, and were rapidly occupied by pastoralists following overland exploration. In the ensuing 150 years, there has been a massive loss and degradation of forests and woodlands. In Victoria, the two main regions supporting Box and Ironbark forests have lost approximately 84% (Benalla region of the Department of Conservation and Natural Resources) and 85% (Bendigo region) of their forests (Woodgate and Black 1988); and Caughley and Gall (1985) estimated a 95% loss of forests and woodlands in the south-west slopes region of New South Wales.

For wildlife that depend on forests and woodlands, the consequences of these changes have been devastating. A number of species have become extinct in the region (e.g. Marlow 1958), many more species are considered threatened (Baker-Gabb 1991), and hundreds of species have experienced regional and local population declines. Every time that remnant woodland is cleared or fragmented, the population decline continues. For example, estimates of the densities of woodland birds (Bennett unpubl. data) indicate that for every 100 ha of woodland that is cleared, between 1000-2000 birds permanently lose their habitat.

A clear implication for conservation and management is that the amount of available habitat sets an upper limit on the maximum size that populations can achieve. This may also impact on conservation recovery efforts. Regardless of scientific management skills, an upper limit on the size of a threatened species population is imposed by the availability of suitable habitat.

Conversely, for species that are able to utilise farmland and grassland environments, these landscape changes have led to an increased amount of habitat. Native species such as Crested Pigeon *Ocyphaps lophotes* and Galah *Cacatua roseicapilla*, have had the opportunity to expand their ranges or increase population sizes. Introduced species, such as European Rabbit *Oryctolagus cuniculus*, Brown Hare *Lepus capensis*, Common Starling *Sturnis vulgaris* and European Goldfinch *Carduelis carduelis* have also benefited from these changes.

Location of remnant natural habitats

A striking difference in the location of remaining forest habitats relates to land tenure: by far the greatest amount of natural vegetation is on public lands. In the Benalla region, for example, 85% of remaining forests are on public land compared to 15% on privately owned land, although private land comprises 87% of the total area (Woodgate and Black 1988). Clearly, public lands must be a primary focus for conservation strategies. This does not imply that forests and woodlands on private lands are not important: they have a critical role where they support habitats that are poorly reserved on public land, they may form valuable corridor links through the landscape, and they are essential if we are to maintain populations of wildlife throughout their natural ranges.

The loss of forests has not been uniform throughout the environment. There has been a selective loss from those areas that have the most fertile soils and are most amenable to agriculture (Newman 1961). In particular, there has been a disproportionate loss of forests and woodlands on the plains, and from the lower slopes and fertile stream valleys. Forests that remain are located mainly on rocky areas, upper slopes, poorer soils, or alluvial floodplains that are subject to periodic inundation. This selective loss has resulted in a greater impact on those components of the fauna that depend on these habitats. Box woodlands dominated by Grey Box, Yellow Box and White Box, for example, have been severely depleted and those remaining have generally been degraded and disturbed. It is not surprising, then, that a number of species that utilised these habitats are now extinct or regarded as threatened (e.g. Bush Thick-knee *Burhinus magnirostris*, Squirrel Glider *Petaurus norfolcensis*, Brush-tailed Phascogale *Phascogale tapoatafa*). Species that utilise these habitats on a seasonal basis are also affected. Yellow Box and White Box are important food sources for nectarivorous birds, such as the Regent Honeyeater *Xanthomyza phrygia* (Webster and Menkhorst 1992), that move between habitats on a seasonal basis. Selective loss of forests may deplete a food resource at a critical time of year and contribute to local or regional population declines.

Recent research in forests of south-eastern Australia has highlighted the importance of patterns of soil fertility. Sites with fertile soils tend to have higher productivity, higher foliage nutrient levels, and a greater diversity and abundance of certain animal species (e.g. Braithwaite *et al.* 1983, 1989). Forests and woodlands on fertile soils are those habitats that were most rapidly cleared for agriculture in the Box and Ironbark belt, leaving little associated vegetation for wildlife. Thus, not only has there been extensive loss of habitats, but clearing has been selective and those that have been lost may have supported the greatest diversity and abundance of wildlife.

How the remaining habitats are distributed

Box and Ironbark forests now exist as a mosaic of patches and strips of varying size, shape and isolation, across the landscape. The largest blocks generally occur on the slopes and foothills, while remnant forests on the plains are primarily small scattered blocks or linear strips along roads and watercourses.

Size and shape of remnants have been shown to be important influences on fauna. Size has consistently been identified as a significant correlate of the number of species present in remnant habitats in Australia (Kitchener *et al.* 1980; Suckling 1982; Bennett 1987; Loyn 1987). With increasing size of remnants an increasing number of species are present. For example, Caughley and Gall (1985) documented a significant relationship between the number of species of reptiles and frogs in nature reserves and State forests in the south-west slopes of NSW and the size of those forests. Size also influences the composition of the fauna that inhabits remnants. Some species are 'generalists' that are able to utilise a range of areas, while others are restricted mainly to larger remnants. Species with 'specialist' requirements for food or habitat are preferentially lost as habitats are reduced in size (Humphreys and Kitchener 1982).

The shape of the remnant vegetation is also important. Linear strips such as roadsides and creekside vegetation, can become 'edge' habitats that may be unsuitable for forest-dependent species. A simple summary is presented in Table 1 of species of birds that occurred most frequently at a comparable series of census plots in Grey Box forest on roadsides and in forest blocks in northern Victoria (Bennett unpubl. data). The difference is striking – only one species (Willie Wagtail *Rhipidura leucophrys*) had a high frequency of occurrence in both landscape elements. Many of the commonly-occurring birds on roadsides are species that forage in farmland (e.g. Australian Magpie *Gymnorhina tibicens,* Galah, Eastern Rosella *Platycercus eximius*).

These patterns of distribution mean that for many species in fragmented landscapes, the amount of suitable habitat may be much less than that apparently present to the casual observer. A false impression of how much habitat remains can easily be gained. For example, in the Northern Plains of Victoria where remaining Box woodlands are mostly linear strips, the amount of suitable habitat for species such as Hooded Robin *Melanodryas cucullata,* Western Gerygone *Gerygone fusca* and Buff-rumped Thornbill *Acanthiza*

Table 1. Commonly occurring birds in Grey Box forests on roadsides and in forest blocks in northern Victoria. (Species that were recorded from four or more 1.0 ha sites, censused twice in spring 1991, are listed in decreasing frequency of occurrence.)

ROADSIDES (n=11) Species	Sites	BLOCKS (n=11) Species	Sites
Australian Magpie	10	White-plumed Honeyeater	9
Striated Pardalote	8	Willie Wagtail	6
Noisy Miner	7	Jacky Winter	5
Willie Wagtail	6	Brown Treecreeper	5
Eastern Rosella	4	White-browned Woodswallow	5
Galah	4	Dusky Woodswallow	4
Yellow-rumped Thornbill	4	Rufous Whistler	4
Brown-headed Honeyeater	4	Grey Fantail	4
		White-winged Chough	4
		Black-faced Cuckoo-shrike	4

reguloides that require forest blocks, is extremely small. Conversely, for species such as Noisy Miner *Manorina melanocephala,* Red-rumped Parrot *Psephotus haematonotus* and Eastern Grey Kangaroo *Macropus giganteus* that thrive in edge habitats, substantial areas of habitat are still available.

Isolation is an important consequence of the fragmented pattern of remnant vegetation. Expanses of farm paddocks are barriers to the movement of many animals that depend on forest vegetation. Small animals with low mobility (e.g. reptiles, small mammals, spiders) are particularly vulnerable to habitat isolation, and the local extinction of many small, isolated populations will inevitably continue. Corridors or 'stepping stones' of natural vegetation may facilitate population continuity between otherwise isolated habitats, by providing links of suitable habitat through the inhospitable environment (Bennett 1990). At Barmah Forest, Victoria, the Superb Parrot *Polytelis swainsonii* nests in large River Red Gums in the forest, and feeds in remnant Box woodlands in nearby farmland. These birds regularly use forested roadside corridors as a pathway for flight between habitats, instead of flying across open paddocks (Webster 1988).

Ecological processes in remnant forests can be disrupted or altered when key plants or animals disappear, or when environmental conditions are altered. We know little about the essential components of processes such as seed dispersal, pollination, predator-prey relationships, and nutrient cycling, or the implications of the breakdown of these processes in remnants. The loss of basic ecological processes can have far-reaching effects on the health and stability of ecosystems. Defoliation and dieback of eucalypts, for example, can have profound effects on rural environments (Beckmann 1990; Landsberg *et al.* 1990). Dieback is generally more severe for isolated trees or small remnants amongst pasture, than for larger protected blocks.

Changes to temporal patterns in the landscape

Changes to time-related processes in the landscape also have implications for biological conservation.

Changes to the age structure of forests

Older trees provide important resources for wildlife populations in Box and Ironbark forests. Tree hollows, which characteristically do not develop until trees reach older stages, are required for shelter and breeding sites by a range of animals such as parrots, cockatoos, owls, possums, gliders and bats. Large old trees may have heavier flowering and nectar flows, and may also be important for their foliage density and mistletoe infestations.

The age structure of Box and Ironbark forests and the relative proportions of older and younger trees show marked variation through the landscape. In Victoria, forests on public land are biased towards younger age classes; the old trees are scarce after a history of felling for mining timbers and forest products. Comparisons of the fauna in forests of different age structures show that animal species that depend on tree hollows are greatly reduced in number, or are absent, from stands where old trees and hollows are scarce (Meredith 1984; Traill 1992).

In contrast, remnants and isolated trees on private land are frequently biased towards older age-classes. In these situations it is the lack of regeneration that is of concern. Unless opportunities for regeneration are provided, profound changes to the rural landscape can be expected as these older trees senesce and die, and tree cover is lost. Roadside strips of vegetation are often valuable as stands in which both older and younger age classes are represented.

Rates of land degradation

The visible effects of land degradation (soil erosion, weed infestation, salination of land and water) and its impact on primary production has been a major stimulus for the growth of the LandCare movement in Victoria and throughout

Australia. Time-related processes such as the compaction of soils, the loss of topsoil layers, the erosion of slopes and stream channels, the rise of saline groundwater, and the salination of streams and wetlands, are all degrading processes that have accelerated over the last 150 years of agricultural settlement. Their effects are far from trivial, because soils and water are basic elements in the sustainability of ecological processes upon which all living things depend. Unless these processes are halted and reversed, farmland will continue to go out of production, and natural ecosystems will continue to be degraded.

Introduction of new species to the landscape

A third major type of change to Box and Ironbark forests is the introduction of new elements into the flora and fauna. Introduced herbivores (e.g. sheep, cattle, rabbits, hares) and their impacts on natural habitats were probably responsible for the first wave of population decline and regional extinction in the fauna of the inland slopes and plains from the 1860's onwards. Medium-sized mammals in the 'critical weight range' of 3500-5500 g (Burbidge and McKenzie 1989) have been the most vulnerable; species such as the Rufous Bettong *Aepyprymnus rufescens*, Bridled Nail-tail Wallaby *Onychogalea fraenata* and White-footed Rabbit Rat *Conilurus albipes*. Introduced herbivores continue to degrade natural habitats and limit regeneration. There is a critical need for research to clearly define these impacts and for active management to prevent further degradation, especially on public lands.

The introduced carnivores, Fox *Vulpes vulpes* and Cat *Felis catus*, are known to be effective predators of native fauna, and are likely to have their greatest impact on ground-dwelling or ground-nesting animals. Other introduced species are potential competitors with native fauna. Common Starlings, for example, compete with native birds for nest sites in tree hollows, and honey bees potentially compete for tree hollows and nectar sources.

Large numbers of introduced plant species are present in the Box and Ironbark forest regions, and now comprise a substantial percentage of regional floras (e.g. 319/1103 species in north-central Victoria, Beauglehole 1980). Introduced grasses and legumes are the basis of agriculture on private land, but unfortunately many of these introduced plants also invade and degrade natural ecosystems.

Landscape perspectives for conservation and management

An important contribution of a landscape perspective to conservation is its emphasis on planning and management at the level of whole landscapes that typically comprise areas of different land-use and varying habitat quality. Some of the implications of this approach to the management and conservation of fauna in Box and Ironbark forests are discussed below.

Conservation and management of threatened species

An understanding of the consequences for animals of landscape pattern and landscape change can complement knowledge of a species' biology to provide an appreciation of its conservation status and causes of decline. Together, these approaches may also facilitate the prediction of those species that are likely to become threatened in the future. For example, Table 2 lists several groups of animal species that utilise Box and Ironbark forests whose conservation status warrants concern. Each group is affected by at least three main types of landscape change.

A landscape approach also emphasises different types of questions that need to be addressed at both the research and management phrases of wildlife conservation. For example, which parts of the landscape mosaic does a particular species use? Do certain parts of the landscape have a higher abundance and diversity of wildlife? What is the spatial pattern and size of species' populations? How easily can a species move between the different habitats that it uses? What are the long-term effects of changes to the availability of resources that a species requires?

Time-related processes and management

Changes to time-related processes are less obvious than changes to the spatial pattern of habitats, but their long-term effects may be equally severe. There are several important implications.

Firstly, there is a time-lag in experiencing the full effects of past changes. The lack of tree regeneration in farmland, for example, will not be fully experienced for many decades until veteran trees collapse and die, and woodland cover disappears. Secondly, the measures that are implemented now to arrest land degradation and enhance conservation may require many years to take effect, and species will continue to decline in the meantime. For example, the cessation of timber harvesting in an Ironbark forest will not result in an immediate increase in the availability of tree hollows – it will take decades for such management actions to have an appreciable effect.

Thirdly, it is essential that land managers and the community appreciate that the decline and extinction of wildlife species is a process, not a sudden event. Typically, this process might involve a widespread species becoming uncommon within a restricted range, then declining further to scarce localised populations, then to rare sightings, and finally local extinction. The decline of the Grey-crowned Babbler in parts of its range in Victoria (Schulz 1991) is an example of such a process (Fig. 1). This species has disappeared from south-western Victoria, and its status in the area north of Melbourne and on the Mornington Peninsula is precarious. Populations in the Wimmera and lower Murray Valley have also declined. We must learn to recognise the symptoms of decline, and to act before species reach crisis situations.

An integrated approach to management and conservation

Box and Ironbark forests are now largely remnants within the wider rural environment in south-eastern Australia. If we are to pursue a national goal of

Table 2. Examples of groups of species of potentially threatened conservation status in box and ironbark forests and major landscape changes that affect their populations.

Species group	Examples of species	Landscape changes with major impacts
Hollow-dependent species that require large areas	Powerful Owl Barking Owl Squirrel Glider Brush-tailed Phascogale Australian Owlet-nightjar	Reduction in total area of habitat Reduction in size of remnants Change in forest age-structure (loss of hollows)
Mobile species that utilise resources in different locations	Little Lorikeet Superb Parrot Swift Parrot Regent Honeyeater Painted Honeyeater Mistletoebird	Reduction in total area of habitat Selective loss of important habitats Isolation of habitats
Forest-dependent species that forage and nest on the ground, or live in or on the ground.	Hooded Robin Southern Whiteface Bush Thick-knee Woodland Blind Snake Bandy Bandy	Selective and extensive habitat loss Degradation of soils and ground vegetation Introduced predators

ecologically sustainable development, then both sustainable agricultural production and sustainability of our flora and fauna are necessary and important goals in these environments. The challenge is to develop an integrated approach to landscape management that encompasses both of these goals.

A landscape perspective emphasises the integration of natural resource management across the whole landscape, rather than being focussed on selected areas (e.g. conservation reserves on public land) to the exclusion of all others. This is especially relevant to the fragmented landscapes that are typical of rural environments in Australia (Hobbs *et al.* in press). For example, large areas of natural vegetation are of great importance for wildlife conservation, but often all that persists in the rural environment are small remnants of various shapes and sizes on both private and public land. Management of these remnants as systems of habitat across the landscape will maximise their value for the conservation of biodiversity, while also maintaining their contribution to the ecological health and sustainability of the rural environment.

Acknowledgements

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References

Baker-Gabb, D. (1991). 'List of threatened fauna in Victoria in 1991'. (Department of Conservation and Environment: Victoria.)

Beauglehole, A.C. (1980). 'Victorian Vascular Plant Checklists'. (Western Victorian Field Naturalists Clubs Association: Portland.)

Beckmann, R. (1989/90). Rural dieback: restoring a balance. *Ecos* **62:** 8-15.

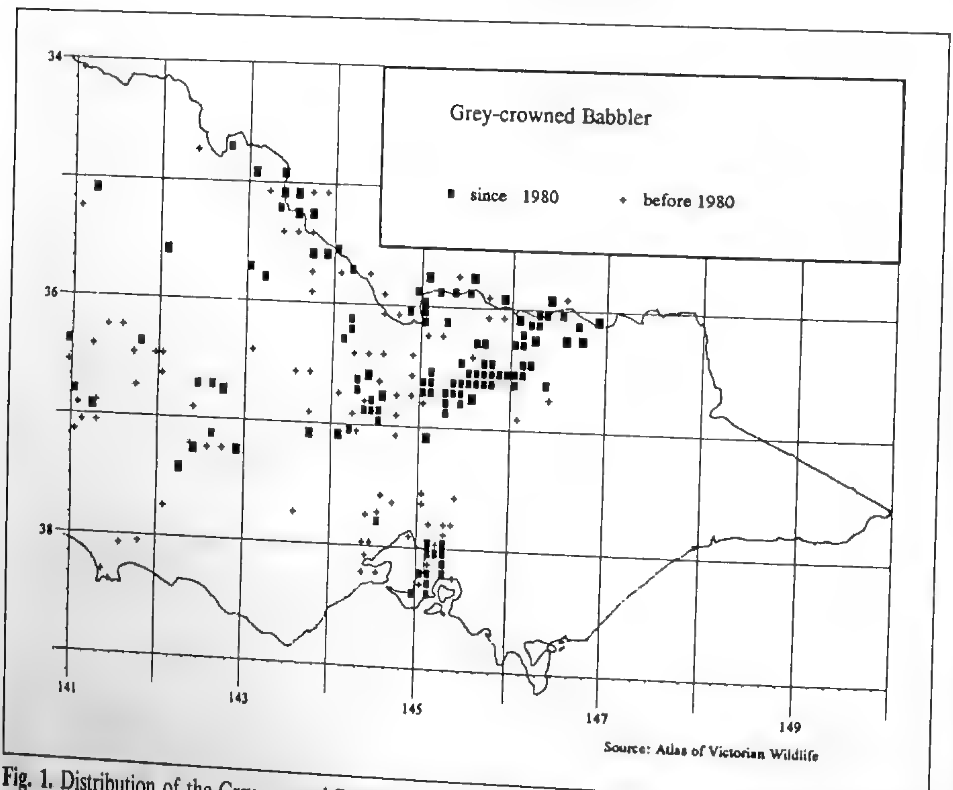

Fig. 1. Distribution of the Grey-crowned Babbler in Victoria. This species no longer occurs in south-western Victoria, and its status near Melbourne and on the Mornington Peninsula is precarious. Its stronghold is in Northern Victoria.

Bennett, A.F. (1987). Conservation of mammals within a fragmented forest environment: the contributions of insular biogeography and autecology. *In* 'Nature Conservation: The Role of Remnants of Native Vegetation'. Eds. D.A. Saunders, G.W. Arnold, A.A. Burbidge and A.J.M. Hopkins. pp. 41-52 (Surrey Beatty: Sydney).

Bennett, A.F. (1990). 'Habitat Corridors: Their Role in Wildlife Management and Conservation.' (Department of Conservation and Environment: Melbourne).

Braithwaite, L.W., Austin, M.P., Clayton, M., Turner, J. and Nicholls, A.O. (1989). On predicting the presence of birds in *Eucalyptus* forest types. *Biological Conservation* **50:** 33-50.

Braithwaite, L.W., Dudzinski, M.L. and Turner, J. (1983). Studies on the arboreal marsupial fauna of eucalypt forests being harvested for woodpulp at Eden, New South Wales II. Relationship between the fauna density, richness and diversity, and measured variables of habitat, *Australian Wildlife Research* **10:** 231-47.

Burbidge, A.A. and McKenzie N.L. (1989). Patterns in the modern decline of Western Australia's vertebrate fauna: causes and conservation implications. *Biological Conservation* **50:** 143-98.

Caughley, J. and Gall, B. (1985). Relevance of zoogeographical transition to conservation of fauna: amphibians and reptiles in the south-western slopes of New South Wales. *Australian Zoologist* **21:** 513-29.

Forman, R.T.T. and Godron, M. (1986). 'Landscape Ecology.' (John Wiley & Sons: New York.)

Frood, D. and Calder, M. (1987). 'Nature Conservation in Victoria. Study Report Volumes 1 & 2.' (Victorian National Parks Association: Melbourne.)

Hansson, L. and Angelstam, P. (1991). Landscape ecology as a theoretical basis for nature conservation. *Landscape Ecology* **5:** 201.

Harris, L.D. (1984). 'The Fragmented Forest. Island Biogeographic Theory and the Preservation of Biotic Diversity.' (University of Chicago Press: London.)

Hobbs, R.J., Saunders, D.A. and Arnold, G.W. (in press). Integrated landscape ecology: a Western Australian perspective. *Biological Conservation*

Humphreys, W.F. and Kitchener, D.J. (1982). The effect of habitat utilization on species-area curves: implications for optimal reserve design. *Journal of Biogeography* **9:** 391-6.

Kitchener, D.J., Chapman, A., Dell, J., Muir, B.G. and Palmer, M. (1990). Lizard assemblage and reserve size and structure in the Western Australian wheatbelt – some implications for conservation. *Biological Conservation* **18:** 179-207.

Land Conservation Council (1978). 'Report on the North Central Study Area.' (Land Conservation Council: Melbourne.)

Land Conservation Council (1983). 'Report on the Murray Valley Area.' (Land Conservation Council: Melbourne.)

Land Conservation Council (1984). 'Report on the North eastern Area (Benalla-Upper Murray) Review.' (Land Conservation Council: Melbourne.)

Landsbergh, J., Morse, J. and Khanna, P. (1990). Tree dieback and insect dynamics in remnants of native woodlands on farms. *Proceedings of the Ecological Society of Australia* **16:** 149-65.

Loyn, R.H. (1987). Effects of patch area and habitat on bird abundances, species numbers and tree health in fragmented Victorian forests. *In* 'Nature Conservation: The Role of Remnants of Native Vegetation'. Eds. D.A. Saunders, G.W. Arnold, A.A. Burbidge and A.J.M. Hopkins. pp. 65-77 (Surrey Beatty: Sydney).

Marlow, B.J. (1958). A survey of the marsupials of New South Wales. *CSIRO Wildlife Research* **3:** 71-114.

Meredith, C.W. (1984). Possums or poles? – the effects of silvicultural management on the possums of Chiltern State Park, northeast Victoria. *In* 'Possums and Gliders'. Eds. A.P. Smith and I.D. Hume. pp. 575-7. (Australian Mammal Society: Sydney).

Newman, L.A. (1961). The Box-Ironbark forests of Victoria. *Forests Commission Victoria, Bulletin* **14.**

Noss, R.F. and Harris, L.D. (1986). Nodes, networks and MUMS: preserving diversity at all scales. *Environmental Management* **10:** 299-309.

Saunders, D.A. (1990). The landscape approach to conservation: community involvement, the only practical solution. *Australian Zoologist* **26:** 49-53.

Schulz, M. (1991). The Grey-crowned Babbler *Pomatostomus temporalis* – a cause for concern in southern Victoria. *Australian Bird Watcher* **14:** 37-43.

Suckling, G.C. (1982). Value of preserved habitat for mammal conservation in plantations. *Australian Forestry* **45:** 19-27.

Traill, B.J. (1992). Box-Ironbark forests: tree hollows, wildlife and management. *In* 'Conservation of Australia's Forest Fauna'. Ed. D. Lunney pp. 119-23. (Royal Zoological Society of New South Wales: Sydney).

Webster, R. (1988). The Superb Parrot. A survey of the breeding distribution and habitat requirements. *ANPWS Report Series No. 12.*

Webster, R. and Menkhorst, P. (1992). The Regent Honeyeater (*Xanthomyza phrygia*): population status and ecology in Victoria and New South Wales. *Arthur Rylah Institute for Environmental Research Technical Report Series No.* **126.** (Department of Conservation and Environment, Victoria.)

Woodgate, P. and Black, P. (1988). 'Forest Cover Changes in Victoria 1869-1987.' (Department of Conservation, Forests and Lands: Victoria.)

Conservation of Remnant Vegetation in the Box and Ironbark Lands of New South Wales

Dominic Sivertsen*

Introduction

Box and Ironbark communities cover over 90% of New South Wales. A plot of the known distributions of the commonest and most widespread Ironbark and Box species in NSW (*Eucalyptus crebra, E. fibrosa, E. melanophloia, E. sideroxylon, E. populnea, E. largiflorens, E. intertexta, E. microcarpa, E. conica* and *E. melliodora*), shows that only the north-west and the south-east corners of the State lack these communities (Fig. 1). In this paper it is the overlap zone between Box and Ironbark species, as they occur west of the great divide (Fig. 2), comprising about one third the area of NSW, which will be discussed; i.e. the Box and Ironbark lands. The NSW National Parks and Wildlife Service currently has three broad-scale vegetation inventory and mapping programmes underway in this region, namely, the Northern Wheatbelt (NWB), the Southern Wheatbelt (SWB), and the Pilliga Nature Reserve (Fig. 3).

Within this area are many vegetation communities other than Box and Ironbark woodlands. They include: Brigalow (*Acacia harpophylla*) lands in the north; Boree (*Acacia pendula*) communities throughout; native grasslands; and wetland, Belah, and riparian communities to name but a few. These communities, and their component plants and animals, do not occur in isolation but as a network; and as conservationists and land managers, our challenge in the future is the conservation of this complex mosaic.

In this paper I intend to explore the processes of change, their effects on biodiversity and their implications for conservation in the Box and Ironbark lands of NSW.

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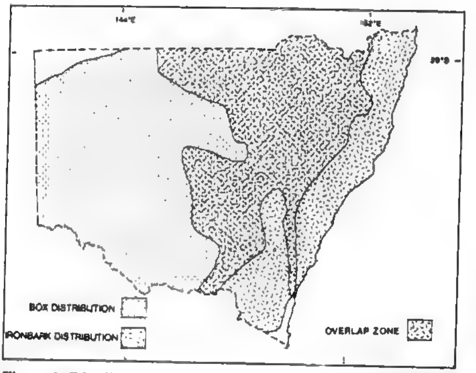

Figure 1. Distribution of common Box and Ironbark species in NSW. (After Brooker and Kleinig, 1983)

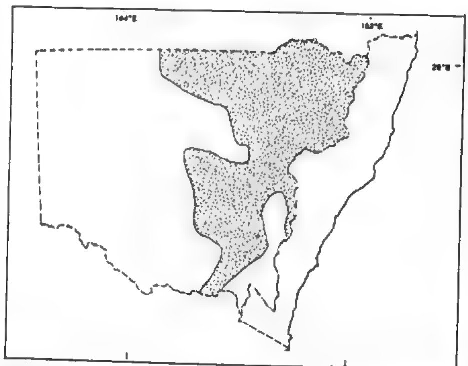

Figure 2. The Box and Ironbark Lands of NSW. The overlap zone between box and ironbark species west of the Great Divide.

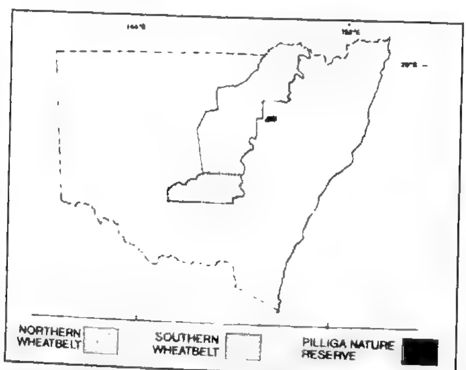

Figure 3. NSW National Parks and Wildlife Service Vegetation surveys current in the Box and Ironbark lands.

Processes of change

A number of processes in this part of New South Wales have considerably changed the Box and Ironbark lands. In order to adequately manage these communities, and the species they contain, we must identify these processes and their effects.

Clearing

Clearing of native vegetation is producing the greatest change in the Box and Ironbark lands of NSW. This region is the main cereal producing part of the State and has been subject to extensive clearing since European settlement, this has resulted in widespread habitat loss and fragmentation. Estimates of clearing vary, however, between 70% and 95% of the original native tree and shrub vegetation has been cleared since the mid 1800's (Murray Darling Basin Ministerial Council 1987). Duggan and Allison (1984) describe a similar trend in native grasslands of the Liverpool Plains. Clearing has also led to severe fragmentation of the remaining native vegetation. Many remnants are small and isolated or joined by narrow corridors. The bulk of these corridors are road verges, road reserves and river-bank remnants. Soule and Gilpin (1991) suggest that the ecological hazards associated with such narrow corridors can mean that they are a net liability for the survival of some species. This is particularly true in corridors containing functioning roads with the additional hazard of road-kills. The lesson here is not to reject corridors, but to assess their utility for species known to occur in the area. For example, a bird such as the Regent Honeyeater (*Xanthomyza phrygia*) may successfully utilize a narrow corridor of trees with disjunct canopy and no understorey, as long as the tree species are favourable. On the other hand, the same corridor may present insurmountable barriers or unacceptable risks to species such as the White Winged Wren (*Malurus leuctopterus*), which requires dense shrubs, or to a small mammal like the Yellow-footed Antechinus (*Anthechinus flavipes*) which requires low shrubs and tussock grasses.

Clearing is an ongoing process. As an indication of contemporary clearing rates, Fig. 4 shows the reduction in woody vegetation cover of all types on the Condobolin 1:100,000 sheet between 1974 and 1989. Clearing has taken this vegetation cover from about 94,000 ha in 1974 to 36,600 ha in 1989; a reduction of 57,400 ha or 61% in 15 years. This is a clearing rate of about 3,800 ha per year.

Clearing means the total destruction of habitat for most native plants and animals. Although stating the obvious, we must realise that preconceived notions of natural distributions of species may no longer apply; the potential distributions of species in the Box and Ironbark lands have been significantly and, apparently permanently, changed.

Fragmentation and isolation cause profound changes in remnant vegetation. Changes to microclimate i.e. the radiation balance, wind effects and water balance result from fragmentation and, together with time since isolation, distance from

Figure 4. Native, woody vegetation of the Condobolin 1:100,000 scale map in 1974 [white box] and what remains in 1989 [black box]

other remnants, size and degree of connectivity will greatly influence species survival in those remnants (Saunders *et al* 1991). For example, such changes: affect the dispersal and reproductive patterns of many plant species (Hobbs 1987); have contributed to the decline in Carnaby's Cockatoo (*Calyptorhynchus funereus latirostris*) in the Western Australian wheatbelt whilst the numbers and breeding success of Galahs (*Cacatua roseicapilla*) have increased (Saunders and Ingram 1987); have contributed to the decline in the Regent Honeyeater (Franklin *et al* 1989) and the Superb Parrot (*Polytelis swainsonii*) (Webster 1988) in eastern Australia; and have brought about decline in invertebrates such as the Chekerspot butterfly (*Euphydryas editha*) from native grassland remnants in California (Ehrlich and Murphy 1987; Ehrlich 1992). A review of the literature will reveal similar trends world-wide and in all taxonomic groups.

Grazing

Grazing by domestic stock such as sheep (*Ovis aries*) and cattle (*Bos taurus*) and feral grazers such as goats (*Capra hircus*) and rabbits (*Oryctolagus cuniculus*) has affected change in the Box and Ironbark lands of NSW. The effects of grazing are, perhaps, more subtle than those of clearing but they are just as important in the survival of many species. Grazing has extensively altered the native grass, shrub and small tree components of native vegetation (Denny 1987 cited in Benson 1991). Some plant extinctions are directly attributable to the effects of grazing (Benson 1991).

In the north of the Box and Ironbark lands grazing has caused a rapid decline in tall perennial native grasses (e.g. *Themeda australis*) followed by a slower decline in shorter native grasses and an increase in unpalatable shrubs. In the south, on the riverine plains, this trend is paralleled by a decline in palatable chenopods (e.g. *Atriplex nummilaria* and *A. vesicaria*) which have been replaced by introduced grasses with poor grazing potential such as *Hordium spp.* (see Adamson and Fox 1982 for a review). The trend in the north is supported by recent work of Grice and Barchia (1992) and is also supported by NPWS work in the wheatbelt. About 89% of the 1200 sites described in the northern and southern wheatbelt surveys show evidence of grazing in the form of sheep, goat and/or rabbit faeces. These sites tend to contain few native perennial grasses or palatable shrubs. However, they do often support shrub layers of unpalatable species. By contrast other sites with low grazing pressure; for example verges of minor roads and fenced off hill-tops, commonly have a diverse shrub and/or tall native grass layer.

Grazing not only removes adult plants, it also inhibits recruitment of many species. There are no juvenile palatable woody species in most sites in the NPWS wheatbelt study areas. In some instances there is abundant post-disturbance recruitment but the overwhelming trend is for there to be little recruitment amongst most tree and shrub species. However, not all plant species suffer decline under grazing regimes; the most notable exceptions are those that are poisonous and unpalatable to stock, many of which have become known as woody weeds (e.g. Budda, *Eremophila mitchellii*, and Deans Wattle, *Acacia deanii*).

Grazing by hard-hoofed animals has also altered soil conditions considerably. Compaction and loss of the original soil surface (60% of the wheatbelt sites showed obvious signs of erosion) affects the habitat availability for many small, ground-dwelling mammals and reptiles. Soil compaction alters water penetration regimes, soil moisture holding capacity and runoff; all of which will ultimately affect the survival of species locally and the quality of ground-water in connected aquifers (see Saunders *et al* 1991; Adamson and Fox 1982).

Hence grazing, like clearing, has significantly affected the Box and Ironbark lands of NSW, the plant and animal species they contain and the processes that support them.

Other processes

State Forests comprise the largest remnants of natural vegetation in this part of NSW and, although they provide important habitat and refuge for many species, they often comprise considerably altered habitat regimes. Most are grazed by either domestic stock or goats and hence, have had their understories altered as described previously. Ironbark species have been selectively logged and, particularly in the west, Box species have been removed to encourage recruitment of the more commercially viable White Cypress Pine (*Callitris glaucophylla*) thus altering the canopy composition dramatically. Hence, although very important, State Forests cannot be equated with unaltered habitat. Native biota will react to these changes in different ways, some will be disadvantaged and decline or disappear whilst others will prosper.

Urbanization, construction of infrastructure (roads, railways, power lines etc), regulation and management of waterways and the introduction of exotic plants and animals have altered the communities of the Box and Ironbark lands of NSW, favouring some species and causing decline in others.

The effects of these processes are cumulative. About 90% of the sites described in our wheatbelt studies have been extensively altered. In mapping remnants it is often difficult to determine what should, and what should not, be included. For example, in many sites Poplar Box (*Eucalyptus populnea*) was found as the canopy species (although this has been thinned as evidenced by stumps and ringbarked trees) with no other native species present! Ground cover consisted solely of introduced pasture species and weeds.

Briggs and Leigh (1988) list some 70 plant species as being rare and/or vulnerable or extinct for this part of NSW (regions 49, 50, 51 and 52 in that reference). In describing 898 sites in the NWB and 290 in the SWB only 7 of these species were found, thus supporting their listing. However, many native species in these studies, other than those listed by Briggs and Leigh, only occurred once or twice; 319 species in the NWB and 207 in the SWB; an average of 41% of the total species found fall into this category. Allowing for edge effects, the cyclic nature of many understorey species (Fox 1990), the natural sparsity of some taxa and for some misidentifications, this suggests that many more species than the 70 listed by Briggs and Leigh (1988) may be rare, endangered or at least in decline in the region.

Many communities in the Box and Ironbark lands fall into the 'extremely altered' category. Figures derived from our wheatbelt data suggest that whilst the canopy species in these communities may not appear to be at risk at the present time, the communities they characterise most certainly are. The long-term prognosis for canopy species such as *Eucalyptus populnea* and *E. sideroxylon* may not be good, however. Adamson and Fox (1982) suggest that decline in these long-lived species is likely. Again, the wheatbelt work supports this concept given the lack of recruitment of canopy species over much of the study area.

These trends of declining species are attributable to the cumulative effects of the processes already discussed.

Conserving what remains

"It is reasonable to suggest that something like half of all terrestrial species are likely to become extinct over the next 50 years, if current trends persist." (May in press, cited in Ulfstrand 1992). This alarming global trend seems true for the Box and Ironbark lands as evidenced by the wheatbelt data presented above. For whatever reasons, good or bad, we find ourselves with a small, fragmented and highly altered remnant of the original Box and Ironbark lands to manage.

Our challenge is to manage, not just species or plant communities but a system which contains native flora and fauna assemblages, pasture and farming lands, feral animals and exotic plants, towns and cities. Part of this challenge is to conserve, not only native life-forms but the processes which support them (Western 1992).

Western (1992) argues that, as scientists, we must begin to bring together autecological research and broad scale inventory and survey to better understand the dynamics of whole ecosystems and thus begin to assess the conservation and management needs of those ecosystems.

Many legislative tools are available in NSW for the conservation and protection of lands. Reservation is an option under the National Parks and Wildlife Act, the Crown Lands Act and the Forestry Act. Provisions exist under our Planning legislation for the formulation of State Environmental Planning Policies (which in effect control development on designated lands) and Local Environmental Plans which can assist Local Governments to protect land for conservation. Another mechanism for the control of development and land-use in rural New South Wales is the 'environmentally sensitive lands' classification of the Soil Conservation Act. Other legislative tools include endangered species legislation, covenants under the Land Titles Act and conservation agreements under the National Parks and Wildlife Act.

All of these will form the backbone of Government initiatives to conserve our natural environments. However, in this paper I have tried to show that the conservation challenge is both urgent and vast. No matter how good the legislation, it can never cover all conservation issues, and legislative tools are often difficult and expensive to apply. Legislation cannot succeed without the active support of the human community. The conservation, revegetation and landscape reconstruction required are far beyond the resources of government agencies and have become a community responsibility (Saunders in press). Community based initiatives such as Landcare, Trees on Farms and Save the Bush are very important starting points for this process and must become an integral part of an ongoing exchange of information among land-owners, land managers, conservationists and ecologists.

If we cannot conserve the remaining native biota and processes of the Box and Ironbark lands, then what hope can we hold out for the continued survival of the rural and urban components of the region? The loss of the native biota with the attendant degradation of soil and water; the microclimatic changes; and the increased possibility of disease and pest outbreaks may well bring about the demise of the rural, and eventually the urban, components of this system.

The final extinction of the Box and Ironbark lands, which is what we face if current trends continue, will be a loss to the whole community. Their conservation presents a challenge to the whole community: to biologists who must provide sound and broad-scale insights before time runs out; to land managers, public and private, to work with broad strategies; to local communities whose active support is vital in meeting this challenge; and to conservationists, who probably already fall into one of these categories but who have a special role to play in keeping the momentum going.

There is no easy and convenient recipe to follow for conserving remnant vegetation in the Box and Ironbark lands of New South Wales. However, the task is not impossible if we can work together to develop the broad-based strategies needed to accomplish the task.

Acknowledgements

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References

Adamson, D.A., and Fox, M.D. (1982) Change in Australasian vegetation since European settlement. *In* 'A History of Australasian Vegetation'. Ed. J.M.B. Smith. (McGraw Hill: Sydney.) 109-160.

Benson, J.S. (1991). The effect of 200 years of European settlement on the vegetation and flora of New South Wales. *Cunninghamia Vol 2. No. 3.*

Briggs, J.D. and Leigh, J.H. (1988). Rare or Threatened Australian Plants. (Special Publication No. **14.** ANPWS: Canberra.)

Brooker, M.I.H. and Kieinig, D.A. (1983). 'Field Guide to Eucalypts', Vol. 1. South-eastern Australia. (Inkata Press: Sydney and Melbourne).

Denny, M. (1987). 'Historical and ecological study of the effects of European settlement in inland New South Wales'. Report to the NSW Nature Conservation Council and National Estate Committee of the Heritage Council of New South Wales. Nature Conservation Council, Sydney.

Duggin, J.A. and Allison, P.N. (1984). 'The Natural Grasslands of the Liverpool Plains, New South Wales'. Eds. I. Sim and N. Urwin. (Department of Environment and Planning: Sydney.)

Ehrlich, P.R. (1992). Population biology of chekerspot butterflies and the preservation of global biodiversity. *Oikos* **63.** *No. 1.*

Erhlich, P.R. and Murphy, D.D. (1987). Monitoring populations on remnants of native vegetation. *In* 'Nature Conservation: the Role of Remnants of Native Vegetation'. (Surrey Beatty & Sons Pty. Ltd.: Sydney.)

Fox, M.D. (1990). Composition and Richness of New South Wales Mallee. *In* 'The Mallee Lands: a Conservation Perspective'. Eds. J.C. Noble, P.J. Joss and G.K. Jones. (CSIRO: Melbourne.)

Franklin, D.C., Menkhorst, P.W. and Robinson, J.L. (1988) Ecology of the Regent Honeyeater *Xanthomyza phrygia. Emu* **89**:140-145.

Grice, A.C. and Barchia, I. (1992). Does grazing reduce survival of indigenous perennial grasses of the semi-arid woodlands of western New South Wales? *Australian Journal of Ecology.* **17**:195-205.

Hobbs, R.J. (1987). Disturbance regimes in remnants of natural vegetation. *In* 'Nature Conservation; the Role of Remnants of Native Vegetation'. (Surrey Beatty & Sons Pty. Ltd.: Sydney.)

May, R.M. (in press). Past efforts and future prospects towards understanding how many species there are. *In* 'Biological diversity and global change, a symposium at the 24th General Assembly of IUBS, Amsterdam'.

Murray-Darling Basin Ministerial Council (1987). 'Murray-Darling Basin Environmental Resources Study'. (SPCC: Sydney).

Saunders, D.A. (in press). The effects of habitat reduction and fragmentation on the mammals and birds of the Western Australian central wheatbelt: lessons for western New South Wales. *In* 'The future of the fauna of western New South Wales'. Eds. D. Lunney, S. Hand, P. Reed and D. Butcher. (Royal Zoological Society of NSW: Sydney).

Saunders, D.A., Hobbs, R.J., and Margules, C.R. (1991) Biological consequences of ecosystem fragmentation. Conservation Biology **5**:18-32.

Saunders, D.A. and Ingram, J.A. (1987). Factors affecting survival of breeding populations of Carnaby's Cockatoo *Calyptorhynchus funereus latirostris* in remnants of native vegetation. *In* 'Nature Conservation; the Role of Remnants of Native Vegetation'. (Surrey Beatty & Sons Pty. Ltd.: Sydney.)

Soule, M.E. and Gilpin, M.E. (1991). The theory of wildlife corridor capability. *In* 'Nature Conservation 2, the Role of Corridors'. Surrey Beatty & Sons Pty. Ltd. Sydney.

Ulfstrand, S. (1992). Biodiversity – how to reduce its decline. *Oikos* **63**:. *No. 1.*

Webster, R. (1988). The Superb Parrot; a survey of the breeding distribution and habitat requirements. *Report Series 12.* (Australian National Parks and Wildlife Service: Canberra).

Western, D. (1992). The biodiversity crisis: a challenge for biology. *Oikos* **63.** *No. 1.*

Geology Group

We are pleased to report that the Geology Group held a most successful meeting on Wednesday, 3rd February in the Herbarium Hall.

There were 22 people present and a number of new faces were noted along with former members. A committee was elected and a programme of meetings and activities is being arranged.

Meetings will be held on the fourth Wednesday of each month in the Herbarium Hall, the next meeting being on the 24th March when Bob Dalgarno, Director Geological Survey of Victoria will speak on 'An Introduction to the Geological Time Scale'.

All Club members are invited to attend.

Ed Grey, Hon. Sec.

The Ecology and Genetics of Remnant Grassy White Box Woodlands in Relation to their Conservation

Suzanne M. Prober* and K. R. Thiele**

Abstract

The grassy woodlands dominated by White Box *(Eucalyptus albens)* originally covered vast areas of the wheat belt from northern Victoria to southern Queensland, but are now one of the most poorly conserved ecosystems in Australia. While White Box trees still remain abundantly scattered throughout the landscape, tree regeneration is limited and the native understorey community is very rare, either due to complete clearing for cropping, replacement by improving pasture, or altered floristic composition and weed invasion caused by livestock grazing. Intensive searching on the central and south-west slopes of New South Wales has revealed only three very small sites with both natural tree cover and a relatively unmodified, natural understorey. Several other sites with natural understorey but few trees have also been found.

A conservation profile for the woodlands is being developed through studies of floristic variation in the woodlands within NSW, and of genetic variation in White Box across its range. Preliminary results indicate that whilst both floristic and genetic diversity at a site are relatively high, differentiation among sites is low (except for floristic variation due to differing management history). Such a result would be advantageous for conservation planning, since few major geographical constraints would apply to reserve selection. Genetic studies also show a significant relationship between population size and genetic diversity, thus aiding estimation of minimum population sizes for reserve design.

Our surveys in southern NSW suggest that grazing by livestock leads to weed invasion, and to a gradual change in native species composition and diversity as grazing levels increase. In particular, a suite of native species is lost very early along this continuum. Effects of other disturbance, especially burning regime, still require further study.

A system for conservation of the grassy White Box woodlands, and other similarly fragmented ecosystems, is proposed.

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Introduction

Eucalyptus albens Benth., or White Box, is the dominant tree in the box woodlands in the eastern part of the wheat-sheep belt of south-eastern Australia. As with other Box woodlands, the White Box woodlands once occupied vast areas of fertile country, but have now largely been cleared for cropping or modified by livestock grazing. The grassy White Box woodlands are classified as one of the most poorly conserved ecosystems in Australia (Specht *et al.* 1974). This paper summarizes the ecology, recent history and current status of the White Box woodlands, and presents preliminary results and recommendations from research directed towards a conservation strategy for these woodlands.

Distribution and ecology

White Box is widely distributed on the gently undulating or hilly country of the western slopes regions of New South Wales. In the north it reaches the southern Darling Downs in Queensland and it extends into northern Victoria in the south. A significant outlying occurrence is in the ranges around the upper Snowy River in Victoria, and there are a few minor occurrences in western Victoria and near Melrose in the southern Flinder Ranges of South Australia (Boland *et al.* 1985).

The climate experienced in these regions is mostly warm sub-humid. We used the BIOCLIM Climatic Database (Nix 1986) to describe the climatic envelope for White Box. Mean annual rainfall is generally between 500 mm and 800 mm, with a change from a slight summer maximum in the north to a slight winter maximum in the south. Mean maximum temperatures in the hottest month range from 27 to 32°C, and mean minimum temperatures in the coldest month range from 5 to -1°C. From 5 to 70 frosts may be experienced each year. Intolerance to heavier frosts may prevent the occurrence of White Box on the more elevated areas of the Tableland (Boland *et al.* 1985).

White Box woodlands develop on deep, fertile soils derived from a wide variety of parent materials. In southern New South Wales they predominate on red and yellow podsolic and solodic soils derived from sedimentary and granite rocks, as well as on minor occurrences of reddish chocolate soils of basaltic origin and terra rossa soils derived from limestone. They are usually replaced by Grey Box *(E. microcarpa)* on the red-brown earths (Moore 1953a; Moore 1970). On the central and north west slopes they are known from podsolics and hard setting loams derived from acid volcanic and various sedimentary rocks, as well as limestone derived soils around Wellington. They can also develop on the deep black or red earths of basaltic origin, which predominate in areas such as the Inverell Plateau and the Darling Downs, and occur in scattered pockets elsewhere (Durham 1953; Moore 1953a; Biddiscombe 1963; Williams 1979).

White Box communities typically form a tall or savannah woodland, with *E. albens* as the single dominant. Trees reach about 25 m in height and the canopy is never completely closed. Blakely's Red Gum *(E. blakelyi)* and Yellow Box *(E. melliodora)* occur as occasional trees, increasing in abundance on lower slopes, and often becoming locally dominant along non-permanent watercourses or on the deeper soils of the valleys. Apple Box *(E. bridgesiana)* is a less common associate, confined to the best-watered sites (Moore 1953a).

Other species can become codominant with the White Box either on less favourable or on ecotonal sites. In the higher rainfall parts to the east Red Stringybark *(E. macrorhyncha)* appears, whilst White Cypress Pine *(Callitris glaucophylla)* is often co- or subdominant on sandy soils largely to the west, but also in the Monaro and Snowy River regions to the east. Red Ironbark *(E. sideroxylon)*, Hill Red Gum *(E. dealbata)* and Black Cypress Pine *(Callitris endlicheri)* can occur with White Box in steeper or rockier areas with shallow soils. Kurrajong *(Brachychiton populneus)* and, in the north, Rough Barked Apple *(Angophora floribunda)*, may occur in areas of good soil drainage. Grey Box *(E. microcarpa)*, Pilliga Box *(E. pilligaensis)* and Poplar Box *(E. populneus)* generally occur further west than White Box, but sometimes intermingle with it in ecotonal areas (Moore 1953a; Costin 1954; Williams 1979; Beadle 1981; Boland *et al.* 1985).

The understorey of the White Box communities is generally dominated by grasses, with numerous herbs and few shrubs. Early explorers and naturalists of the region reported that the general aspect was parklike (Andrews 1920), and that the ground was dominated by 'oat or forest grass' (presumably Kangaroo Grass, *Themeda triandra*, Sturt 1833) or 'covered with thick grass and gay flowers' (Bennett 1834). Greater detail of the understorey in its pre-European condition is not to be found in their descriptions. The understorey today, where not entirely removed for cropping or improved pastures, is highly modified by sheep and cattle grazing. In 1920, Andrews reported that Kangaroo Grass was almost entirely extinct from the upper Murray region. Various studies describe changes in the dominant species of the pastures, typically from *Themeda triandra, Stipa aristiglumis* and *Poa* spp. to *Stipa falcata* and *Danthonia* species, through to short forms of *Danthonia* and eventually invasion by introduced annuals and the native *Bothriochloa macra* as grazing intensity increases (Moore 1953b; Moore (1970). In contrast, Williams (1979) reports a predominance of *Bothriochloa macra* on the loamy soils of the northern slopes region of New South Wales, and suggests that this was the natural dominant and is not radically affected by grazing.

On more marginal sites, usually with shallow or sandy soils, shrubs become more abundant in the understorey. Because of their occurrence on less desirable country, these shrubby woodlands have not been as greatly modified as the grassy woodlands, hence the grassy woodlands will be the main subject of this paper.

History

Before European settlement, light grazing by soft-footed marsupials and recurrent burning by aborigines were the major forms of disturbance which contributed to the structure and species composition of the White Box woodlands (Andrews 1920; Lodge and Whalley 1989). Andrews (1920, p.27), describing the upper Murray region of NSW and Victoria stated:

> 'The natives were accustomed to burn it off almost every year and thereby prevented the heavy growth of young trees. That these frequent fires had the effect of keeping the country open was demonstrated in many parts. After settlement put an end to the practice, and the aborigines had died out, dense masses of scrub then took possession of large areas of valuable country . . .'

It is also likely that, while frequent burning encouraged the dominance of *Themeda triandra* (Lodge and Whalley 1989), burning prevented formation of a dense *Themeda* sward, allowing a high diversity of other herbs and grasses to co-occur (Stuwe and Parsons 1977).

Europeans first encountered the White Box woodlands in 1817, when John Oxley explored the Lachlan and Macquarie River areas. On this trip, the type specimen of White Box was collected by Alan Cunningham. Later exploration, leading the way for settlement in the White Box country, included the discovery of the upper Murray in 1924 by Hamilton Hume, and investigations in northern NSW by Thomas Mitchell in 1829 (Perry 1963).

Settlement, bringing with it grazing by sheep and cattle, began around 1825 in the Wellington Valley and Mudgee areas. By 1829 settlement had spread to the Liverpool Plains in the north and Gundagai in the south (Perry 1963; Andrews 1920). Settlement and stock numbers increased steadily through the 1830s and 1840s and most of the White Box woodlands would have been settled to some degree by the end of this period (Andrews 1920; Barker 1987; Lodge and Whalley 1989).

Consolidation of settlement occurred in the latter part of the nineteenth century. The gold rushes of the 1850s, then the expansion of railways, the granting of freeholds and the reduction in size of leaseholds in the 1880s, led to further clearing for cropping and more intensive grazing of the native pastures by livestock. Combined with the increasing numbers of rabbits and decreased fire frequency, changes in the original species composition of grazed lands were inevitable. Invasion by annual grasses such as *Briza, Bromus, Vulpia* and *Hordeum* are evident from as early as 1878 (Bentham 1878).

After 1900, the most significant effects on the already modified understorey of the woodlands in southern and central NSW were the increasing use of superphosphate and the spread of subterranean clover (Peel 1973). This eventually led to the replacement of most native pastures with improved pastures of various introduced grasses and legumes. In the northern, summer rainfall areas, pasture improvement never became widespread, so even today natural pastures predominate on the north west slopes (Lodge and Whalley 1989).

Current Status

Land in areas of White Box woodland is predominantly under private freehold tenure. Given the difficulties of settling a new country with few resources, it is not surprising that few areas of productive grassy woodland were fenced off in the early years to exclude grazing stock. Consequently, we know of no sites on private property which contain little-modified grassy White Box woodlands.

Small areas of the woodlands were set aside for public use early in the history of settlement, and a few of these, including cemeteries, travelling stock routes and reserves, railway easements and road reserves, still contain remnants of unmodified or less modified woodland. Travelling stock routes and road reserves are significant for their trees, often providing faunal habitat and allowing tree regeneration in a landscape generally with few or scattered trees. Understorey is variable, ranging from entirely weedy to, rarely, almost entirely native and unmodified by grazing. Railway easements and unused portions of cemeteries are commonly cleared of trees, but a few still contain little-modified understorey.

The grassy White Box woodlands are extremely poorly represented in reserves. The few reserves that do contain grassy White Box woodlands were gazetted long after modification had already occurred. Exceptions include the Wongarbon Nature Reserve, which contains perhaps 0.3 ha of White Box with a natural grassy understorey, and the extensive but outlying example of White Box woodlands in the Snowy River National Park in north-eastern Victoria.

After two seasons of survey in the woodlands on the south west slopes and on the central west slopes south of Molong, NSW, we estimate that less than 0.01% of the grassy White Box woodlands in this region remain relatively unmodified. We have found only three sites with both tree cover and native understorey relatively intact. The largest site (c. 10 ha) is in a cemetery near Cowra, another on a roadside strip about 10 m wide and 300 m long, and the third (c. 2 ha) in a travelling stock reserve. We have found six further sites with a relatively good-condition native understorey but with few or no trees remaining. Most of these are in cemeteries of small villages, and two are on railway easements.

Current Research

We are currently researching the ecology and genetics of the grassy White Box woodlands, in order to develop a conservation and management profile for them. Our initial aims have been to describe the distribution and variation of the woodlands, and to identify significant and valuable sites. Future aims are to make explicit recommendations for reserve selection and design, and to investigate management options for maintaining existing sites, and rehabilitating partly-modified, moderately weed-invaded, sites.

We are surveying the understorey of the White Box woodlands throughout New South Wales, using a sampling strategy which stratifies for climatic region, geological type and management history. We are studying the genetic (allozyme) diversity of White Box throughout its range. Preliminary results indicate that:

(1) Floristic diversity at a site is generally high (up to 87 species or 63 native species in a 0.1 ha quadrat). Even extremely small remnants (0.1 ha) may have high numbers of native species, and be relatively free of weeds, if they have not been grazed by sheep or cattle.

(2) Floristic variation between sites is generally low; that is, apart from the wide variation due to management history, there is little differentiation in floristics on differing soil and geological types, and in differing climatic regions. The only pattern apparent so far is a split between sites in the south (approximately south of Dubbo), and sites in the north, corresponding with predominantly winter and predominantly summer rainfall areas respectively (Fig. 1a), and with an increase in weed abundance in the south (Fig. 1b). The increased weed abundance in the south is likely to reflect the difference in pasture management between northern and southern areas (see above). Further floristic variation may yet be found on the black earths of northern NSW, which have not yet been adequately sampled.

(3) In southern NSW, grazing by livestock leads to weed invasion, and to a gradual change in native species composition and diversity as grazing levels increase. A suite of native species, including the Australian Yam

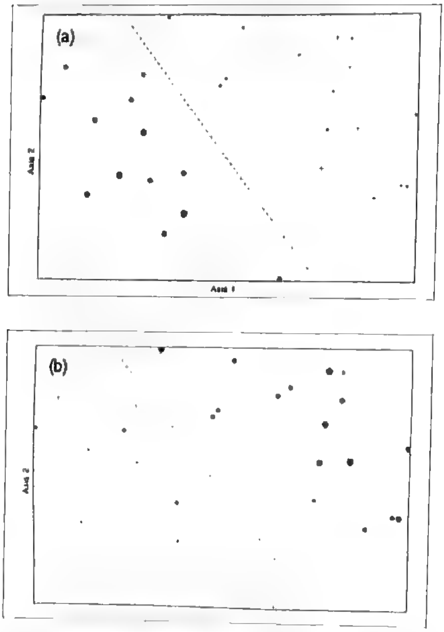

Fig. 1. Ordination (using Nonmetric Multidimensional Scaling, Kruskal 1964) of 30 quadrats recorded from the grassy white box woodlands throughout New South Wales, showing the differentiation between sites north of Dubbo (bottom left) and sites south of Dubbo (top right). Size of circles indicates (a) mean rainfall of the hottest quarter and (b) weed abundance.

Daisy *(Microseris lanceolata),* Twining Fringe Lily *(Thysanotus patersoni),* Leafy Templetonia *(Templetonia stenophylla)* and Purple Diuris *(Diuris punctata),* are lost very early along this continuum. Native species diversity can initially increase with very light grazing, but then declines with higher levels of grazing.

(4) Within the population the genetic diversity for White Box is higher than for any eucalypt previously examined (H_e (unbiased expected panmictic heterozygosity)=0.29, Prober and Brown in prep.).

(5) Genetic differentiation between populations is one of the lowest for eucalypts (5.7%), and there is no apparent geographic pattern in relationships between the 25 populations examined (Prober and Brown in prep.).

(6) There is a significant relationship between the number of trees in a remnant and the genetic diversity within its population (Fig. 2, Prober and Brown in prep.). Genetic diversity increases with an increasing population size up to c. 500 individuals (=20-50 ha of woodland), but thereafter shows little further increase up to population sizes of over 10,000 individuals. This number of c. 500 may reflect the number of individuals required to contain the diversity existent in original populations, or to avoid increased inbreeding after fragmentation. It is important to note that the sampled populations are only 1-2 generations beyond clearing, and so with more generations this critical figure may increase. A similar study for the Australian Yam Daisy, an important component of the original White Box understorey, is presently underway.

Reserve design

We see the results listed above as important in designing a reserve system for the grassy White Box woodlands. There are four important properties of these woodlands that affect reserve design. Firstly, the relative uniformity of the White Box understorey across the range of the woodlands, and the low genetic variation between populations of White Box, means that reserve selection is relatively unconstrained by floristic and genetic patterning. Rather, reserves selected on

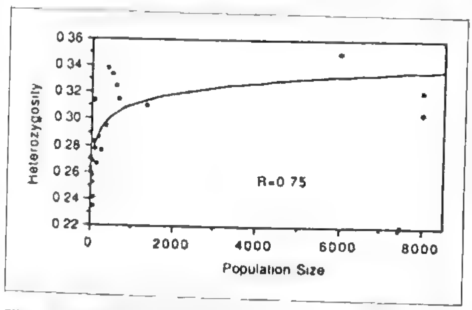

Fig. 2. Relationship between genetic diversity (unbiased expected panmictic heterozygosity) and population size for remnant white box populations.

other criteria, such as availability, are likely to conserve much of the floristic and genetic variation of the woodlands.

Secondly, high quality remnants (i.e., little modified sites with predominantly native species) are all relatively small (0.1 ha to 10 ha). Our studies suggest these still contain significant species diversity, and as no extensive and continuous areas of woodland remain intact, these small remnants are critical to the conservation of the woodlands. Furthermore, small areas appear to be able to resist major weed invasion, provided that they are not grazed, that there is no significant extraneous nutrient inputs (e.g. fertilizers leaching or broadcast from adjacent paddocks), that they are managed properly, and that the soil is not disturbed.

Thirdly, there are very few high quality remnants. There is a larger number of lower quality sites (with a somewhat modified, weed-invaded understorey, but still a significant complement of native species). A selection of these lower-quality sites would be required as part of an effective reserve system.

Finally, these sites are currently under a diversity of land-tenures, ranging from crown land controlled by local governments (e.g. cemeteries) and state public authorities (e.g. rail and road easements, travelling stock reserves) to private freehold. Management practices applied by these diverse tenure-holders in the past have succeeded in preserving some remnants up to the present day. As long as management practices at sites do not change, there is no reason to believe that current managers will be unable to continue this into the future.

Most nature reserves are relatively large, high quality, contiguous, and tenured to a single managing body. We believe that this model of reserve design is inappropriate for conserving the grassy White Box woodlands, and propose a new system that we believe to be more appropriate in this case.

A series of small, high quality sites is available across the state, which, although widely separated, could form the core of a reserve system. On the south and central west slopes, however, these sites total no more than 40 ha, and would be inadequate alone. With the addition of other, lower-quality sites, the total area could be sufficient to provide a reasonable representation of the major floristic and genetic variation, especially if sites are selected from both northern and southern NSW.

We propose that these sites be linked together by agreement into a single 'Grassy White Box Woodlands Reserve'. We see no reason that tenure of all sites should be transferred to a single body. Rather, some day-to-day management could be provided by the current tenure-holders, with a management and policy umbrella provided by a central body. It may, however, be practical that tenure of the core areas be transferred to the central body. If tenures of other areas were to be transferred, they may be best vested in local LandCare groups, Friends groups, Boards of Management etc.

We believe that this system would have several key advantages. It would encourage an integrated view of management (this would be difficult if every significant site were reserved in isolation). It would be flexible, allowing that other sites found to meet defined criteria could easily be added to the reserve system. It would allow some forms of landuse (e.g. light grazing by travelling stock) to continue. It would allow some recognition to high quality sites even though they may be too small to be otherwise considered for reservation. Finally, it would allow significant and increasing local involvement and awareness.

Nearly 20 years ago Specht *et al.* (1974) and Fenner (1975), recommended a national system of ecological reserves in Australia. Specht *et al.* considered about half of Australia's 1200 ecosystems as being adequately conserved. At the other extreme, they listed seven major Australian plant formations that are virtually absent from or poorly conserved in the network (Specht *et al.* 1974, Specht 1981). One of these is the woodland communities of the wheat belt areas of southern Australia, including the White Box woodlands. Many of the other Box woodland types included in this group, share some or all of the properties of the White Box woodlands listed above. A 'White Box Grassy Woodlands Reserve' along the lines proposed above could form a model for more effectively conserving these other ecosystems.

Woodland management

Given their history of frequent burning by the aborigines, it is likely that woodlands require some form of active management to maintain their pre-European character. Frequent burning, mowing and strategic grazing by livestock are the only practical methods available (Stuwe and Parsons 1977; Lunt 1991). High-quality sites forming the core of a reserve system will need management to maintain their high species diversity. Since the management regimes imposed for the last 150 years have allowed these sites to survive, continuing the same managements is an obvious starting point. However the historical management is not necessarily optimal for these sites.

Sites of lower quality, with moderate weed invasion and a lower native species diversity, may benefit from more intensive management to shift the native/weed balance and, possibly, the reintroduction of important species that have been lost. If restorative management practices are possible, the reserve system is essentially open-ended. We would envisage that, for instance, landholders with moderate-quality sites that would not necessarily qualify immediately for inclusion in the reserve system, may be willing to use restoration management for several years, after which the area could join the reserve.

We are currently planning long-term experiments to evaluate some possible management regimes for maintaining high quality sites, and for restoring modified and moderately weedy sites.

References

Andrews, A. (1920). 'The First Settlement of the Upper Murray, 1835-1845'. (D.S. Ford: Sydney).

Barker, T. (1987). European settlement. *In* 'Scenic and Scientific Survey of the Central Western Region'. Eds. D.C. Goldney and I.J.S. Bowie, pp. 47-56. (Mitchell College of Advanced Education: Bathurst).

Beadle, N.C.W. (1981). 'The Vegetation of Australia'. (Cambridge University Press: Cambridge).

Bennett, G. (1834). 'Wanderings in New South Wales'. Volume 1. (Bentley: London).

Bentham, G. (1978). 'Flora Australiensis: A description of the plants of the Australian Territory'. (Reeve and Co.: London).

Biddiscombe, E.F. (1963). A vegetation survey of the Macquarie Region, New South Wales. Technical Paper, Division of Plant Industry, CSIRO Australia. No. **18.**

Boland, D.J., Brooker, M.I.H., Chippendale, G.M., Hall, N., Hyland, B.P.M., Johnston, R.D., Kleinig, D.A. and Turner, J.D. (1985). 'Forest Trees of Australia'. (Nelson, CSIRO: Melbourne).

Costin, A.B. (1954). 'A Study of the Ecosystems of the Monaro Region of New South Wales, with Special Reference to Soil Erosion'. (A.H. Pettifer, Government Printer: Sydney).

Durham, L.J. (1953). A general survey of the Keepit Catchment Area. Part 1. *Journal of the Soil Conservation Service of N.S.W.* **9,** 70-80.

Fenner, F. (ed.) (1975). A National System of Ecological Reserves in Australia. Australian Academy of Science Report No. **19.**

Kruskal, J.B. (1964). Multidimensional scaling by optimizing goodness of fit to a nonmetric hypothesis. *Psychometrika* **29,** 1-27.

Lodge, G.M. and Whalley R.D.B. (1989). Native and natural pastures on the Northern Slopes and Tablelands of New South Wales. NSW Agriculture and Fisheries Technical Bulletin No. **35.**

Lunt, I.D. (1991). Management of remnant lowland grasslands and grassy woodlands for nature conservation: a review. *'The Victorian Naturalist'* **108,** 56-66.

Moore, C.W.E. (1953a). The vegetation of the south-eastern Riverina, New South Wales. I. The climax communities. *Australian Journal of Botany* **1,** 485-547.

Moore, C.W.E. (1953b). The vegetation of the south-eastern Riverina, New South Wales. II. The disclimax communities. *Australian Journal of Botany* **1,** 548-567.

Moore, R.M. (1970). South eastern temperate woodlands and grasslands. *In* 'Australian Grasslands'. Ed. R.M. Moore, pp. 169-190. (Australian National University Press: Canberra).

Nix, H.A. (1986). A biogeographic analysis of Australian elapid snakes. *In* 'Atlas of Elapid Snakes of Australia'. Ed. R. Longmore, pp. 4-15. Australia Flora and Fauna Series No. 7. (Bureau of Flora and Fauna: Canberra).

Peel, L.J. (1973). History of the Australian pastoral industries to 1960. *In* 'The Pastoral Industries of Australia'. Eds. G. Alexander and O.B. Williams, pp. 41-75. (Sydney University Press: Sydney).

Perry, T.M. (1963). 'Australia's First Frontier. The Spread of Settlement in New South Wales 1788-1829'. (Melbourne University Press: Melbourne).

Prober, S.M. and Brown A.H.D. (in prep.) Conservation of the White Box woodlands. I. Population genetics and fragmentation of *Eucalyptus albens. Biological Conservation.*

Specht, R.L. Roe, E.M. and Boughton, V.H. (1974). Conservation of major plant communities in Australia and Papua New Guinea. *Australian Journal of Botany Supplement* No. **7.**

Specht, R.L. (1981). Conservation of vegetation types. *In* 'Australian Vegetation'. Ed. R.H. Groves, pp. 394-410. (Cambridge University Press: Cambridge).

Sturt, C. (1833). 'Two Expeditions into the Interior of Southern Australia During the Years 1828, 1829, 1830 and 1831. Vol. I'. (Smith, Elder and Co.: London).

Stuwe, J. and Parsons, R.F. (1977). *Themeda australis* grasslands on the Basalt Plains, Victoria: floristics and management effects. *Australian Journal of Ecology* **2,** 467-476.

Williams, A.R. (1979). A survey of natural pastures in the north-west slopes of New South Wales. Department of Agriculture NSW Technical Bulletin No. **22.**

Rural Dieback and Insect Damage in Remnants of Native Woodlands

Jill Landsberg*

Rural dieback — the premature and relatively rapid decline and death of native trees on farms — is widespread in Australia, but its causes are not necessarily the same in all regions and for all affected trees. The most frequently demonstrated causes are secondary salinisation and insect damage. Changes in soil water availability, nutrients, pH or physical properties may also be involved, but have not been thoroughly investigated. The same is true of airborne salt, farm chemicals and physical damage, all of which are more likely to be localised in their impact. Current knowledge about rural dieback is reviewed in Landsberg and Wylie (1991, updated from 1988).

In the southern tablelands of New South Wales, insect-damage is probably the major direct cause of dieback of *Eucalpytus blakelyi* trees. This was shown by Landsberg *et al.* (1990), who compared stands of trees that were heavily used by livestock with otherwise similar stands that livestock rarely visited. They found that:

(1) defoliation by insects, dieback and tree death were all more severe in the stands used by livestock;

(2) despite site stress such as soil acidity, tree branches that were protected from herbivores produced prolific regrowth foliage;

(3) insect abundance was not directly related to numbers of trees, since tree numbers were similar in both types of stands but insects were much more abundant in the stands used by livestock;

(4) floristic and avian diversity were much reduced in the stands used by livestock, but levels of predation of insects were similarly high in both types of stands, at least during the period of the study; and

(5) insects feeding on trees in the stands used by livestock grew bigger and more quickly, probably because values of nutrients in soil and foliage were higher in these stands. The most likely cause of this nutrient enrichment was pasture improvement and subsequent redistribution of nutrients by livestock.

They concluded that nutrient enrichment may be a key factor contributing to the abundance of defoliating insects, and hence to rural dieback, in remnants of woodland used by livestock.

Subsequent work by Old *et al.* (1990) showed that the probable agent of dieback in one of the stands of trees studied by Landsberg *et al.* was a species of fungi that causes cankers and subsequent death of tree branches. However its action appears to be secondary, since it shows greatest development on trees suffering chronically high levels of insect defoliation.

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References

Landsberg, J. and Wylie, F.R. (1991). A review of rural dieback in Australia. *In* 'Growback '91'. Eds. T. Offor and R.J. Watson. (Growback Publications: Fitzroy, Victoria.)

Landsberg, J. and Wylie, F.R. (1988). Dieback of rural trees in Australia. *Geo Journal* **17**: 231-237.

Landsberg, J., Morse, J. and Khanna, P. (1990). Tree dieback and insect dynamics in remnants of native woodlands on farms. *Proceedings of the Ecological Society of Australia* **16**: 149-165.

Old, K.M., Gibbs, R., Craig, I., Myers, B.J. and Yuan, L.Q. (1990). Effect of drought and defoliation on the susceptibility of eucalypts to cankers caused by *Endothia gyrosa* and *Botryosphaeria ribis*. *Australian Journal of Botany* **38**: 571-581.

Apiculture in Box and Ironbark Forests

Linton Briggs*

Introduction

Although Australia's Box-Ironbark woodlands extend to all Australian eastern states, this conference inevitably developed a focus on the Victorian woodlands by virtue of its sponsorship and the location of the conference. This paper focuses on the Box-Ironbark woodlands and forests of Victoria because of the author's local knowledge accumulated through activity as a commercial apiarist over a period of forty years.

However, discussion and outcome of the conference should be of value in helping to identify conservation strategies applicable to the refurbishment of these important woodlands in all eastern states.

This paper discusses the structure of the Australian apiculture industry, the origin of honey bees in Australia, the critical relationship between the working by commercial beekeepers of native plants of the Myrtaceae family in Victorian forests and woodlands, particularly eucalypts, and the continuing viability of the apiculture industry. Also discussed are some facts that relate to the objectives of nature conservation which are considered compatible with the practice of migratory commercial apiculture as well as some means by which the decline of the Box-Ironbark woodlands may be arrested and maintained in perpetuity as an essential ingredient of the Australian landscape and the biota in general.

The Australian apiculture industry

Beekeeping is a craft of man, and has been for thousands of years. This ancient craft attracts people from all walks of life, all over the world, wherever honey bees are to be found, whether the motive be for profit, for science, or the humble feeling of affinity for one of nature's truly remarkable creations. Thirteen thousand (13,000) Australians are the owners of 700,000 registered bee hives.

However, the bulk of Australia's honey and beeswax production derives from the operations of 2000 commercial and semi commercial beekeepers, a thousand of whom can be regarded as the industry's mainstream producers. Annual farm gate value of production, based on current honey prices, is $40m. In 1991-92, the value of the industry's production in retail prices was $80m.

Other sectors include commercial honey bee queen production which multiplies and markets to honey producers genetically improved races and strains of honey bees (*Apis mellifera*). This is done to improve production and productivity, honey bee exports, pollen production for human consumption, and the horticultural and agricultural crop pollination which is rapidly emerging as an important sector conferring mutual economic benefits on beekeepers and farmers. In addition, there is an efficient packaging and marketing sector served by the Australian Honey Packers' and Marketers' Association. Most mainstream honey producers have supply arrangements with respective packers. Honey produced from Victorian Box and Ironbark woodlands and forests almost invariably is a high quality product, eagerly sought by packers for premium domestic retail outlet.

Many of the human food, seed, and pasture crops grown in Australia today require insect pollination in order to maximise production. In the ecologically disturbed environment of the Victorian farmland, 90% of all insect visitors to flowering plants are honey bees (estimate from Victorian Department of Agriculture). In a recent study by the University of New England crop pollination in Australia by honey bees is valued at $1.2b per annum. The importance of the enormous external benefit of the Apiculture industry to the wider community should be under-

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stood and never underestimated so far as the economic production of quality food products is concerned, not only in Australia but around the world.

Most commercial apiarists operate between 400 and 800 hives, although some operations are much larger, managing up to 2,000 hives. The apiarist migrates these hives several times a year to areas where it is known that periodically one to several plant species will flower and provide a source of nectar and pollen for a predictable calendar period. About half of an apiarist's sites are likely to be located on public land (including reserves), and about half on private land.

In Victoria, commercial apiarists regard an economically efficient foraging area to be about 800 ha for a commercial apiary located in most eucalypt forests. The woodland eucalypt estate, although slowly diminishing on freehold land, is also utilised from time to time by the industry. In Victoria, an average commercial apiarist occupies about 20 individual bee sites on an occasional basis and in total about 16,000 ha of foraging area per annum. This example is very much a rule of thumb measure, for there would be up and down estimate variations not only within Victoria, but in all other states, according to the extent and type of available forage because individual bee sites do not provide commercially useful honeybee forage over a full season or on an annual basis.

The Apiculture Industry is well organised for a comparatively small primary industry. The peak policy forming body is the Federal Council of Australian Apiarists' Association and there are 50 state and regional beekeeping associations. On behalf of industry constituents the FCAPA maintains through producer levies, two Commonwealth statutory arrangements – the Australian Honey Board, which regulates exports and product promotion, and the Honey Bee Research and Development Council.

The origin of Honey Bees in Australia

The Old World honey bee which had evolved to become a pollinator of European food crops was brought to Australia with European settlement.

At the time of the introduction, during the early part of the nineteenth century, it is probable that the pollination potential was less a factor in the introduction than European man's desire to bring to this new country the marvellous insect which, for tens of thousands of years, had given man an abundant, highly nutritious food and natural food sweetener. The newly introduced honey bees quickly colonised Australia's forest systems which were richly endowed with melliferous flora (nectar and pollen producing plants). As a result all Australian forest systems with the necessary ingredients to sustain honey bees now contain a stable permanent feral honey bee population.

There is evidence that by at least the late 1860's, settlers clearing the bush came across feral honey bees, and in my own district in North Eastern Victoria at least, they were supplementing diet and in some cases income from the rudimentary harvesting of bush honey. Before the turn of the century, there were many well organised commercial honey producing apiaries. These early commercial beekeepers derived their initial stocks from the, by then well established, feral honey bee population.

In recent years, there has been some debate as to whether the introduced honey bee has had or continues to have an adverse effect on the reproductive success of Australian native flora and fauna. Some early experiments, designed to investigate the possible impact of honey bees on native flora and fauna, are considered by the FCAAA to be deficient in design and execution (FCAAA Policy 1987). Unfortunately, some results of these studies have been influential in forming negative attitudes towards honey bees so far as their interaction with the natural environment is concerned. The industry recognises legitimate concern and, in the absence of reliable data that could confidently shed light on this complex question, the industry has been proactive in seeking hard data through properly designed and executed research that should allow the development of correct public land management policies for commercial beekeeping throughout Australia. In 1987, the industry developed a policy document, 'Honey Bees in Australian Conserved Forests', to assist the wider community, including land managers, to a better understanding of the industry's position. The policy, although now in need of some updating, remains essentially relevant. (FCAAA Policy 1987).

A number of research programs are currently being performed by various institutions with the full cooperation of the commercial industry. For example, a two year research program designed to test the effects of feral honey bees on the reproductive success of native bees has commenced in north eastern Victoria. This study will be performed by the Latrobe University. The industry has assisted through consultation and remains available throughout the project for further input, if required.

Properly designed and executed research is necessary to test a recurring hypothesis in Australia that honeybees are increasing hybridisation of native plant species. Overseas study, including the work of von Frisch (1953), demonstrates the remarkable fidelity to a particular floral source that is a characteristic of honeybee foraging behaviour. The extension of this information is that foraging by honey bees does not increase hybridisation through the transfer of pollen between species. Loads of pollen carried by honey bee foragers rarely contain pollen grains sourced from more than one plant species. A honey bee forager is programmed before leaving the colony to forage one species only, and she will continue to do so with remarkable fidelity until she is programmed to another species. Other bee species around the world including many of the three thousand or so native Australian species are not so selective (Michener 1974).

The industry submits that native birds, bees, other insects and wind currents are responsible for the cross pollination of Australian native plant species that results in the level of hybridisation which is occurring as a natural evolutionary process in Australian forests and woodlands. The testing of the hypothesis through cooperative effort between industry and research institution would be supported by industry. Similarly the interest of the industry would be attracted through competent research, to testing the hypothesis that feral honey bees in the undisturbed natural environment adversely affect the reproductive success of hollow nesting fauna. Industry observation is that direct competition for nesting sites is rare in the undisturbed environment because of the abundance of hollows with suitable volume, aspect, and entrance dimension specification. Furthermore, feral honey bee colony survival rate is poor because of the high energy requirements of honey bees which cannot be sustained by the natural environment between the sporadic super abundant eucalypt honey flows that are the feature of the Australian environment.

The apiculture industry melliferous resource base

The principal melliferous resource base of the industry is vested in the native plants of the continent, particularly those of the family Myrtaceae, eucalypts in particular. For example The Honey Research Council survey (1989) shows that in the State of Victoria, eucalypt forests and woodlands, and some banksia heathland, growing on public and freehold land constitute 84% of the industry's honey and pollen resources. With the exception of South Australia which has a greater reliance on ground flora (pasture and weed species), this acute dependence on eucalypts in particular is generally reflected across Australia wherever commercial apiculture is practiced.

Beekeepers have become the most knowledgeable people in the community, in a practical sense, about the flowering habits of eucalypts simply because the economic success of their respective operations is critically geared to those powers of observation which enable them to assess crop potential, and subsequent management decisions.

The inherent sporadic flowering behaviour of eucalypts of which no species regularly flowers on an annual basis contrasts with most melliferous flora of the

Northern hemisphere, whether it be of tree, shrub, or pasture plant form, and where, from a beekeeping management perspective, resource behaviour is much more predictable than in Australia.

Eucalypts, probably because of variability in climate including rainfall, have evolved to bud and flower according to stimuli that are not yet completely understood. General 'buddings' of respective eucalypt species occurs at sporadic intervals, and most bud well in advance of flowering, usually the season before, and sometimes two years or more in advance. Relatively few eucalypts bud and flower in the same season. Notable exceptions are in fact Red Ironbark, (*E. sideroxylon*), Grey Box (*E. goniocalyx*) and White Ironbark (*E. leucoxylon*). Grey Box and Ironbark are referred to as 'short budders' because only a short time elapses between budding and flowering. Grey Box, for example, puts on new growth during the spring (not every spring), sets bud by the end of November or sometimes a little later and commences flowering in late February of the same season.

Average periods between general 'flowerings' are somewhere between three to eight years according to species. The intervals between flowerings may be extended as a result of the effects of drought and wildfire. A run of above average years of rainfall tend to decrease the periods between flowering. An average flowering period for a summer flowering eucalypt stand is about 6 weeks. Although flowering usually takes place at a particular time within a calendar year for particular species, the frequency of flowerings is irregular and most often are many years apart thus sporadic flowering behaviour of the eucalypts moulds the nature of beekeeping in Australia.

This general phenomenon has had two important effects on the Australian beekeeping community. To be successful, individuals and mainstream commercial honey production must always be geared to the need to migrate wherever nature dictates from time to time. Economics play an important role in how distant a species may be worked. It is not uncommon, however, for mainstream commercial beekeepers to transport their apiaries for distances up to 500 km or beyond, several times each year. Many Victorian commercial beekeepers for example from time to time work in South Australia and New South Wales as well as Victoria in order to maintain commercial viability.

It should be understood that migratory commercial apiarists also value highly other Box woodlands and Boxes that form part of the mosaic of forest species. For example, magnificent remnants of the once great Yellow Box woodland are still important on loamy soils throughout the state. Red Box (*E. polyanthemos*), Black Box (*E. largiflorens*) both yield premium quality honey from time to time. White Box (*E. albens*) is a species avoided by most commercial apiarists in Victoria because this winter flowering species induce a deleterious effect in honey bees.

The seemingly itinerant mode of mainstream commercial honey production thus stands revealed as a unique craft embracing a specialised knowledge of the natural environment as well as the ability to maintain and manage large honey bee populations in order to take economic advantage of the contemporary situation.

Bee sites are in public land are rented from the Victorian Department of Conservation and Environment. Other states have similar arrangements with respective Departments. Most public land bee sites each contain several eucalypt species and understorey plants.

Bee sites are also temporarily located on freehold property, where remnants of the once great eucalypt woodland remain in sufficient quantity to yield commercial quantities of honey. Sometimes, agricultural crops including leguminous pasture are worked on freehold land, (distinct from formal crop pollination contracts) and both farmers and beekeepers derive mutual benefit in these cases.

Honey yields from respective bee sites vary greatly, according to:

- species of eucalypt (reliability of yield and important factor);

- density of budding;
- climate (rainfall, soil moisture, temperature, wind);
- colony stocking rates;
- managerial skill of the apiarist.

Competent mainstream commercial honey producers, like any competent farmer of animals, are able to assess the economic carrying capacity of the area of land over which the honey bees of the apiary will forage. Most well budded public land bee sites will economically carry 150 colonies (hives) during the relatively short 'honey flow' period of about 6 weeks per species. In exceptional circumstances, under optimal budding and species distribution conditions, a site could carry 300 colonies (two truckloads). Today, most honey flows seem to yield between 30 kg and 60 kg per colony. Rarely do yields exceed 60 kg per colony. Frequently, yields are less than 30 kg per colony.

Therefore, it should not be surprising to learn that the beekeeping industry has for many decades been in the vanguard of community effort to conserve and expand the native plant environment. The native plant resource in states other than Victoria (where the Land Conservation Council since 1970 has provided the community with an excellent public land management planning mechanism), is declining for commercial beekeepers. Factors causing this include land clearing, particularly in Queensland and New South Wales, some forestry practices such as chip wood production and intensive logging, urbanisation, some public land management practices, forest diseases and pests and occasionally wild fire.

The apiculture industry, for ecological as well as economic reasons, has been consistent and insistent in raising its voice in concert with other members of the concerned wider community about the accelerating degradation of the land and the landscape that has resulted from the unplanned removal of native vegetation from the land over the the two centuries that have elapsed since the first blows of a steel axe rang out in this ancient land.

A vision for the future

It might be useful to reflect at this time that throughout the evolution of mankind, the historical record tells us that wherever man settled the land and began to till the soil, erect buildings and graze animals, land degradation has occurred, and in the fragile environments such as for example, the Middle East, it has often occurred on a wide scale. In 400 B.C. in Greece, Plato noted and lamented how the mountains in Attica had once been clothed with fine trees, the land then producing good pasturage for cattle, but now the land was only good for bees. Obviously, some melliferous shrub, understorey species, or weed, in the absence of trees, must have flourished, at least for a time.

In the Old Testament of the Bible, the Book of Kings tells of great cedar forests in Lebanon which were cut down by thousands of King Solomon's forest workers and transported by sea to Palestine for building purposes. Analysis of pollen grains in honey found stored in the tombs of ancient Egyptian Kings reveal that thousands of years ago, a range of plants once grew in Egypt that no longer naturally occur in the region.

Today, man understands the causes of land degradation, and has the skills and resources to set about the task of healing the land, at the same time safely ensuring continuity of farming of the land to feed and clothe its people. Thus revegetation of strategic parts of the Australian landscape in a carefully planned and sympathetic manner is vital to the future well being of our continent. Planned revegetation throughout the once extensive Box and Ironbark woodlands which is representative of locally indigenous plant communities is a critical component of my vision for the future.

Refurbishment of Box and Ironbark woodlands therefore needs to take into account, as far as it is possible to do so, the full range of associated eucalypt species according to original distribution. The collection of seed from local communities for propagation, and the careful matching of soil type to species would play an important part in successful establishment or extension of Box and Ironbark woodlands.

Critical to the establishment and maintenance of such woodlands would be the need to simultaneously establish understorey that are, or used to be found locally, particularly leguminous *Acacia* spp.

A characteristic of Red Ironbark not widely understood by the community at large is that there is a summer or 'early' flowering form which is of particular conservation and economic value. It is indistinguishable botanically from later flowering forms, and relatively small provenances of this summer flowering form are located at Whroo near Rushworth, the Whipstick near Bendigo, and at Tarnagulla. The original forest estate of Victoria probably contained other early flowering Red Ironbark provenances. It would seem logical to take this factor into account when planning the establishment or extension of Ironbark woodlands in this state, in an attempt to proportionately mimic original Red Ironbark distribution.

Of particular local significance are the outstanding Green Mallee (*E. viridis*) remnants on the iron stone ridges on freehold property to the west of Benalla which are to my knowledge the most eastern distribution of this species in Victoria. These remnants in my view are of high conservation significance because of their location and extraordinary large form.

Most importantly the goodwill and the cooperation of Australia's farming sector is absolutely essential in the decades ahead if the goal is to be fulfilled across the nation. The cooperation and support of the beekeeping industry sector of the community can be guaranteed for any extension of the nation's melliferous flora estate which must, in time, have a beneficial flow on for the industry, if for no other reason.

Obviously, mapping of all salinity recharge areas over time and revegetation with native flora indigenous to the region is a massive but necessary conservation strategy, the implementation of which would ultimately provide benefit to farmers and the nation and all its people. It is a project that will require intelligent long term planning that should include the process of consultation and the development of incentives and even levels of compensation for strategically placed land owners. In some circumstances, it could become necessary for the public purse to be used to purchase through the freehold land market, strategically important land for revegetation in order to help restore the health and productivity of adjacent freehold land. The trade off for the community through the expenditure of public funds would be the consequent expansion of the forested public land estate.

Clearly, the implementation of this overall woodland refurbishment strategy would incidentally do much for the maintenance and extension of the Box and Ironbark woodlands.

A major key to the acceleration of woodland refurbishment in the freehold land estate is to link conservation strategy with economic and other benefits for land holders. It must be understood that farmers love the land from which they derive their livelihood, and from which they incidentally provide the wider Australian community with much of their food and fibre. The linkage of their love for the land with economic benefit, particularly in economic recessional climates such as is affecting the whole community at present, can become powerful conservation tools.

In general, farmers are beginning to understand that some traditional farming practices are having an adverse effect on the land, and are concerned. The growth of the LandCare movement, and individual revegetation efforts across Australia are testimony to understanding and positive corrective action by some members of the farm community.

Above all, present day farmers should not be blamed for the degraded woodlands the community has inherited as a result of some past land management practices. Indeed, we should not parcel blame or recrimination towards our earlier rural communities, who simply did not and could not foresee all the adverse effects that widespread and unplanned clearing of the woodlands and forests would ultimately have on the natural environment. Instead, the community as a whole should now resolve with determination to work together in a spirit of cooperation over the next 100 years towards goals that should be agreed through consultation between all community sectors including farmers.

The best opportunity we have of refurbishing the freehold woodlands I believe is through an agreed strategy to establish a woodlot/s on every broadacre freehold property that is located in eucalypt woodland, or former woodland districts. Fundamentally, the proposal would need to be made economically attractive to the landowner during the woodlot establishment period, for the farmer of the establishment generation would not otherwise benefit. Succeeding generations of farmers, and the nation and its people would reap continuing benefit for different reasons as the woodlots grew to maturity and became managed for sustainable yield. It would be up to the community to determine economic incentives during the establishment period, but these could include taxation deductions, fencing subsidies, rates exemptions, land rental, and so on.

The concept of woodlot establishment in the farmlands is already attracting attention from researchers and farmers, not only because of easier establishment and management than for example, as would be the case with small groups of trees or even single trees, but because eucalypt woodlots would provide, in the long term, in addition to aesthetic and conservation values, an enormous and enduring commercial on-farm structural and firewood timber resource right across the length and breadth of the nation.

Aesthetically, the landscape would change somewhat with the appearance of woodlots on every farm instead of the single, large trees dotted about the land scape to which we have grown accustomed. Although I believe single trees may have a better chance of survival when growing in the farmlands in association with woodlots.

The original extent of the great and ancient woodland, although not being restored strictly to its former appearance, would be preserved sufficiently to continually remind future generations of Australians of its early greatness.

I am confident the woodlot system will be embraced by the total community including farmers, since it will also allow the land to continue to be used for cropping and grazing and will, in fact, enhance these pursuits.

Woodlots on every farm, particularly in association with on-farm water conservation, will make an enormous contribution to the maintenance of native bird and animal habitat. Importantly, the establishment of woodlots, particularly when strategically planned and planted, will go a long way towards conserving the land surface from further degradation.

I am confident that, eventually, the ownership of farmland will carry with it the responsibility of maintaining a percentage of freehold land under eucalypt woodlot forest, managed for sustainable yield.

I am also confident, as the decades tick by, the Australian eucalypt woodland estate can expand and be maintained in perpetuity. Where there is a common will, there will be a way. What we need to do now is to sit down as a community and set short, medium, and long term goals that are realistically achievable over the period of the next 100 years.

References

FCAAA Policy 1987. Honey Bees in Australian Conserved Forests. Available from FCAAA, RMB 1630, Glenrowan, Vic. 3675.

Michener, C.D. (1974). 'The Social Behaviour of Bees' (Harwood University Press, Massachussets: USA).

The Honey Research Council Survey (1989). Victorian Melliferous Resources. *In* FCAAA Policy 1987, Appendix IV.

VonFrisch, K. (1953). 'The Dancing Bees'. (Harcourt Brice: London).

Making it Happen: Strategies Needed to Conserve Box and Ironbark Forests

Margaret Blakers*

The shift from 'nature' to 'biodiversity' over the last few years mirrors a changing perception – conservation of the natural environment is no longer a peripheral concern of 'nature-lovers' but, rather, an issue of central concern to governments, industry and the community. Australia and over 150 other countries have signed the International Convention on Biological Diversity; State and Federal Governments are preparing biodiversity strategies (Biological Diversity Advisory Committee 1992; Department of Conservation and National Resources 1992); and the protection of biodiversity is a fundamental tenet of ecologically sustainable development.

The biodiversity debates of recent decades have mainly concerned the use of public land, particularly forests. Debates of the future will increasingly be about the conservation of flora and fauna on land that is used predominantly for agriculture. Here the issues are more complex; environmentally, socially, and economically, because remnant native vegetation and habitat are fragmented, often degraded, and occupy land (and water) under a variety of tenures and uses. The conservation of Box and Ironbark forests exemplifies all these complexities.

This paper briefly outlines some of the questions which will need to be addressed in developing strategies for the conservation of Box and Ironbark forests, and for ecologically sustainable land management generally.

Strategies

Strategies are plans for achieving change. Issues as complicated as the conservation of Box and Ironbark communities require not one strategy but a range of strategies. They must take account of issues at differing physical scales (individual land areas, local, regional and interstate), and differing temporal scales, from immediate to decades and centuries.

At the broadest scale, conservation of Box and Ironbark communities requires management of habitats from Tasmania to Queensland and South Australia because birds such as the Swift Parrot and Regent Honeyeater move seasonally or nomadically over this range. It also needs sustained action to ensure that the requirements of dependent species are continuously available over the long-term; for example, trees planted now will not develop hollows suitable for many animals until the century after next.

Ecologists, biologists and naturalists have a major task in defining the states of the Box and Ironbark forests which are necessary either to minimise losses of biodiversity or, more desirably, to give a reasonable level of confidence that all species and communities can continue to survive and flourish in the wild. The development of these objectives, and of mechanisms for monitoring and review, are essential components of any strategy.

Environmental issues

Other papers in this seminar describe the extent and condition of Box and Ironbark forests in detail. These communities are evidently severely diminished and degraded. Few areas are managed for conservation, and much of what remains relatively intact is in fragments on roadsides or in cemetries; which are vulnerable to disturbance. The degree of fragmentation is also a threat in its own right, increasing the likelihood that chance events will lead to local and regional extinctions. On agricultural land, the remnants of the overstorey trees are old, with very little regeneration. On much public land, logging prevents trees from reaching ecological

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maturity. Climate change is a looming threat.

Ongoing threatening processes include clearing for agriculture, firewood gathering, wood harvesting, grazing, dieback, inappropriate fire regimes, agricultural chemicals and disturbance associated with fire prevention works and the installation and maintenance of utilities. Most of these threatening processes are broad-scale and incremental in nature. They can only be addressed by widespread, permanent changes in the current management practices of local and state governments, public authorities and landholders.

Economic and social issues

Because Box and Ironbark forests are predominantly either on private land or on awkward pieces of public land such as roadsides which are intimately affected by the management of adjacent private land, landholders inevitably have a major role to play in their conservation. We therefore need to know who owns or manages land, and the economic and social environment in which they are working.

This environment is changing rapidly. Global economic trends and the increasingly non-interventionist stance of governments are accelerating structural adjustment in agriculture (Lawrence, 1992). They are producing major shifts in population and services within rural areas, and increasing economic and social pressure on many landholders. Their consequences for land management and biodiversity conservation are major, but not yet adequately analysed. The following description highlights some of the trends in Victoria; the trends for NSW and Queensland are likely to be similar.

The dominant use of land in Victoria is for agriculture. Agricultural establishments occupy about 58% of the State (13.1 million hectares on freehold land with an additional 1.5 million hectares of public land licensed for grazing).

There has been a longstanding trend to aggregation of farms, and increasing displacement of labour by capital. The number of farms in Victoria declined from around 80,500 in 1922/23 to around 33,000 in 1990 (OCE, 1992). The rural labour force has declined correspondingly to about 94,000 people in 1990 (less than 5% of the State's workforce) (OCE, 1992).

The majority of farms are run by families (60%) or sole operators (29%); about 5% are corporately operated (Cribb, 1989). During the 1980s, about two-thirds of farmers became net borrowers from the banking system and about 40% of these are in difficulties with their debts (DA and OOE, 1991). The proportion of part-time operators has increased significantly as farmers seek off-farm income. As well, new people are entering farming for commercial, lifestyle or speculative reasons (DA and OOE, 1991). There is also evidence that the average age of farmers is in the mid-50s and increasing (OCE, 1992). These factors all suggest that there will be major changes in land ownership over the next decade as today's farmers retire.

Economically, agriculture has diminished in relative importance as mining, manufacturing and services contribute increasingly to employment and economic activity. Agriculture contributes about 5% of Australia's national income; it remains an important export industry, contributing about 24% of Australia's export income in 1990 (OCE, 1992).

A significant amount of Victoria's non-urban freehold land (3.4 million hectares) is occupied by lower density residential, recreational or small-scale farming users (DA and OOE 1991). This is likely to increase as Victoria accommodates a projected 34% increase in population (1.6 million people) over the next 40 years; Ballarat, Bendigo and Albury-Wodonga have been nominated as regional growth centres (DPUG 1990, Government of Victoria 1992). In Victoria, much of the land likely to be under pressure for rural residential or small-scale farming is within the historical distribution of Box and Ironbark communities.

A thorough analysis of social economic factors will need to look not just at gross trends, but also at their distribution both socially and geographically. We need to know who will be the farmers or land-owners of the future, and relate their characteristics (e.g. family or corporate ownership) to the agricultural capability, biodiversity value, speculative value and susceptibility to degradation of the land they occupy. The implications of a declining rural workforce when conservation work is almost invariably labour-intensive also need to be investigated.

The economic pressures to increase productivity through more intensive management or larger farm size, or both, generally work against the conservation of remnant native vegetation. We need a detailed understanding of the trends and forces operating in each major agricultural industry sector so that effective mechanisms for the long-term maintenance of biodiversity values on private land can be established.

Some potentially positive aspects of the changes are the increasing role of non-traditional landholders with greater resources at their disposal, and the possiblity for farmers to reduce their dependence on the traditional agricultural sector. High value products that use less land may provide more flexibility to accommodate conservation requirements. Tree-growing (for wood production as well as for biodiversity and land protection), and tourism and recreation are economic activities that can combine with farming and conservation. The development of co-operatives to undertake non-traditional activities may help to provide the skills and scale of enterprise necessary for economically viable operations.

Towards strategies

Many landholders are already acting individually to protect remnants; in Victoria many shires are assessing roadside vegetation and preparing management plans and action has been taken to control the clearing of native vegetation. These are all positive developments, as is the enormous interest in the issue demonstrated by this Conference.

Broad-scale strategies for conserving extensive communities such as the Box and Ironbark forests will take time to emerge, but some directions and pre-requisites are evident.

First, major changes in rural land management, including the provision of resources to assist conservation management (especially restoration), will require increased awareness at an individual and political level. Urban dwellers, who comprise about 85% of the population, are especially important. This Conference is one step towards building public awareness. A proposal for a 'hollow-tree survey' is outlined as another mechanism for making some aspects of the problem 'visible'.

Secondly, a system of reserves on public land is the essential core of any long-term conservation plan. At present, there is no system of conservation reserves which adequately protects Box and Ironbark communities across their range.

Thirdly, conservation reserves need to be complemented by active measures to protect and manage remnants on other public and private land, and in some cases to revegetate sites. Retention of existing native vegetation and natural regeneration is economically and ecologically preferable to revegetation.

Fourthly, the conservation of these communities and their dependent species will require concerted action by the governments of at least four States (including Tasmania) and the Commonwealth. Formalised agreements amongst these parties may be a useful mechanism for highlighting critical areas of responsibility, especially in relation to protecting migratory species and their habitats, and threatened species with populations in more than one State. Monitoring programs will also need to span the entire historical distribution of the Box and Ironbark communities and should be co-ordinated.

Fifthly, local government has an important role to play through land use planning (including fire prevention management), direct management of roadsides and other critical remnants, and in Victoria through its ability to apply differential rating to encourage conservation.

Finally, there is an urgent need for wide debate about the scale and implications of the social, economic and environmental changes taking place in rural Australia. To underpin this, we need a clearer understanding and more critical analysis of the relationships between the economy and the environment, especially in the globally deregulated economic regime that now prevails.

Future action

Many of the changes set in train by the initial clearing and development of pastoral industries are still working their way through the ecosystem. Vast areas that formerly were woodland or forest now carry only remnants of the original overstorey trees and these are nearly all old, and in many cases already dead or dying. Measured rates of loss over several decades in grazing land are 1-2% per annum (e.g. Clifton and Sands 1988). It takes over a century for trees to mature and start to develop hollows suitable for wildlife. The current rate of loss and lack of recruitment means that a critical shortage of mature trees and hollows looms, potentially threatening species dependent on these resources.

Lindenmayer has investigated Mountain Ash trees with hollows, and defined a sequence of forms representing trees in different stages of growth, senescence and decay. He has used this typology to survey forests and predict the future availability of hollows for Leadbeater's Possum.

Lindenmayer's approach could be used in a large-scale co-operative project to map the age structure of trees on rural land, providing current and predictive data of enormous value for wildlife management. Participants would need to apply a standard sampling procedure at each survey site to select the trees to be described; assign each tree to an age class defined by the sequence of forms; identify the tree species and provide any additional information required.

The proposal has characteristics which make it eminently suitable for a co-operative project: the basic information that participants must collect can be made very simple; additional information can be added by those with the time and enthusiasm; useful data can be collected on an *ad hoc* basis; the reliability of data can be easily verified; and the need to obtain thorough coverage of a region provides a challenging but achievable goal.

Perhaps a large-scale hollow tree survey can be completed before the next 'Atlas of Australian Birds' starts?

References

Biological Diversity Advisory Committee (1992). A National Strategy for the Conservation of Australia's Biodiversity. Draft for public comment. (Department of the Arts, Sport, the Environment and Territories: Canberra.)

Clifton, C.A. and Sands, R. (1988). Decline of River Red Gum (*Eucalyptus camaldulensis*) on grazing land in Western Victoria. *Research into Rural Tree Decline* 4:4-6.

Cribb, J. (1989). 'Australian Agriculture, the complete reference on rural industry'. Vol. 2, National Farmers Federation.

Department of Agriculture and Office of the Environment (1991). 'A review of rural land use in Victoria'. (Government of Victoria: Melbourne).

Department of Conservation and Environment (1992). Flora and Fauna Guarantee Strategy: Conservation of Victoria's Biodiversity. Draft prepared under the Flora and Fauna Guarantee Act 1988. (Department of Planning and Urban Growth: Melbourne).

Government of Victoria (1992). 'A Place to Live: Shaping Victoria's Future'. (Victorian Government Printer: Melbourne).

Lawrence, G. (1992). Rural Social Structure: Implications for Water Management in Australia. Paper presented at the Australian Rural Water Demand Management Workshop, Sydney 25-26 February 1992.

Office of the Commissioner for the Environment (1992). Agriculture and Victoria's Environment. 1991 State of the Environment Report. (Government of Victoria: Melbourne.)

The Regent Honeyeater Project

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This project was initiated in the Lurg region of North-eastern Victoria to improve the habitat of native fauna, including species such as the Squirrel Glider, the Grey-crowned Babbler, the Bush Thick-knee and especially the Regent Honeyeater. The populations of all these species are in a rapid decline. This project included work on interconnecting shelter belts, gully erosion, corridors, salinity revegetation, blocks of existing vegetation and unused road and roadside vegetation. In all, it focussed on enhancing some 14 kms of corridors and roadside works at a cost of approximately $40,000.

We have had a very positive response to the project. It has proven that people from different backgrounds can work together in spite of their different reasons for contributing — be it protection for domestic stock with the shelterbelts or solely for the protection of native fauna.

Our area has a mix of both traditional farmers (those that make or attempt to make their living solely off their property) and those that own property, be it 10, 20, 50 or 100 acres but do not rely on it to earn their living. The latter earn most of their income off the farm, and probably subsidise the property out of that income. Both types of land holders may have different points of view towards this particular project. For example, the traditional farmer may need every square inch of his property in production just to have the luxury of being able to feed his family, whereas the smaller landholder may be only too willing to plant half of his block with trees because he does not need to produce anything from that land in order to be able to feed his family.

One of the ways we could establish connecting corridors fairly quickly is by fencing off unused roads currently leased by adjacent property owners and letting these areas regenerate naturally where there are existing trees, or replanting native stock in places where there is no existing vegetation. Again there are strong economic restrictions for this not happening. The responsibility for fencing unused roads rests solely on the shoulders of the adjacent property owners, whether they lease the land and graze it, or not, and at somewhere between $3,000 and $4,000 per km for fencing, this is an option that will not be taken up by landholders without assistance. It is necessary that the actual landholders do the fencing because it makes no economic sense to fence them out and manage the unused roads independently. Another point to remember is that Local Government may be required to keep some unused roads for access to land that may be sub-divided at some future date.

Costs for this type of conservation are prohibitive for an individual. Apart from the initial material there are heavy costs associated with on-ground works; labour and erection are nearly double the expense of the materials themselves and preparatory work can double the cost of planting the area, and so it goes on, and the burden on the rural landholder, where on-ground action is needed to solve the problem, becomes greater and greater. Now, not only are they being asked to supply the land for tree planting, about $1,000/acre in this area, but are also increasingly asked to prepare that site, buy trees, plant and guard the trees, and then fence the area and protect and maintain the trees as well. With primary produce commodity prices falling daily and production costs rising by the hour, the scope of the individual landholder to achieve anywhere near enough rehabilitation of habitat in time, is fast becoming an impossibility. The trees cost

* Co-Ordinator, Molyullah-Tatong Tree and Land Protection Group.

money, the tree guards cost money, the fencing costs heaps of money, the time taken to rehabilitate costs money, the loss of production costs anxiety and job losses, and the maintenance of all this great work we have done costs money. And if that is not enough we found that by creating all this wonderful habitat for the Regent Honeyeater, we also enhanced the habitat for pest plants and animals to thrive in. Something that we did not want or need to happen, and this necessitates further on-going maintenance to retain the work already completed, and adds further to the costs.

However, landholders within the Molyullah-Tatong Tree and Land Protection Group and others, such as the Warrenbayne Boho and Swanpool and Districts Groups, have indicated that they are prepared to support these types of projects by providing the sites, some manpower and the support and maintenance of the finished product. Without that support, the projects will never get off the drawing board; without funding and backing from the urban based conservationists and community, they will never get on the drawing board. In my opinion we all have to pull together. No more of the city versus the country, the farmers versus the 'greenies', Labor versus Liberal. One in, all in. Then and only then will we be able to achieve our goals.

May I finish by posing a question or two: Where do we find the funding to pay the costs? How do we share the workload? When do we start?

Conserving Remnant Habitat on Private Land

Ian Davidson*

Background

The most widespread use of private land in Victoria is that of agriculture, with grazing stock and cropping predominating. Historically these two land uses have caused the clearing of vast tracts of land particularly in fertile non mountainous areas. At present the direct clearing of native vegetation has been greatly reduced through legislation (Native Vegetation Retention) and reality in there is very little fertile private land left to clear.

In northern Victoria the greatest single threat to woodland habitat is the lack of regeneration in farmland due to grazing, which will mean whole landscapes will rapidly change as trees in farmland senesce and die. This process is now under way – already in some areas we have missed 150 years of tree and shrub replacement.

By way of practical example the following project is a summary of one way of conserving remnant habitat on private land. This project focused on a threatened species of fauna, the Superb Parrot, whose survival was threatened primarily through habitat loss.

Superb Parrot project in Victoria

Distribution

With the clearing of the Box woodlands in northern Victoria, the historical range of Superb Parrots contracted from west of Melbourne to where the only birds regularly seen are within 20km of the Murray River between Echuca and Yarrawonga.

Problem

Whilst nest sites in Barmah Forest are being identified and protected the foraging habitat is mainly located on private land subject to the typical array of degrading processes ie. fragmentation, lack of regeneration, destruction of under-storey.

Strategy

Effort was focussed on the foraging habitats as these were seen as the most threatened habitats where the Department of Conservation and Natural Resources (CNR) was least likely to influence positive changes in management in the short term. Our Strategy involved:–

1. The development of a resource document with the important foraging habitat mapped by an ecologist and accompanied by a report outlining practical management recommendations for important remnant habitats. The project area was delineated by the distances travelled, ie. within 10 km of nest sites, by Superb Parrots when feeding young, as outlined by Webster and Ahern (1992). The mapping was done on 1:25,000 Mapsheets and covered approximately 25,000 Ha. This stage is important because it provided the basis for discussions with land managers i.e. it allowed CNR to present a clear strategy.
2. A community process was undertaken by the Land for Wildlife Extension Officer involving:
   (a) discussion of plan with local government roadside managers, as most of the intact habitat occurred along roadsides.
   (b) one on one meetings with landholders to present aspects of the report of relevance to them, and to seek their ideas and input on any works they would be prepared to undertake.
   (c) a public meeting to consolidate project and gauge overall community support. This led to a questionnaire for all participants and initiation of a local steering group, annexed by an existing community group – Nathalia Tree Group. (At present participants include 40+ landholders, 2 Shires,

* DCNR Benalla Region.

3 school groups, 1 community group and associated interested community members).

(d) finalise plan to form basis of funding application with specific details including areas to be fenced and costings.

I think that it is fair to say that this project has been a success to date and is being transformed into positive actions in the field due to the degree of ownership shown by the group. These projects must take a long term view, not the all too common budgetary cycle timing, thus having the effect of changing overall management practices. For example, some people are reluctant to become actively involved until they can see positive changes occurring. I also advocate the use of a single species to highlight the more complex issues involved in ecosystem conservation. This enables the community to galvanise around a single issue, which then facilitates greater awareness about the species habitat. Obviously the best species to select are those specialists associated with the vegetation communities requiring protection.

Actions to date

- Collection of some seed and the compilation of a seed collection calendar for future seed collection.
- Growing of plants from seed collected.
- Fencing of some areas.

Other Works Underway

- Major search for nest trees in Barmah during 1992 breeding season.
- Identification of wintering sites and assessment of their security.

Due to this bird's life cycle it only spends approximately six months in Victoria. It is important to determine the security of habitat used for the other six months (believed to be around the Savernake area).

Major points in preparation of plan to conserve remnant habitat on private land

• Clear long term goal.	(Protect and enhance the remnant Box woodlands abutting Barmah Forest).
• Good resource information.	(1:25,000 map highlighting the important remnants).
• Practical habitat enhancement recommendations.	(Practical ways to protect and enhance remnants, eg. fencing, planting, reducing soil disturbance, etc).
• Present above to the community for their consideration and input.	(Enables ownership, improvement and modification of plant to suit landholders' needs).
• Preparation of accepted plan.	(Enables a single package, including the agreement of the community to be provided to potential sponsors, providing a clear picture of what works will be achieved for what price).

The Action Plan for Australian Birds

by Stephen Garnett
Published by: *Australian National Parks*
Available from The Royal Australian Ornithologists Union,
21 Gladstone Street, Moonee Ponds, Victoria 3039
cost $21.50 (includes postage)

The Endangered Species Programmed has comissioned a series of Action plans for the major groups of flora and fauna. Stephen Garnett's Action Plan for birds is the first of the series to be published.

The Plan summarises the conservation status of all endangered and threatened birds in Australia. It contains relevant biological information including threats, habitat and current distribution, occurrence in reserves and current management plans (if any) in place. Future management actions, including costs, highlight what is required if the conservation of endangered species is to be taken seriously in Australia.

This Action Plan gives a comprehensive summation of what is known about each species and gives a realistic benchmark for the effort required. All those dealing with environmental reports and submissions pertaining to habitat issues will find it an essential resource.

Robyn Watson

Grasses of Temperate Australia

by C.A. Lamp, S.J. Forbes and J.W. Cade
Publishers: Inkata Press, Melbourne. 1990. r.r.p. $54.95

The book begins with an interesting account of a range of aspects of grasses. These include weeds and grasses which are toxic or otherwise harmful to stock, uses of grasses (pasture plants in particular but also woody bamboos, etc.), the role of cereals in the development of agriculture and the co-evolution of herbivores, man and grasslands.

An illustrated account of grass morphology then provides a good introduction for the non-botanist, and this is backed up by an extensive illustrated glossary.

The rest of the book - and the main part of it - is concerned with the identification and description of grasses. Identification begins with what is essentially a key, dividing grasses, on inflorescence and other easily visible characters, into five main groups (Types 1-5) and then into subdivisions labelled as figures (Figs. B-M). This is followed by detailed descriptions and illustrations of individual species, accompanied by notes on habitats and distribution and often on indentification and/or material designed to help farmers. The last covers topics such as the value of a species as a pasture plant, its hazards to stock, its establishment and its climatic and soil requirements.

The list of references is substantial and valuable, but, for the general reader who wishes to go further, there are some omissions from the important comprehensive books which together cover all of the area concerned except Tasmania. These include the 1986 edition of the 'Flora of South Australia', the key to all Australian grass genera by Watson and Dallwitz (1985) and the admirable but long out of print book by Gardner (1952) on Western Australian grasses; publication of the key to all Australian grass species by Simon (1990) may have post-dated that of the work under discussion.

Identification has invevitable problems because the book is not comprehensive. It covers about one in six of the grass species of temperate Australia and, while these are common ones, the user can never be certain that a grass to be identified is in the book and can be separated satisfactorily from similar ones which are not. The key is an important first step to identification, but unfortunately it is marred by a number of mistakes. For example, at least a dozen taxa are recorded in an incorrect group, and about half of these cannot be identified because they are missing from their correct group. Examples of the latter are the awned *Alopecurus* and *Phleum* in Fig. F (spikelets awnless) and the awnless *Ammophila* and *Anthoseanthum* in Fig. G (spikelets awned). *Paspalidium constrictum* is missing from the appropriate group (Type 4), and it seems likely that the illustration of this species has been switched with that of *Panicum bisulcatum.*

Otherwise, the text has a number of errors (eg., the glume labelled as a floret in Fig. 12), statements that should be qualified (eg., the limit of subfamilies to two) and things that the reviewer would have done differently (? improved). The last includes the removal of the unlabelled Fig. 10, which is repeated in the labelled Fig. 11 (a drawing of a plant, not merely a culm). The question of nomenclature is debatable, but it seems desirable to record, at least as alternatives, all changed names accepted by recent authors - eg., the change of most species of *Hordeum* to *Critesion.*

The illustrations are generally very good, but they are a little uneven in quality and completeness and a few (eg., the one of *Imperata cylindrica)* do not seem to have survived reproduction satisfactorily. The lack of uniformity caused by the wide range of artists is emphasized by the restriction of green colour to the interesting old illustrations by J.P. Eckert and L. Lang. Stretching a drawing across two pages is debatably desirable, and the one of *Setaria verticillata* is a disaster because there is no match at all between adjacent parts of the drawing on the two pages.

In all, the book is well constructed, it provides an excellent set of descriptions and illustrations of a large number of grasses and it will be particularly useful for the general reader for whom it is designed. However, small flaws are rather numerous, and there will undoubtedly be some problems with indentification.

References

Gardner, C.A. (1952). 'Flora of Western Australia'. Vol. 1, Part 1. Gramineae. (Government Printer: Perth).

Jessop, J.P. and Toelken, H.R. (Eds.). (1986). 'Flora of South Australia'. Part IV. (Government Printing Division: Adelaide).

Simon, B.K. (1990). 'A Key to Australian Grasses'. (Queensland Department of Primary Industries: Brisbane).

Watson, L. and Dallwitz, M.J. (1985). 'Australian Grass Genera'. Second Edition. (Australian National University Printing Service: Canberra).

Notice of the Annual General Meeting

The Annual General Meeting of the Field Naturalists Club of Victoria will be held at the Astronomer's Residence, Birdwood Avenue, South Yarra at **8 p.m. on Monday, April 5, 1993.**

Agenda

1. Confirmation of the minutes of the previous Annual General Meeting held on 13 April 1992.
2. Receipt and adoption of Annual Report for the year ended 31 December 1992.
3. Receipt and adoption of Financial Statements and associated reports.
4. Election of Members of Council.
5. Election of Office Bearers.
6. Appointment of Auditors (remuneration to be determined by Council).
7. Future of the Kinglake Block.
8. Any other business of which proper notice has been given in accordance with the Articles of Association.
9. President's Address – 'A Mallacoota Medley'.

Election of Councillors and Office Bearers

All members of Council and Office Bearers retire annually but are eligible for re-election. Nominations by two financial members of the Club are required for the following positions.

Council

President
Vice-President
Ten other members

Office Bearers

Secretary
Treasurer
Assistant Treasurer
Editor
Activities Co-ordinator
Librarian
Excursion Secretary
Conservation Co-ordinator
Publicity Officer
Sales Officer (Books)
Sales Officer (Victorian Naturalist)

This is your Club, and all members are urged to ensure its on-going viability by filling **all** the above positions with persons willing and able to contribute to activities, functions and the general work of the Club. Arrange a nomination for yourself or encourage some other appropriate member to be nominated.

Nominations should be in the hands of the Secretary before the Annual General Meeting.

The Field Naturalists Club of Victoria

In which is incorporated the Microscopical Society of Victoria

Established 1880

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

OBJECTS: To stimulate interest in natural history and to preserve and protect Australian fauna and flora.
Members include beginners as well as experienced naturalists.

Patron

His Excellency, The Honourable Richard E McGarvie, The Governor of Victoria.

Key Office-Bearers December 1991

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Vice-President: Dr. MALCOLM CALDER, Pinnacle Lane, Steels Creek, 3775 ((059) 65 2372).

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Geology: Miss KARINA BADER, 73 Richardson Street, Albert Park, 3206 (690 4653).

Fauna Survey: Miss FELICITY GARDE, 30 Oakhill Road, Mt. Waverley, 3149 (808 2625 A.H.).

Microscopical: Mrs. ELSIE GRAHAM, 147 Broadway, Reservior, 3073 (469 2509).

MEMBERSHIP

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

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The Victorian Naturalist

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since 1884

F.N.C.V. Calendar of Activities

May	
Sun 2	General FNCV Excursion. Fungi at FNCV Block Kinglake. Leader Tom May. Meet at block 10 a.m. Private transport.
Tues 4	Fauna Survey Group Meeting. Design, Construction and Revegetation of Wetlands - Steve Yorke. Herbarium Hall 8 p.m.
Sat 8	Fauna Survey Group Field Survey. Leadbeater's Possum Survey. Contact Ray Gibson, 874 4408
Mon 10	General FNCV Meeting. Beyond Bird Watching - Ian Endersby. Herbarium Hall 8 p.m.
Thurs 13	Botany Group Meeting. Coastal Satlmarsh Vegetation (Barwon Estuary) - Jeff Yugovic. Herbarium Hall 8 p.m.
Wed 19	Microscopical Group Meeting. Freshwater Filamentous Algae under the Microscope - Tim Entwisle. Astronomer's Residence 8 p.m.
Sat 22	Botany Group Excursion. Coastal Ferns and Plants. Leader Hilary Weatherhead. Contact Joan Harry 850 1347
Wed 26	**Geology Group Meeting.** Film Night. 'Our Dynamic Earth, The Building of the Earth, Earthquakes of San Fransisco. **Astronomer's Residence 8 p.m. (note change).**
June	
Tues 1	Fauna Survey Group Meeting. Members night - slides, exhibits and discoveries by members. Herbarium Hall 8 p.m.
Sun 6	**General FNCV Meeting. Hosted by Botany Group.** Evolution of the Australian Flora - Graeme O'Neil. Herbarium Hall 2 p.m.
Sat 12 - Mon 14	Fauna Survey Group Field Survey. Wilson's Promontory (post-fire ecology study). Contact Russell Thompson, 434 7046.
Wed 16	Microscopical Group Meeting. Wasp Parasites of Caterpillars - Ian Faithfull. Astronomer's Residence 8 p.m.
Wed 23	Geology Group Meeting. Building Stones of Melbourne - Rob King. Herbarium Hall 8 p.m.
Sat 26	Geology Group Excursion. Sources of Stones that built Melbourne. Leader Rob King. Met at Herbarium Hall 2 p.m.
Sat 26	Botany Group Excursion. Fungi. Leader Tom May. Meet 10 a.m. Picnic area at Tooradin. Melway reference - map 144 A3. Private transport.

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

The Victorian Naturalist

F.N.C.V.

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Assistant Editors: Ed and Pat Grey

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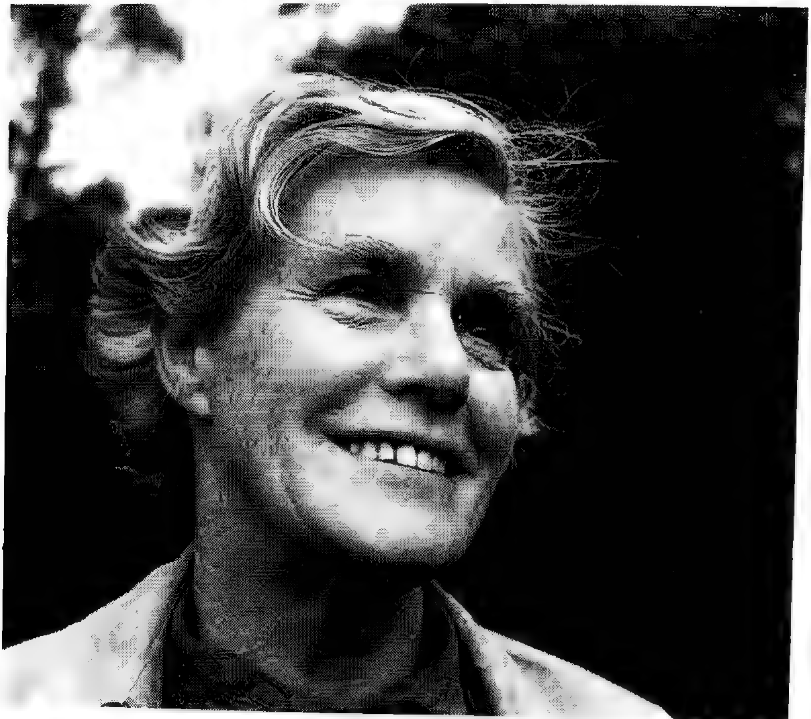
Cover Photo: Rooting Shank, *Collybia radicata,*
photographed by Rod Barker.

Australian Natural History Medallion



Mrs Enid L. Robertson

Mrs Enid L. Robertson, distingushed botanist, ecologist and conservationist from Adelaide, has been awarded the prestigious Australian Natural History Medallion for 1992. The award was presented in Adelaide by Dr Margaret Davies, Vice-President of the Royal Society of South Australia, at a meeting of the South Australian Society for Growing Australian Plants. The Field Naturalists Club of Victoria was represented by the President, Dr Arthur Farnworth, and his wife, Enid. The text of Dr Davies address follows.

It is my very great pleasure to be asked in my capacity of Vice-President of the Royal Society of South Australia to present the Australian Natural History Medallion to Enid Robertson.

Enid is, of course, well known to all of you. She is undoubtedly appreciated since this is the second successful nomination by this Society for recognition of her outstanding contributions in many areas - the first being the Association of Societies for Growing Australian Plants Australian Plant Award for 1990/91.

Enid has had an appreciation of natural history since her childhood and this has given her a lifetime of concern for the natural environment and nature conservation - a concern that is evidenced in the most practical of ways - Enid doesn't only recognise what needs to be done - she goes out and does it!

As a research assistant in the Depatment of Botany at the University of Adelaide for a period of 20 years, Enid has contributed substantially to our knowledge of the Australian marine flora.

In addition to this professional contribution, however, Enid makes an enormous voluntary contribution by way of her participation in a wide range of organisations (such as this) and specialist committees. Her involvement with the National Trust and its Nature Preservation Committee is visibly recorded in the Watiparinga Reserve owing its care and preservation to her innovative and effective management.

The Native Vegetation Authority and Native Vegetation Council benefit from her wise advice as does the Mitcham Open Space Advisory Committee.

Enid does not confine her interest in natural history to committee service. She is a very popular public speaker at seminars, meetings of Natural History groups and school functions. She is one of those very special people who can convey her message and enthusiasms to any age and interest group.

Enid's contributions and dedication to the care and understanding of our natural environment has been recognised in a number of ways. In 1986 she was awarded an Australian Heritage Award in the Nature Conservation category and in 1988 received a Bicentennial medallion, Women 88 Awards. In 1991 she was recognised as one of a hundred notable contributors to the S.A. National Parks, was awarded the Australian Plants Award: Professional category, an Award for Excellence from the Mitcham City Council and the Nature Conservation Award by the Field Naturalists Society of S.A.

To this impressive list joins the Australian Natural History Medallion for 1992 for meritorious contribution to the understanding of Australian Natural History.

I have very great pleasure in presenting this medallion on behalf of the Field Naturalists Club of Victoria to a very worthy recipient.

The Australian Natural History Medallion, established in 1939 and administered by The Field Naturalists Club of Victoria, is awarded each year to the person judged to have made the most meritorious contribution to the understanding of Australian natural history. Enid Robertson is a very worthy winner and joins an illustrious group of medallionists.

Book Review

Rainforest Fungi of Tasmania and South-east Australia

by Bruce Fuhrer and Richard Robinson

Publisher: *CSIRO, 314 Albert Street, East Melbourne, VIC 3002.*

95 pages with colour plates, r.r.p. $19.95 (soft cover).

This book is particularly relevant for all those people interested in the fungi found in the cool temperate rain-forests of Tasmania and South-east Australia, where myrtle beech is the dominant species. While not claiming to be a comprehensive coverage of all species or genera, the book provides a guide to the fungi species most likely to be seen, as well as some of the rare fungi.

Clear colour photographs plus descriptive text notes help make field identification relatively simple and the size of the book (150mm by 210mm) enables it to be readily carried in a pack.

The photographs deserve special mention as they are not only technically brilliant but capture the textures and colours of the subjects. The book is visually rich and leaves the reader with an appreciation of the beauty of these fungi.

Ed. Grey

Some Highlights of my 65 years among Fungi

J.H. Willis*

The only kind of fungus that claimed any of my attention, as a little boy at Stanley, N.W. Tasmania, was *Agaricus campestris* (the common Field Mushroom, possibly introduced) that in season we avidly collected for food, though one was aware of other, different-looking fungal growths. Early in 1928, when aged 18, I had the great good fortune to begin training at the Victorian School of Forestry, Creswick. That School's Principal, Mr Edwin J. (Ted) Semmens, happened to be also a keen student of fungi who encouraged me to collect and identify species inhabiting both the pine plantations and natural eucalypt forest around the township; use was made of his own immense, freely-shared knowledge of the subject and of certain standard books in his library (e.g. Carlton Rea's 'British Basidiomycetae', 1922).

In no time I became familiar with the larger, frequently seen items in the Creswick district, such as *Coprinus comatus* (Shaggy Cap), *Oudemansiella radicata* (Rooting Shank), *Lactarius deliciosus* (Orange or Saffron Milk-cap) and *Suillus luteus* (Sticky Bolete) - the last two being introduced species, always near or under pines - , *Trametes versicolor (Rainbow Fungus), Piptoporus portentosus* (White Punk) and *Tremella mesenterica* (Orange-folded Jelly Fungus).

One was soon aware that many kinds of toadstool could not be named with certainty (or even tentatively) using every available text; these were likely to be undescribed species that lacked formal names. Since almost any walk through the forest would turn up a number of fungi not observed previously, their pursuit (and notebook recording by descriptions, while fresh) became a fascinating pastime indeed, even when ending in some nomenclatural cul-de-sac!

The Creswick bushland could put on an amazing autumnal show of fungi, among which the colourful members of gilled *Cortinarius, Russula* and *Mycena* were as conspicuous as several genera of the puffball group were strange and intriguing: rubbery-stalked, red-mouthed *Calostoma;* fleshy-rayed 'Earth Star', *Geastrum indicum;* completely subterranean, strongly odorous *Mesophellea;* delicately latticed, iodaform smelling 'Basket Fungus', *Ileodictyon (Clathrus).*

Of all the fungi noted at Creswick during my 3-year residence at the V.S.F. none was more interesting than a white-capped, pink-gilled, pink-spored, amply-ringed and rosy-fragrant agaric that looked remarkably like *Metraria insignis,* as depicted on colour plate 18, fig 131 in M.C. Cooke's 'Handbook of Australian Fungi' (1892). This rare toadstool was seen on a single occasion (December 1930) and, to my knowledge, it has been recorded only once again - at Wonga Park on the river Yarra, November 1949. Doubtless, Cooke's monotypic *'Metraria'* was actually a species of *Amanita,* appearing after summer rains and related to *A. rosea.*

My first encounter with what is probably the world's largest terrestrial fungus, *Phaeogyroporus portentosus,* took place at Sailor's Falls near Daylesford in March 1929. I was walking there with two fellow students from the V.S.F., and we each took turns at carrying this monster bolete (some 6 kg) the 22 km back to Creswick - for the edification of Ted Semmens. Another very showy, crimson-topped and yellow-spored species, *Boletellus obscurecoccineus,* was discovered by my future wife and me at Drake's Creek (S.E. from Creswick) on her birthday, 30th May, 1931. That was also the day of our formal engagement, made doubly memorable by

* 102 Male Street, Brighton, Vic 3186

the profusion of colourful fungi that came our way. It was to be another half-century before we learned the correct botanical name of that gaudy 'birthday bolete'. This one, and numerous other fungi of the district, were exquisitely painted in watercolour by my wife's invalid brother, Malcolm I. Howie, who executed studies of 208 fungal species before he died in January 1936 - see obit. in *The Victorian Naturalist* **53:** 21-22 (1936).

School vacations from 1927 to 1931 were spent chiefly in the Goulburn Valley, at Nathalia where my father was managing the Bank of Australasia (now A.N.Z. Bank). The flat, open, dryish terrain of this district had its own suite of interesting fungal species, even if much fewer than in Creswick's rich diversity. The puffball assemblage, Gasteromycetae, were prominent along creek frontages and sandy rises around Nathalia. A most exciting trophy was the large spectacular *Battarraea stevenii* (Drumstick Puffball) to 30 cm tall, also the contrastingly small, stalked *Tulostoma minutum* (to 2 cm only); others were: *Mycenastrum corium* (5-10 cm diameter and free from the soil), *Calvatia candida, Gedstrum floriforme* (tiny 'Earth Star'), the unusual and spongy-stalked phalloid *Lysurus gardneri* of lawns in the township.

As a forest cadet, at the end of 1932 I was appointed to Belgrave in the Dandenong Forest District which then extended from Melbourne easterly to the Bunyip River and down to the north coast of Western Port - altogether a marvellous region for any budding mycologist.

After marriage, in October 1933, I set up home at Cockatoo, working as an assistant forester chiefly in the Gembrook section of the district. While patrolling several operational sawmill areas, I became acquainted with remoter ranges and fern gullies around the watersheds of the upper Bunyip River, McCrae, Tomahawk, Back and Diamond Creeks. All this damp forest land provided a wealth of hitherto unfamiliar fungi, e.g. *Polyporus mylittae* ('Blackfellow's Bread'), *P. sclerotinius* and *P. tumulosus,* with their massive subterranean sclerotia, large orange-textured *Piptoporus australiensis* ('Curry Punk', from its powerful, permanent odour), the bristly gregarious toadstool *Lacrymaria asperospora,* big gilled fungus on sassafras trunks *Agrocybe parasitica,* red-armed phalloid *Anthurus javanicus,* an impressive obligate parasite of *Nothofagus* trees *Cyttaria gunnii* (the 'Beech Orange', having globular honeycombed fructifications during November -December).

A gem among the 500 odd species of larger fungi in the Dandenongs was certainly *Beenakia daCostae;* this little downy, snow-white, top-shaped fungus (to 3 cm high) bears on its under-surface rather long, tawny, spine-like teeth. Its habitat is quite odd - on dry powdery debris under large logs (commonly of *Eucalyptus regnans*). The genus *Beenakia* was considered endemic to Victoria, until someone found the same thing in a tropical rainforest of West Africa. While at Cockatoo I came to know mycologists Dr Ethel. I McLennan (Melbourne University) and Professor J.B. Cleland of Adelaide, through copious correspondence with him; both proved extremely helpful.

After I came to live permanently in Melbourne (October 1937), having joined the staff of the National Herbarium, fungal researches continued; one was grateful for the availability of much extra literature, also of the compound microscope. I contributed several short papers to *The Victorian Naturalist* and in 1941 ventured to bring out 'Victorian Fungi', a pioneering F.N.C.V. field guide to some 120 commoner species of gilled fungi; its title was changed to 'Victorian Toadstools and Mushrooms' in a 1950 edition, two further up-dated editions appearing in 1957 and 1963.

Trips to the Mallee (especially Mildura district) yielded *Polyporus basilapiloides* ('Stone-making Fungus') and several unfamiliar genera of puffballs (*Disciseda, Chlamydopus, Podaxis* and *Phellorinia*) not to omit the curious cup-fungus *Peziza austrogeaster* of sandhills. During a memorable excursion to Anglesea (August 1968) I found a sizeable colony of the morel-like *Underwoodia beatonii* - a rarely seen terrestrial of coastal sand, associated with old *Melaleuca lanceolata* (Moonah trees). Alpine tracts of the Bogong High Plains provided spectacular examples of smelly *Aseroë rubra* ('Red Starfish Fungus', amongst grass), on Snow Gum wood *Piptoporus maculatis- simus* and *Tyromyces pulcherrimus* (spongy, crimson brackets); the minuscule yellow cup-fungus (1-2mm) *Bisporella oritis* was always restricted to old opened capsules of the protead *Orites lancifolia.*

A very exciting experience, back in June 1942, had been under guidance by Mr and Mrs Paul Fisch (of East Doncaster) to a spot along Koonung Creek; there, beneath Silver Wattle trees, they were able to show me **four** large species of "Vegetable Caterpillar", all growing together within a few square metres: *Cordyceps gunii, C. hawkesii, C. cranstounii* and *C. robertsii* - what an unforgettable sight!

During my term as Australian Botanical Liaison Officer in Great Britain (1958/59), it was stimulating to meet up with a number of notable British mycologists, including Drs Elsie M. Wakefield, John Ramsbottom, R.W.G. Dennis, Derek Reid and Stephen Hutchinson. With their help, and on field forays of the British and French Mycological Societies, I was to enlarge my repertoire by many European species, e.g. *Cordyceps militaris* (Isle of Wight), *Cantharellus cibarius* (Loch Lomond) and Stink Horn *Phallus impudicus* (Dwingelo, Holland).

In 1965, jointly with E.D. Gill, I published through the Royal Society of Victoria a paper on a fossilized fungus *(Hypoxylon annulatum).* These remains were very well preserved (even to ascospores) in a Tertiary seam of brown coal at the Yallourn open-cut mine.

In mid-May 1969 a visit to O'Reilly's, Lamington National Park, Queensland, brought to light material of a new tooth-fungus; it was later named *Steccherinum willisii* by R.A. Maas-Geesteranus in Holland. On the same occasion, a putrid smell in the rainforest led one to a white form of the phalloid *Anthurus javanicus.* Even in retirement I can't resist the never-ending enchantment of the fungal world. Central Australia has unexpectedly produced a Brazilian phalloid, *Itajahya* around Uluru (Ayers Rock); the tropics have delighted me with a wealth of such polypores as white *Trametes muelleri,* multiseriate *Gloeophyllum concentricum,* the elegant yellow-stalked *Microporus xanthopus* ('Wine-Glass Fungus') and leathery, lilacine, honey-combed species of *Pseudo favolus.* Last, but not least, a little brilliant red puffball came my way on Norfolk Island (October 1989) - the second known record of *Secotium fragariosum.*

First record of *Mycenella* (Xerulaceae) in Australia

Cheryl Grgurinovic*

Abstract

The genus *Mycenella* (J.E. Lange) Singer had not been recorded in Australia prior to collections in 1981 of *M. margaritispora* (J.E. Lange) Singer from Victoria which are described below.

Introduction

The genus *Mycenella* (J.E. Lange) Singer was erected by Lange (1914) as a subgenus of the genus *Mycena* (Pers. ex Fr.) Gray and raised to generic level by Singer (1938). Collections from Victoria of the type species of the genus, *Mycenella margaritispora* (J.E. Lange) Singer, are described here as a first record of the genus from Australia. A number of other species occur in the southern hemisphere: *Mycenella fuliginosa* Singer from Argentina (Singer 1964); *M. minima* Singer from Chile (Singer 1969); *M. eriopoda* (Sacc. & P. Syd.) Singer from Argentina (Singer 1952a; 1964); *M. polylepidis* Singer from Argentina (Singer 1989); *M. funebris* Singer from Tierra del Fuego, mainland Argentina and Chile (Singer 1952b; Singer 1964; Singer and Digilio 1953); *M. aristoteliae* Singer from Masatierra, Chile (Singer 1959); and *M. subtropicalis* Singer from Argentina (Singer 1964).

Materials and methods

As each collection of *Mycenella* was made, notes were taken describing the substratum upon which the collection was growing, the presence of any distinctive odour, and the growth habit, that is whether solitary, scattered, gregarious or caespitose. Spore prints were made as soon as possible after collection.

The procedures of macroscopic examination and the terminology used are based on those of Largent (1977). Colours of the basidiomata were recorded using Rayner (1970). Although the macroscopic characters for *Mycenella* were determined on fresh collections, the microscopic characters were determined later, using specimens preserved by freeze drying using a Dynavac high vacuum freeze drying unit, model FD16.

The procedures for microscopic examination and the terminology used were those of Largent *et al.* (1977). Measurements of microscopic structures were recorded from fragments of basidioma stained with ammoniacal Congo Red and then mounted in a five per cent aqueous solution of potassium hydroxide. Data on the number of measurements taken per number of collections examined is given (for example, (27/1), twenty-seven measurements from one collection [Bas 1969]). Data given for spores include the length/breadth ratio (mean length divided by mean width) and the quotient (sum of lengths divided by sum of widths). Basidiomata were also examined for sarcodimitic tissue (Corner 1966).

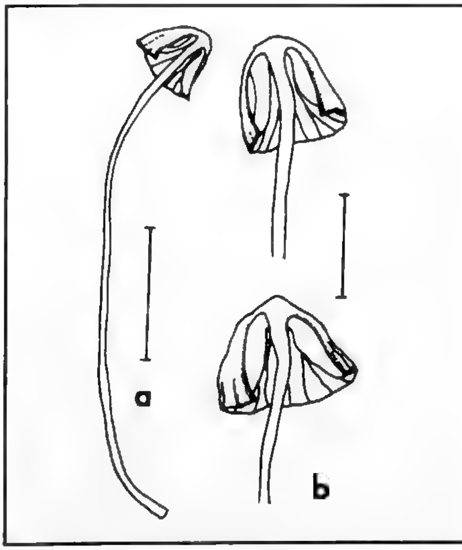


Fig. 1. *Mycenella margaritispora*: a, longitudinal section of basidioma, Bar = 10 mm; b, longitudinal sections through pileus, Bar = 5 mm.

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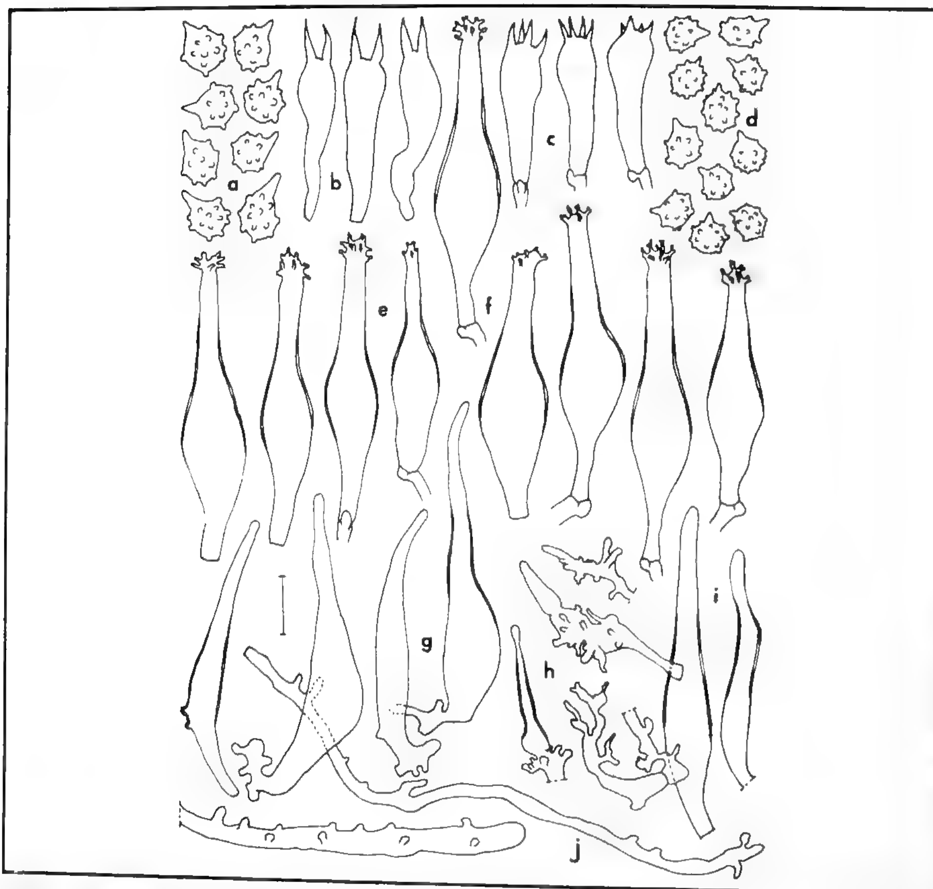

Fig. 2. *Mycenella margaritispora:* a, spores from two-spored basidia; b, two-spored basidia; c, four-spored basidia; d, spores from four-spored basidia; e, cheilocystidia; f, pleurocystidia; g, caulocystidia; h, pileal surface; i, pileocystidia; j, stipe surface. Bar = 10 µm.

Mycenella margaritispora (J.E. Lange) Singer in *Lilloa* 22: 291 (1951). Figs 1-2.

Mycena margaritispora J.E. Lange in *Dansk Bot. Arkiv* 5: 37 (1914).

Pileus to 10 mm diam., to 5 mm high, conic to steeply conic or campanulate, slightly umbonate or not, silky, moist, minutely radially rugulose; margin entire, translucent-striate, slightly flared at maturity; 'sepia' to 'umber' at apex, becoming 'isabelline', 'hazel' or dark 'umber', then light 'isabelline' to 'isabelline' at margin; flesh thin to thick, tapering gradually to margin, white to watery grey. *Lamellae* narrowly adnate to adnate, ascending, distant, narrow to moderately broad, with two series of lamellulae, rarely one or three, with occasional bifurcate branching near margin of pileus, minutely denticulate at edge, sides minutely pubescent, white with slight 'hazel' tinge towards pileus. *Stipe* to 41 mm long, to 1 mm diam., cylindric, smooth except towards apex where minutely denticulate from caulocystidia, dry, polished, with sparse short white strigose hairs at base, or base naked, cartilaginous, fistulose, pallid to 'hazel' at apex, becoming dark 'honey', dark 'hazel' or 'umber' towards base. *Odour* not distinctive.

Basidiospores (two-spored basidia, from collections *4681* and *1782*) (27/1), 6.4-8.3 ($\bar{x}$ = 7.6, SD = ± 0.46) x 5.6-7.8 ($\bar{x}$= 6.85, SD = ± 0.51) µm, L/B = 1.1, Q = 1.1; (four-spored basidia, from collection *41581*) (26/1), 5.3-7.2 ($\bar{x}$ = 6.3, SD = ± 0.54) x 4.8-8.3 ($\bar{x}$ = 6.1, SD = ± 0.91) µm, L/B = 1.0, Q = 1.0 (excluding ornamentation); globose to subglobose, with large conical apiculus to 4.0 µm long, nodulose, with large obtuse nodulae to 0.9 m high, inamyloid, hyaline. *Basidia* (25/1), 22.0-31.2 [-46.0] ($\bar{x}$ = 28.1, SD = ± 4.33) x 7.0-8.4 ($\bar{x}$ = 7.7, SD = ± 0.36) µm, with sterigmata to 5.6 µm long, two- or rarely four-spored (*4681, 1782*) or four-spored (*41581*), clavate, with clamp connection at base. *Cheilocystidia* moderately abundant, (25/1), 51.6-67.0 ($\bar{x}$ = 56.5, SD = ± 4.20) x 8.7-12.1 ($\bar{x}$ = 9.9, SD = ±1.19) µm, fusoid-ventricose, with a long, tapering neck, with many short excrescences at apex, rarely none, slightly thick-walled from apex to middle of ventricose region or just below neck, walls to 1.2 m thick, with clamp connection at base, hyaline. *Pleurocystidia* moderately abundant, (17/1), 48.0-61.6 ($\bar{x}$ = 55.7, SD = ± 4.13) x 6.4-18.4 ($\bar{x}$ = 11.65, SD = ± 2.39) µm, similar to cheilocystidia, with clamp connection at base. *Hymenophoral trama* regular, non-dextrinoid. *Pileal surface* an epicutis, consisting of filamentous to cylindrical hyphae with abundant, short, rod-like to cylindrical excrescences, hyphae (11/1), 1.6-3.8 ($\bar{x}$ = 2.8, SD = ± 0.70) µm diam., some terminal cells slightly thick-walled and appearing pileocystidioid; pileocystidia scattered or moderately abundant in places, (2/1), 57.6-61.6 x 8.6-10.6 µm, fusoid to fusoid-ventricose, without apical excrescences, slightly thick-walled in ventricose region or in neck region. *Pileal context* non-dextrinoid. *Stipe surface* of filamentous hyphae, with short rod-like to cylindrical excrescences. *Caulocystidia* moderately abundant over stipe surface, (9/1), 44.8-78.4 ($\bar{x}$ = 58.0, SD = ± 10.07) x 6.0-10.5 ($\bar{x}$ = 8.3, SD = ± 1.69) µm, fusoid-ventricose, with few apical excrescences or none, sometimes slightly thick-walled in neck region. *Stipe context* non-dextrinoid. *Sarcodimitic tissue* present at base of stipe only. *Clamp connections* present.

Habit, habitat and phenology

Gregarious; on trunk of *Nothofagus cunninghamii* (Hook.f.) Oerst., on trunk of *Bedfordia salicina* (Labill.) DC. and on trunk of *Acacia melanoxylon* R. Br. Specimens collected from May to July.

Collections

Victoria: Sherbrooke Forest, Hardy Creek, 10.v.1981, *C.A. Grgurinovic 41581* (CBG 9302147). Glen Nayook, 7.vi.1981, *C.A. Grgurinovic 4681* (CBG 9302148); 20.vii.1982, *C.A. Grgurinovic 1782* (CBG 9302149).

The spores and basidia of Australian collections are similar in size to those of European and North American collections. Smith (1947) recorded the spores as (5-) 6-8 µm. Kühner (1938) recorded the spores as 5.5-6.5 µm and the basidia as 20-25 x 7-8.5 µm. Boekhout (1985) recorded the spores as (5.5-) 6.3-8.1 x (4.5-) 5.1-6.7 (-7.4) µm and the basidia as 23-35 x 6-8 µm.

Australian collections have two- or four-spored basidia. Horak (1968) also recorded the basidia as two-or four-spored. The collections he examined were *Mycenella lasiosperma* (Bres.) Singer, which he considered conspecific with *M. margaritispora*. Boekhout (1985) recorded collections from the Netherlands as having two-spored basidia, as did Smith (1935; 1947) for collections from North America.

Australian collections also have slightly thick-walled cheilocystidia and pleurocystidia. They are, however, the same size as those in European and North American collections. Boekhout (1985), Smith (1935, 1947) and Kühner (1938) described the cheilocystidia and pleurocystidia as thin-walled.

Collections from the Netherlands are reported as having a hymeniform pileal surface (Boekhout 1985). This disagrees with what was found in Australian collections and also with the description of the pileal cuticle by Horak (1968), and by Singer (1986) who reported that the epicutis in *Mycenella* is not hymeniform.

Boekhout (1985) noted that *M. margaritispora* is characterised by a small, conical to campanulate pileus and cheilocystidia with simple or coralloid excrescences at their apex. In the latter aspect this species agrees with *M. lasiosperma* (Bres.) Singer, which according to some authors (e.g. [Horak 1968] Kühner 1938: 612, 1980: 896) is conspecific with *M. margaritispora*. He noted that the latter species seemed to differ from *M. lasiosperma* in the smaller non-fasciculate basidiomata, in the absence of a rooting base and in having a not very pronounced smell. Bigelow (1984) noted that further study of the spores of North American and European collections variously identified as *M. margaritispora, M. bryophila* (Voglino) Singer, *M. trachyspora* (Rea) Bon, *M. lasiosperma* (Bresadola) Singer, *M. kuehneri* Romagnesi, *Mycena nodulosa* Smith, is in order. When comparing various accounts of these species there is some confusion about the definitive characteristics of each, and an examination of spores under the scanning electron microscope may provide additional information which will aid in clarifying the number of species which actually exist.

Sarcodimitic tissues in the stipe have been reported for two species of *Mycenella: M. bryophila* (Corner 1966; Natarajan and Raman 1981) and *M. nodulosa* (A.H. Smith) Boekhout (Redhead 1987).

The generic and family relationships of *Mycenella* have been the subject of much dispute. *Mycenella* was originally described as a subgenus of *Mycena* (Lange 1914) which Kühner (1938) reduced to a section. Singer (1936) initially transferred the species of *Mycena* subgenus *Mycenella* to *Marasmius* section *Laccariosporae*, but subsequently recognised *Mycenella* as a genus (Singer 1938; 1986) in the tribe *Marasmieae*. Kühner (1980) placed *Mycenella* with *Mycena* in the tribe *Myceneae*. He did this on the grounds that species of *Mycenella* possess intracellular pigmentation and are much too mycenoid in habit to be placed in the tribe *Marasmieae* (Kühner 1980).

Mycenella can be distinguished from *Mycena* by its spores which are globose, inamyloid, and nodulose or smooth, and have a large apiculus. *Mycenella aristoteliae, M. eriopoda, M. subtropicalis, M. funebris* and *M. salicina* (Voglino) Singer have smooth spores. However, these species, with the exception of *M. aristoteliae,* have a large apiculus. The apiculus of the latter species is described as 'not very voluminous' (Singer 1959). Species of *Mycenella* also have non-dextrinoid hyphae, whereas most species of *Mycena* have dextrinoid hyphae.

Romagnesi (1940) indicated that *Mycenella* and *Xerula* are closely related, and in fact were not divided by a hiatus. He believed that the two genera should be combined under the name *Mycenella*. Singer (1986) noted that it may be argued that the pilosity of the Xerulas is nothing but an extreme of the (microscopical) hairs observed in *Mycenella*, and it may be said that if smooth spores are admitted in *Mycenella (M. salicina)*, echinate spores should also be admitted in the large-spored forms *(Xerula)*. However, Singer believed that these characters coincided with the general habit of the basidiomata, and therefore a correlation between two important characters exists. He stated that at the moment one could not go beyond Romagnesi's demonstration of affinity between the genera *Mycenella* and *Xerula (= Oudemansiella)*.

Redhead (1987) circumscribed the family Xerulaceae Jülich to include twenty-five genera characterised by the presence of sarcodimitic tissues. Many of these genera have been closely linked by other characters (Redhead 1987) and had all been formerly placed in the large family Tricholomataceae Roze *sensu lato*. Bas

(1990) reduced Xerulaceae to the tribe *Xeruleae* in the Tricholomataceae. The *Xerulaceae* contains *Mycena, Mycenella* and *Xerula*. Redhead (1987) considered *Mycenella* to be more closely related to *Xerula* than to *Mycena*.

Acknowledgements

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References

Bas, C. (1969). Morphology and subdivision of *Amanita* and a monograph of its section *Lepidella*. *Persoonia* **5:** 285-579.

Bas, C. (1990). Notulae ad floram Agaricinam Neerlandicam-XVII. On tribus names in the family Tricholomataceae *sensu lato*. *Persoonia* **14:** 233-235.

Bigelow, H.E. (1984). Spore ornamentation in the Tricholomataceae. II. *Sydowia* **36:** 11-18.

Boekhout, T. (1985). Notulae ad floram Agaricinam Neerlandicam-IX. *Mycenella*. *Persoonia* **12:** 427-440.

Corner, E.J.H. (1966). 'A Monograph of Cantharelloid Fungi'. (Oxford University Press: London.)

Horak, E. (1968). Synopsis generum Agaricalium (Die Gattungstypen der Agaricales). *Beitrage zur Kryptogamenflora der Schweiz* **13:** 1-741.

Kühner, R. (1938). Le Genre *Mycena*. *Encyclopedie Mycologique* **10:** 1-710.

Kühner, R. (1980). Les hyménomycètes agaricoïdes, *Numéro spécial du Bulletin de la Société Linnéenne de Lyon* **49.**

Lange, J. (1914). Studies in the agarics of Denmark I. *Dansk botanisk arkiv udgivet af Dansk botanisk forening* **1:** 1-40.

Largent, D.L. (1977). 'How to Identify Mushrooms to Genus I: Macroscopic Features'. (Mad River Press, Inc.: Eureka, California.)

Largent, D.L., Johnson, D. and Watling, R. (1977). 'How to Identify Mushrooms to Genus III: Microscopic Features'. (Mad River Press, Inc.: Eureka, California.)

Natarajan, K. and Raman, N. (1981). South Indian Agaricales-IX. *Sydowia* **33:** 225-235.

Rayner, R.W. (1970). 'A Mycological Colour Chart'. (Commonwealth Mycological Institute: Kew, Surrey, and British Mycological Institute.)

Redhead, S.A. (1987). The Xerulaceae (Basidiomycetes), a family with sarcodimitic tissues. *Canadian Journal of Botany* **65:** 1551-1562.

Romagnesi, H. (1940). *Mycenella* et *Xerula*. *Bulletin de la société mycologique de France* **56:** 59-65.

Singer, R. (1936). Studien zur Systematik der Basidiomyceten. *Beihefte zum Botanischen Centralblatt* **56 B:** 137-174.

Singer, R. (1938). De Nonnulis Basidiomycetibus. *Botaniceskie meterialy Otdela sporovyh rastenij Botaniceskogo instituta imeni V.L. Komarova Akademii nauk SSSR* **4 (10-12):** 4-8.

Singer, R. (1952a). Type studies on agarics III. *Lilloa* **25:** 463-514.

Singer, R. (1952b). The Agarics of the Argentine Sector of Tierra del Fuego and limitrophous Regions of the Magallanes Area. *Sydowia* **6:** 165-226.

Singer, R. (1959). Basidiomycetes from Masatierra (Juan Fernandez Islands, Chile). *Arkiv för Botanik* **4:** 371-400, pls V-XII.

Singer, R. (1964). *Oudemansiellinae, Macrocystidiinae, Pseudohiatulinae* in South America. *Darwiniana* **13:** 145-190.

Singer, R. (1969). Mycoflora australis. *Beiheft zur Nova Hedwigia* **29:** 1-405.

Singer, R. (1986). 'The Agaricales in Modern Taxonomy', 4th edn. (Koeltz Scientific Books: Koenigstein, Germany.)

Singer, R. (1989). New Taxa and New Combinations of Agaricales (Diagnoses Fungorum Novorum Agaricalium IV). *Fieldiana* n.s. **21:** 1-133.

Singer, R. and Digilio, P.L. (1953). Pródromo de la flora agaricina Argentina. *Lilloa* **25:** 5-462.

Smith, A.H. (1935). Studies in *Mycena*. I. *American Journal of Botany* **22:** 858-877.

Smith, A.H. (1947). 'North American Species of Mycena'. (University of Michigan Press: Ann Arbor, and Oxford University Press: London.)

Thysanophora in Australia

J.A. Simpson*

While examining samples from unthrifty caucasian fir trees, *Abies nordmanniana* (Steven) Spach, from northern New South Wales we observed an unusual Hyphomycete growing on recently fallen needles. The fungus was identified as belonging to *Thysanophora* Kendrick, a small genus of six described species, not previously reported to occur in Australia.

Materials and Methods

For isolation of the fungus, conidia were picked off conidiophores using a sterile moist needle and plated on 1.25% malt extract agar containing 50 µg mL^{-1} streptomycin sulphate. Isolates were subsequently grown on Czapek yeast autolysate agar (CYA), malt extract agar (MEA) and 25% glycerol nitrate agar (G25N) prepared according to Pitt (1979). Inoculated plates were incubated at 5°C, 25°C and 37°C.

After seven days the plates were examined, colony diameters measured, described and examined microscopically. Colony colours were determined using Kornerup and Wanscher (1983). Microscopical observations were made on material mounted in lactofuchsin (Carmichael 1955). Production of laccase and tyrosinase was tested for using α - naphthol and p-cresol drop tests as described by Kaarik (1965).

Results

Thysanophora penicilloides (Roumeguere) Kendrick

≅ *Haplographium penicilloides* Roum.

Sclerotial morph *Sclerotium glauco-albidum* Desmagieres

≅ *Thysanophora glauco-albida* (Desm.) Morelet

Conidiophores erumpent from stomata on conifer leaves or borne in a dense stand from surface hyphae on agar media, erect, to 700 x 8-17 µm, thick walled, olivaceous brown, paler above, septate, with an apical penicillus, and frequently, proliferation of the conidiophore from just below the penicillus to give rise to a sympodial series of heads; metulae in verticils of 3-8, slightly divergent, 11-17 x 3.6 µm , each metula bearing 2-7 phialides at its apex; phialides lanceolate, 9-15 x 2.0 -3.5 µm, hyaline to pale yellowish brown in age, with tapering colulla but no collarette; conidia dry, hyaline to pale brown, subglobose to ellipsoidal, 2.0-5.1 x 1.6-3.0 µm, finely roughened, borne in disordered basipetal chains (Fig. 1A-C).

CYA, 20°C, 7 days : colonies 14-17 mm diameter, plane with a dense stand of conidiophores, olive, 3E3 to 4E3, exudate and soluble pigment absent, reverse yellowish brown, 3F3 "goose turd".

MEA, 25°C, 7 days: colonies 21-31 mm diameter, plane, yellowish brown, 4F3-4 'sepia', margin 1-2 mm wide white, exudate and soluble pigment absent, reverse 4F3-4.

G25N, 25°C, 7 days: colonies 3-4 mm diameter, subhyaline, no sporulation.

CYA, 5°C, 7 days: colonies 2-3 mm diameter, subhyaline, no sporulation.

CYA, 37°C, 7 days: no growth.

Laccase: negative.

Tyrosinase: negative.

Specimens examined: New South Wales, Guyra, on dead fallen leaves of *Abies nordmanniana*, D. Crossing, 19 February, 1993, DAR 69515.

Discussion

Overseas the conidiophores of *T. penicilloides* and of other species of *Thysanophora* are often associated with white to brown or olivaceous brown sclerotia (Kendrick 1961, Stolk and Hennebert 1968, Barron and Cooke 1970,

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Ellis 1971). No sclerotia were observed on the leaves of the Guyra collection or in culture. Willetts and Bullock (1992) have suggested sclerotia are derived from conidiogenous or ascogenous tissues. No teleomorph is known for any species of *Thysanophora*. The penicilli of *T. penicilloides* are similar to those of species

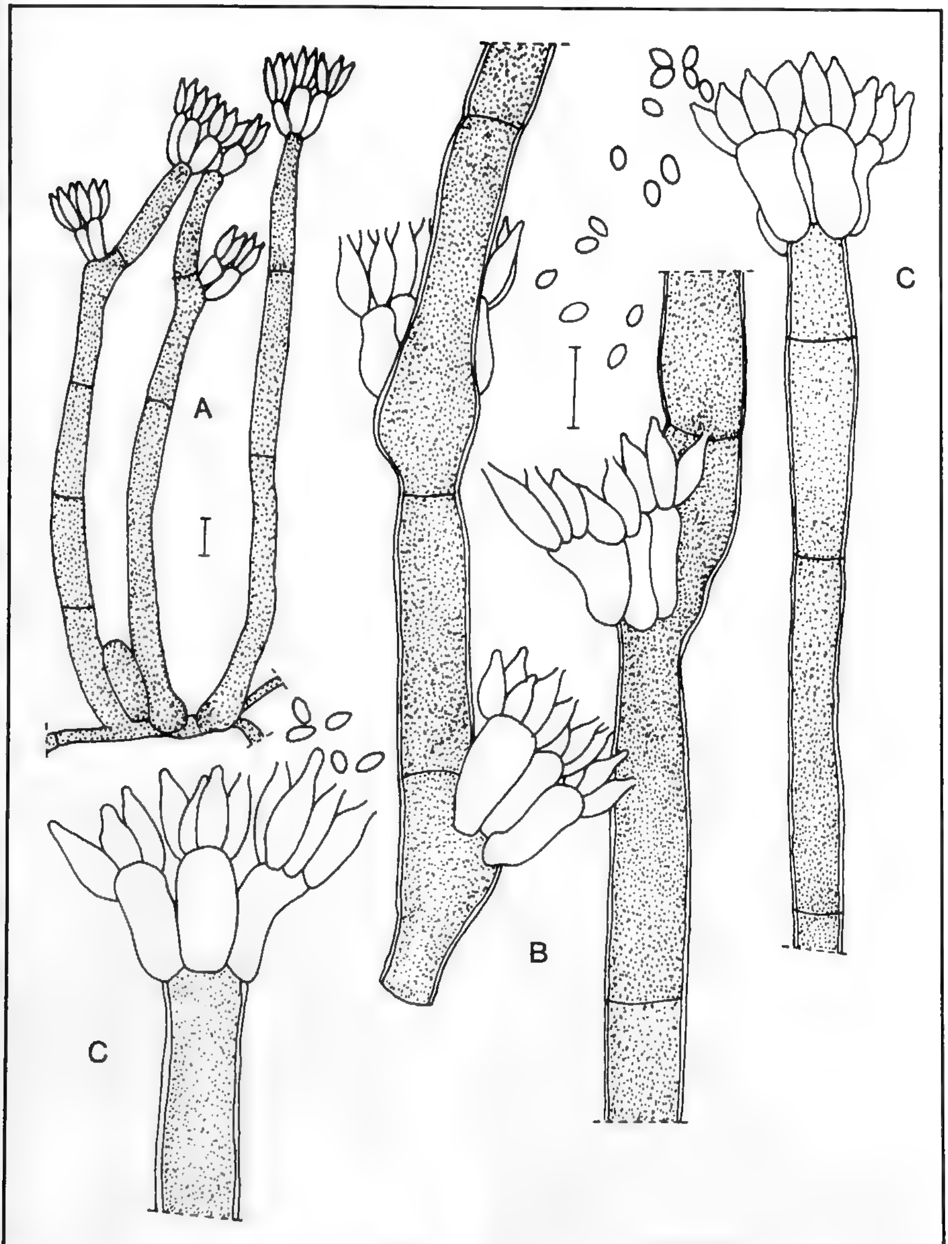

Fig. 1. *Thysanophora penicilloides.* **A.** Group of conidiophores emergent from *Abies* leaf. **B.** Proliferations of the conidiophore. **C.** Apical penicillus and conidia. (Bar = 10 µm).

of *Penicillium* Ludwig subgenus *Biverticillium* Dierckx section *Simplicium* (Biourge) Pitt. Subramanian (1979) observed 'that most phialidic Hyphomycetes producing dry conidia in true chains have teleomorphs in the Eurotiales'. However, no species of the Eurotiales (von Arx 1987) is known to have sclerotia like those of species of *Thysanophora*. Pitt (1979) rejected the idea of any close relationship between *Penicillium* and *Thysanophora*. If the sclerotia are of ascocarpic origin, their absence from the Guyra collection may indicate the teleomorph is heterothallic and only one mating type was introduced.

The presence of a sclerotial morph presents a nomenclatural problem first addressed by Kendrick (1961). He placed *Sclerotium glauco-albidum*, which was described in 1851, into synonymy with *T. penicilloides* the basionym of which was described in 1890. Kendrick found no *Thysanophora* conidiophores on the type collection of *S. glauco-albidum*. Because the genus *Thysanophora* is characterised by its conidiophores rather than its sclerotia Kendrick chose not to typify the genus with a type consisting only of sclerotia. Morelet (1968), however, made the valid combination *Thysanophora glauco-albida*. I have chosen to use the nomenclature of Kendrick (1961) rather than Morelet (1968) in view of Recommendation 59A.2 of the International Code of Botanical Nomenclature (Greuter 1988) which states 'When in naming a new morph of a fungus the epithet of the name of a different, earlier described morph of the same fungus is used, the new name should be designated as the name of a new taxon or anamorph, as the case may be, but not as a new combination based on the earlier name'.

T. penicilloides is reported to be common on rotting leaves of *Abies grandis* (Douglas ex D. Don) Lindl, in the United Kingdom and occasionally on *Larix, Picea* and *Pseudotsuga* (Ellis and Ellis, 1985). Kendrick (1961) also reported it from fruits of *Cornus, Sorbus* and *Coprinus*, and from soil. Careful searches may reveal it in south eastern Australia in gardens with old trees of *Abies, Larix* or *Picea*.

Acknowledgements

I thank C.A. Grgurinovic for Figure 1 and M. Priest for advice on the occurrence of *Thysanophora* in Australia.

References

Arx, J.A. von (1987). A re-evaluation of the Eurotiales. *Persoonia* **13:** 273-300.

Barron, G.L. and Cooke, W.B. (1970). A new *Thysanophora*. *Mycopathologia et Mycologia Applicata* **40:** 353-356.

Carmichael, J.W. (1955). Lacto-fuchsin: a new medium for mounting fungi. *Mycologia* **47:** 611.

Ellis, M.B. (1971). 'Dematiaceous Hyphomycetes'. (Commonwealth Mycological Institute : Kew.)

Ellis, M.B. and Ellis, J.P. (1985). 'Microfungi on land plants. An identification handbook' (Croom Helm : London.)

Greuter, W. (ed.) (1988). 'International Code of Botanical Nomenclature' (Koeltz Books: Konig- stein.)

Kaarik, A. (1965). The identification of the mycelia of wood-decay fungi by their oxidation reactions with phenolic compounds. *Studia Forestalia Suecia* **31:** 1-38.

Kendrick, W.B. (1961). Hyphomycetes of conifer leaf litter. *Thysanophora* gen. nov. *Canadian Journal of Botany* **39:** 817-823.

Kornerup, A. and Wanscher, J.H. (1983). 'Methuen handbook of colour. Third edition' (Methuen: London.)

Morelet, M. (1968). Micromycetes du Var et d' Ailleurs. *Annals Societe Scientifique Naturelle Archeol, Toulon et Var* **20:** 102-106.

Pitt, J.I. (1979). 'The genus *Penicillium* and its teleomorphic states *Eupenicillium* and *Talaromyces*'. (Academic Press: London.)

Stolk, A.C. and Hennebert, G.L. (1968). New species of *Thysanophora* and *Custingophora* gen. nov. *Persoonia* **5:** 189-199.

Subramanian, C.V. (1979). Phialidic Hyphomycetes and their teleomorphs - an analysis. *In* 'The Whole Fungus', Ed B. Kendrick, 125-151. (National Museums of Canada for Kananaskis Foundation: Ottawa.)

Willetts, H.J. and Bullock, S. (1992). Developmental biology of sclerotia. *Mycological Research* **96:** 801-816.

Host Specificity of Disc-fungi in the Genus *Banksiamyces* on *Banksia.*

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Banksiamyces is a uniquely Australian genus of small Disc-fungi, found only on *Banksia* cones. Four species of *Banksiamyces* have been described (Beaton and Weste 1982, 1984) each recorded up to now from a single, different species of *Banksia* (*Banksiamyces macrocarpus* on *Banksia spinulosa* Fig. 1; *Banksiamyces toomansis* on *Banksia marginata; Banksiamyces katerinae* on *Banksia ornata* Fig. 2; *Banksiamyces maccannii* on *Banksia saxicola* Fig. 3. Beaton and Weste (1984) also noted that infertile (and hence unidentified) collections have been made of *Banksiamyces* on *Banksia canei, B. integrifolia* and *B. serrata. Banksiamyces* has thus been found on all seven Victorian *Banksia* species. *Banksiamyces* has also been observed on some Western Australian *Banksia* species (Ian McCann, pers. comm.) and on the Queensland *B. conferta* cultivated in Victoria.

Fresh fruiting bodies are stalked, with a concave disc on the upper surface where the spores are produced. *Banksiamyces macrocarpus* (also illustrated, in colour, by Fuhrer 1985) is considerably larger than the other species, with a disc up to 20 mm in diameter. The remaining species all produce fruiting bodies which rarely exceed 5 mm diameter. *B. toomansis* can be distinguished by the blue-grey disc and white granular outer covering to the stipe surface and disc underside. In *B. katerinae* both the disc and the outer covering are dark grey. *B. maccannii* has much larger spores than the preceding species and the outer surface is not noticeably granular.

When dried, the fruiting bodies of *B.*

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Fig. 1. *Banksiamyces macrocarpus* on *Banksia spinulosa* (c. x1).

Fig. 2. *Banksiamyces katerinae* on *Banksia ornata* (c. x1).

Fig. 3. *Banksiamyces maccannii* on *Banksia saxicola* (c. x1).

toomansis and *B. katerinae* do not shrink much and assume a characteristic laterally compressed form (Fig. 2) with the edge of the disc being strongly inrolled. This mode of drying is similar to other fungi in which the spore producing area is protected after drying prior to later rehydration when favourable conditions recur. Further observations of material in the field are required on this matter. In contrast, *B.macrocarpus* dries in an irregular manner and shrinks to a relatively greater degree than the other three species.

The four species also differ in the distribution of gelatinous tissue within the fruiting bodies and in the position of the fruiting bodies on the cone. *B. katerinae* is found predominantly on the exposed surface of the seed capsules, towards the lips of the valves, sometimes massed on the valve lips, whereas *B. toomansis* tends to occur on the cone surface between the seed capsules and on the exposed portion of the seed capsule distal to the lips of the valves.

In most dried collections spores are rarely found even though frequent in fresh material prior to drying. Perhaps there is mass discharge of spores during drying, although at least some spores would be expected to adhere to the disc surface especially in those species where the disc edges are inrolled after drying. Fruiting bodies placed when fresh in 70% alcohol appear to retain spores and this method of preservation should be used for at least some fruiting bodies from each collection. In the absence of spores there are sufficient other distinguishing characters, as described above, for satisfactory identification.

Beaton and Weste (1984) considered that each species of *Banksiamyces* was limited in occurrence to one host species. We were therefore suprised to find for sale at a craft market a cone of *Banksia marginata* (for use in making ornamental animals) upon which were present two different species of *Banksiamyces (B. katerinae* and *B. toomansis),* the identification of which was confirmed by Gordon Beaton. The cone had been collected on Kangaroo Island, where the only species of *Banksia* are *B. marginata* and *B. ornata.* The cone did lack the persistent styles usual in *B. marginata,* but further typical material of *B. marginata* was received from Kangaroo Island (via Ian McCann) on which there were also the same two species of *Banksiamyces.*

The finding of two species of *Banksiamyces* on the one host prompted a closer look at the host range of the Victorian species. Observations now include: (1) *B. toomansis* on *Banksia saxicola* (Fig. 4), (2) *B. toomansis* and *B. maccannii* on the one cone of *Banksia saxicola,* (3) *Banksiamyces toomansis* and *B. katerinae* on the one cone of *Banksia ornata,* (Fig. 5), (4) *Banksiamyces toomanis* on *Banksia canei,* and (5) two different but unidentified species of *Banksiamyces* on *Banksia serrata.* Thus *Banksiamyces toomanis* is found on at least four different species of *Banksia, Banksiamyces katerinae* on two species and *B. maccannii* on one species. *B. macrocarpus* remains the only species on *Banksia spinulosa,* and has only been found on that host.

Beaton and Weste (1982) considered, but did not accept, the possibility that the different species which they described

Fig. 4. Dried fruiting bodies of *Banksiamyces toomansis* on *Banksia saxicola* (c. x1).

Fig. 5. Dried fruiting bodies of *Banksiamyces toomansis* (paler fruiting bodies) and *B. katerinae* on *Banksia ornata* (c. x2).

were in fact a single species which produced fruiting bodies of different morphology on different hosts. The finding of typical fruiting bodies of two different species on the one host, and also of the same species on more than one host, supports the contention that morphology is not affected to any major extent by the host. Differences in position of fruiting bodies are also constant when two species co-occur. On *Banksia ornata,* fruiting bodies of *Banksiamyces katerinae* are found massed near the lips of the valves whilst those of *Banksiamyces toomansis* on *Banksia ornata* occur mainly toward the base of the seed capsule, as they do on other hosts.

There are more than 70 Australian species of *Banksia* and one species in Papua New Guinea (George 1984). It will be of interest to see what is the host range of each *Banksiamyces* in relation to all species of *Banksia,* and to see if further species of *Banksiamyces* are discovered. Investigation of the occurrence of different species of *Banksiamyces* on different species of *Banksia,* similar to the study of the fungus *Cyttaria* on *Nothofagus* by Korf (1983), may provide useful information on possible evolutionary relationships in both host and fungus.

Acknowledgements

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References

Beaton, G. and Weste, G. (1982). *Banksiamyces* gen. nov., a discomycete on dead *Banksia* cones. *Transactions of the British mycological Society* 79:271-277.

Beaton, G. and Weste, G. (1984). A new species of *Banksiamyces* on *Banksia saxicola* (Proteaceae). *Tranactions of the British mycological Society* 83:533-535.

Fuhrer, B. (1985). 'A field companion to Australian fungi'. (The Five Mile Press: Hawthorn.)

George, A.S. (1984). 'The *Banksia* book'. (Kangaroo Press: Sydney.)

Korf, R.P. (1983). *Cyttaria* (Cyttariales): coevolution with *Nothofagus,* and evolutionary relationships to the Boedijnopezizeae (Pezizales; Sarcoscyphaceae). *Australian Journal of Botany. Supplementary Series* 10:77-87.

A *Hypocreopsis* (Fungi) from Nyora, Victoria

Tom May* and John Eichler**

Approximately 3 km north-west of Nyora, near the South Gippsland Highway, is a parcel of public land of about 640 hectares which supports native vegetation growing on predominantly sandy soils. Vegetation communities present are quite varied and include heathy woodland, wet heathland, riparian forest and sedge swampland. In areas seen by us the vegetation is in good condition, with little evidence of weed invasion.

The parcel of land straddles the South Eastern Railway. The part north of the railway is mostly committed to sand extraction, the southern portion is, however, uncommitted (Land Conservation Council 1991). The future of public land in the eastern half of the Melbourne region is currently under review and the Land Conservation Council is expected to release proposed recommendations for public comment in April 1993.

During surveys of the vascular plants of the area a peculiar fungus was collected which proved to be an undescribed species of the ascomycete genus *Hypocreopsis* (Fig. 1). The fruiting body occurs on dead wood and forms a firm, raised patch up to 6 cm in length with strongly lobed margins; the lobes being up to about 2 mm broad and clasping the substrate. The surface is brown, with the tips of the lobes a paler yellowish-brown. Older specimens often have white, powdery areas.

Fig. 1. *Hypocreopsis* sp. (c. x1).

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The spores are elongated-ellipsoid in shape. There are one to three (sometimes as many as six) septa and the spore surface is ornamented with low warts. Spores are produced in asci which line flask-shaped chambers (perithecia) embedded in the fruiting body. These chambers open to the upper surface through tiny pores. Asexual spores (conidia) are also produced. *Hypocreopsis* is a relative of *Hypocrea* and *Nectria,* distinguished by the combination of a *Hypocrea*-like fruiting body and *Nectria*-like spores (Doi 1977).

Fruiting bodies have been seen in June and July. Most specimens were found on dead branches of *Leptospermum myrsinoides,* but occasional fruiting bodies were also observed on dead *Banksia marginata.* The *Hypocreopsis* seems to be associated with overmature stands of *Leptospermum myrsinoides* which have reached a height in excess of 3 m and are collapsing. These stands have obviously had a long fire free history. The effect of fire on the *Hypocreopsis* is unknown but should be investigated.

In macroscopic appearance the Nyora collection has a remarkable similarity to the rare Northern Hemisphere *H. ricciodea* (= *H. lichenoides*), illustrated by Dennis (1960) and Strid (1967), which, however, has smooth spores. An even rarer species known from a few collections from North America and Scotland, *H. rhododendri,* is also macroscopically very similar to *H. lichenoides,* and does have roughened spores, but the spores differ in that they have a single septum and are less elongate (Dennis 1975). Other species in the genus produce very different fruiting bodies (Samuels 1988). The Nyora collection is thus considered to represent a distinct species which will be formally described elsewhere.

A number of synonyms of *H. riccioidea,* such as *H. lichenoides,* have specific epithets which refer to the similarity of the fruiting body to that of a lichen. There do not appear to be any previous collections or references to the Nyora species, but it is possible that it may have been inadvertently identified as a lichen, especially if old and weathered specimens were seen, and thus specimens should be looked out for amongst lichen collections in herbaria.

Some fruiting bodies were directly overlying fruiting bodies of a quite different species of fungus (a resupinate species of *Hymenochaete).* Other species of *Hypocreopsis,* including *H. lichenoides,* have also been recorded on various fungal hosts (Samuels 1988).

Other fungi present at the *Hypocreopsis* site in July included *Amanita* sp., *Barya agaricicola* (yellow individual perithecia on decaying agaric fruiting bodies); *Coltricia cinnamomea;* a dark grey *Cantharellus* with a strong odour of old cheese when dried, unclamped hyphae and 4-5 spored basidia (possibly *C. fuligineus*); a brilliant pink *Cantharellus,* more robust and less orange than the common *C. cibarius* var. *australiensis; Dermocybe* sp.; *Discinella terrestris; Gymnopilus sapineus; Hydnellum* sp.; *Hydnum repandum; Lactarius subdulcis; Leotia lubrica;* and *Pycnoporus coccineus.* Voucher collections of some of these species, and of the *Hypocreopsis* are deposited in the National Herbarium of Victoria. *Hygrophorus lewellinae* was found at a nearby site. The two species of *Cantharellus, Hygrophorus lewellinae* and the *Hydnellum* are all species which have been infrequently encountered in Victoria.

It is of interest that Strid (1967), in a survey of known collections of *H. riccioidea,* found that most were from sites with a 'maritimely influenced climate'. It is possible that the Nyora *Hypocreopsis* may have a similar distribution. *Hygrophorus lewellinae* is also known in Victoria only from near-coastal sites (Tarwin, Westernport, Lower Glenelg). Few collections of macrofungi have been made from coastal sites and no doubt other interesting species await discovery. There is a need for further systematic surveys to determine the rareness or otherwise of the unusual species noted from Nyora, especially the *Hypocreopsis* sp., and the fidelity of the species to particular habitats.

The Nyora site is in an area which has little vegetated public land. It is likely to have a high value for nature conservation because of its size, the range of vegetation communities present, the integrity of the vegetation, and the presence of several species of fungi, which, at least on present information, must be considered rare. A submission has been made to the Land Conservation Council advising of the presence of the *Hypocreopsis* sp., with a recommendation that the site should be included in a flora and fauna reserve.

Acknowledgements

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References

Dennis, R.W.G. (1960) 'British cup fungi and their allies'. (Ray Society: London.)

Dennis, R.W.G. (1975). New or interesting British microfungi, III. *Kew Bulletin* 30:345-365.

Doi, Y. (1977). Revision of the Hypocreales with cultural observations X. Two new species of the genus *Hypocreopsis. Bulletin of the National Science Museum, Series B (Botany)* 3:99-104.

Land Conservation Council (1991). Melbourne Area, district 2 review: descriptive Report. (Land Conservation Council: Melbourne.)

Samuels, G.J. (1988). Fungicolous, lichenicolous, and myxomyceticolous species of *Hypocreopsis, Nectriopsis, Nectria, Peristomialis* and *Trichonectria. Memoirs of the New York Botanical Garden* 48:1-78.

Strid, A. (1967). *Hypocreopsis lichenoides* (Tode ex. Fr.) Seaver, a rare ascomycete. *Svensk Botanisk Tidskrift* 61:79-87.

The Cinnamon Fungus. Is it a Threat to Australian Native Plants?

Gretna Weste*

The short answer is Yes! The epidemic attack by the cinnamon fungus on the unique Australian Flora is a botanical tragedy. Such destruction is unknown elsewhere in the world.

What is the cinnamon fungus? Where did it come from? The cinnamon fungus, *Phytophthora cinnamomi* is entirely microscopic and consists of threads which infect intact plant roots and wounds in the base of the stems. It was first isolated from cankers in the cinnamon trees growing in the mountains of Western Sumatra in 1822. It is therefore, an introduced and illegal immigrant into Australia. It belongs to the Oomycetes, a group of organisms closely linked to the Fungi but with motile spores, cellulose walls and aseptate threads or hyphae. There are about 50 species of *Phytophthora* ranging from free-living marine species to those parasitic on higher plants. One species causes potato blight, infamous since the Irish famine of 1845, and hence directly responsible for many famous Americans who emigrated from starving Ireland to America, the land of promise. However, while the potato blight fungus attacks only one or two closely related species of plant, the cinnamon fungus attacks over a thousand different plant species, many of them Australian natives.

The cinnamon fungus *P.cinnamomi* produces sporangia containing tiny kidney-shaped swimming spores which have two flagella but no cell wall. Masses of these are produced following warm wet periods in spring. They swim or are carried in water or puddles and are attracted to roots. They encyst on the roots, and the germ tube penetrates the root, killing the cells (Fig. 1). The fungus penetrates all roots tested, whether susceptible, or not, temporarily stops root growth and may produce a new crop of swimming spores in 24 hours. In resistant plants, such as most eucalypts, grasses and sedges the fungus stops there, and no root rot develops. But in susceptible hosts the threads grow through the root tissue producing extensive root or collar rot. The primary symptom is root rot, which is invisible since it occurs in the soil. As a result of infection water transport is inhibited and infected plants develop chlorosis (yellowing), dieback of the branches and finally die from drought. These are the visible but secondary symptoms.

The pathogen also produces thick walled resistant spores both in root tissue and externally in gravel or soil. These can survive dry conditions. There is a sexual stage which requires two mating types and only occurs rarely. The diagram (Fig. 2) shows these stages in the life of the fungus, but it is a very adaptable organism and will produce either swimming spores or resistant spores and these germinate in various ways depending on nutrient and water supply. Normally the fungus requires temperatures greater than 10 degrees C. and moist soil for growth, but heat, cold or dryness do not kill it merely prevent active growth. The pathogen remains alive inside roots, or soil clumps

Fig. 1. Swimming spores of the cinnamom fungus encysted on the root of *(Eucalyptus sieberi)* - Silvertop.

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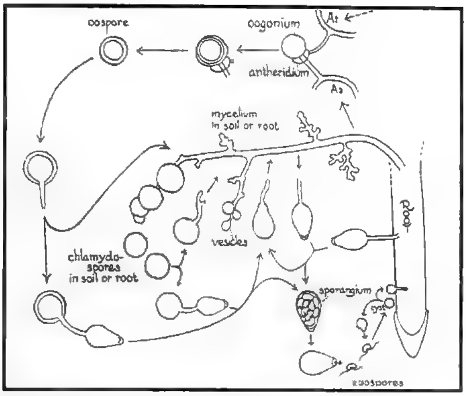

Fig. 2. Phytophthora cinnamomi life cycle.

or gravel heaps. Wetness and warmth favour production, dispersal and infection by swimming spores.

The natural enemies for this pathogen are the soil microbes, and for this reason epidemic disease occurs in soils or gravels which are low in organic matter and therefore contain relatively few soil microbes. Soils like those of most Mountain Ash forests, such as Sherbrooke, contain enormous numbers of soil microbes and are termed 'suppressive'. Thus, although Mountain Ash is susceptible, dieback disease is unlikely to be a problem, whereas the soils of the Brisbane Ranges have relatively few soil microbes. In addition they are shallow, poorly drained and contain a mass of susceptible roots, providing a delectable feast for this fungus.

Most Victorian open forests, woodlands or heathlands grow on poor soils with low organic content and few soil microbes. The Stringybark and Ash group of eucalypts are susceptible, whereas most other eucalypts are resistant. Moreover most of the colourful shrubs in these communities are highly susceptible. This is wildflower country! In spring the maximum numbers of swimming spores are produced. When a warm, wet spring is followed by warm summer rains double crops of swimming spores are formed. In moist periods many plants can cope with a few rotted roots, but when the warm moist periods are followed by hot dry conditions, such as frequently occur in autumn, the plants die. If water stress is severe following a wet period, there may be epidemic deaths, as occurred in 1970-71 in open forests and heathlands over the whole of southern Australia. Epidemic deaths therefore, are likely when a combination occurs with enormous numbers of swimming spores, then efficient dispersal during a prolonged wet period, a dense growth of susceptible roots and subsequent host water stress. The roots become infected during warm wet conditions but the plants die in periods of water stress because insufficient water reaches the leaves. Once the pathogen is present in soil and roots there is no practical way of removing it from a native plant community.

What cash-crop plants does the cinnamon fungus threaten? It threatens Avocado, Pineapple, stone fruit, citrus, Macadamia, Chestnut and Walnut. But these are produced in orchards or crops and may be treated chemically. Phosphorous acid may be sprayed on the leaves or injected into the trunk. Native communities cannot be treated in this way.

Is there a threat in Victoria? Victoria has few vulnerable endemic species growing where disease threatens, but consider, for example *Pultenaea graveolens (v), Grevillea chrysophaea, Prostanthera decussata(r)* and *Olearia pannosa (v)* in the Brisbane Ranges and *Grevillea repens(Rr)* from Kinglake. These may all be at risk. The most susceptible Victorian species are *Isopogon ceratophyllus* and *Monotoca scoparia* but these are plentiful. *Xanthorrhoea australis* is a special case, because although plentiful, it is killed completely by *P. cinnamomi* and is very slow growing, producing few seeds unless fire stimulated. In addition it is a characteristic feature of Victorian open forests.

Whole plant communities are at risk in Victoria. The open forest with its sclerophyllous, shrubby understorey becomes a sedge woodland after dieback disease. Victoria stands to lose some of its most attractive plant communities with colourful, scented, bird, mammal and insect pollinated flowers. These are replaced by drab communities of grasses and sedges which are wind pollinated. Work on Anglesea heathlands (Wilson *et al.* 1990) has shown a significant reduction in small-mammal populations with this change. Populations of *Antechinus stuartii* and *Rattus lutreolus* (Swamp Rat) were reduced by 60% and 83% respectively after infection. The Heath Rat *Pseudomys shortridgei* is a restricted species which needs a floristically rich vegetation for its survival in the Grampians. The battle for survival of the Helmeted Honeyeater *Lichenostomus melanops cassidix* is made more difficult because some of the trees it inhabits are infected with dieback.

Where are the diseased plant communities in Victoria? The worst examples are in the Brisbane Ranges (Figs. 3, 4 and 5), in East and South Gippsland, in the Victoria Valley of the Grampians (Fig. 6), in Kinglake National Park, Angahook Forest Park and Wilson's Promontory National Park (Fig. 7).

Work on Victorian plant communities has shown that *P.cinnamomi* in open forests and heathlands causes death of more than 25% of the overstorey and from 50-75% of the understorey. There is a change in understorey from bright colourful shrubs to grasses and sedges, a loss of diversity, a decline in plant numbers or abundance, increased bare ground, a loss in birds and small mammals and a real risk for permanent loss of vulnerable, rare or endangered endemic species. A great loss of our wildflowers (Weste 1986).

How is the disease spread? The fungus is spread by **PEOPLE,** particularly by

Fig. 3. Brisbane Ranges in Victoria. Dieback in the trees.

Fig. 4. Brisbane Ranges, Victoria, dieback in the understorey, 1973.

Fig. 5. Brisbane Ranges, Victoria, dieback in the understorey, 1973. Disease front - dead and healthy grass trees.

Fig. 6. Victoria Valley, Grampians, dieback in overstorey (Siphon Road).

Fig. 7. Dieback, Miller's Landing, Wilson's Promontory, 1972.

and during all construction activities, such as roading, logging or mining, wherever heavy equipment is used and driven through the bush. Soil, gravel and mud are collected from infested areas and dumped in *Phytophthora*-free vegetation or roadside. Other potent means of spread include changes in drainage, movement of soil and gravel, planting infected stock from nurseries, and less often by animals, bush walkers or flower pickers in the gravel or mud adhering to boots or fur. These methods of spread have all been documented. Wherever infection occurs, whether in a heap of infested gravel at the road verge, or from mud on bush-fire fighting trucks, drainage will carry it downhill very rapidly - this has been measured at 400 m. per annum in several districts. There is also a slow spread, 4-6 m. per annum, from root to root uphill. Unfortunately some commercial nurseries are responsible for spreading several *Phytophthora* spp., including *P. cinnamomi*. Plants in containers which are well watered may survive infection and normally do not show symptoms, but die when planted out and subject to water stress. Tests on nursery stock have shown a high percentage of infections (Hardy and Sivasithamparam 1988). Many people involved in plant propagation do not understand either the need or the practice of hygiene. Sterile soil becomes contaminated by rubbish, by dead or sick plants or by drainage from these, or from gravel dumps or drives. Two changes are required: firstly a half-day's certificated training in hygiene, and secondly inspection by trained independent observers. At present there is a self-accreditation scheme which, at best, falters periodically and is subject to misinterpretation.

The problem in Western Australia is enormous. Dieback and death of Jarrah *Eucalyptus marginata* were first reported in the early 1920's, and were considered as due to poor management etc. Nearly fifty years later *P.cinnamomi* was isolated and shown to be the major cause of Jarrah dieback (Podger 1968). During those 50 years the pathogen spread through the valuable Jarrah forests always adjacent to logging, road or construction sites. The disease escalated with the use of heavy off-road mechanical equipment post 1942, until certain devastated areas of the forest were labelled 'graveyards' (Shea *et al.* 1978, Shearer and Tippett 1989). Soil disturbance, with activities such as logging and mining, distributes the fungus very effectively. The pathogen destroys the understorey rapidly, especially the dominant, highly susceptible *Banksia grandis*. The fungus remains alive in the dead Banksia roots for up to three years. Two or three years later the Jarrah trees die. They have a two-tier root system, the superficial roots succumb early. Deep 'sinker' roots penetrate pores in the laterite capping and grow down into the water table below the bauxite and these are killed there by swimming spores of *P.cinnamomi*. The tree then dies from lack of water.

Western Australia's flora contains 45% of Australia's endemic species, 365 of them. The flora is therefore of major scientific importance. Dieback occurs in parts of all the state forests and in a thousand parks. Because the disease destroys the Jarrah, it affects the water supply, the timber industry, the cut-flower trade, nursery sales and tourism. The Department of Conservation and Land management (C.A.L.M.) spends an enormous amount of money, expertise, research and labour on Phytophthora control. Eight species of *Phytophthora* cause problems but none is as destructive as *P.cinnamomi*. In the southwest of the state 4,000 species of flowering plant grow, 1,000 of these are susceptible and 300 species are actually at risk (Wills 1991). The area is considered a major centre of speciation with high species diversity and a large number of endemics. The plant communities at risk are Banksia woodlands, shrubland and heathlands, Jarrah forest and dunes, but not arid country or Karri forests, all are fire adapted. Species at risk include 18 *Banksia* spp, 29 species of rare, susceptible heaths and plants from Myrtaceae and Fabaceae, and their bird and marsupial pollinators. Vertebrate pollinators are required by 58 species of West Australian plants. In one area an 88% reduction in bird species followed dieback (Hart 1983). *Banksia brownii* survives in tissue culture, as the known populations are all diseased.

The department of C.A.L.M. strictly controls all off-road activities and enforces hygiene for all forestry, mining and park procedures. A sophisticated aerial dieback detection system enables the accurate location of a single diseased Banksia or grass tree in the understorey. Colourful brochures are produced to alert people to dieback risks. The flora of the west is colourful, spectacular, of high genetic diversity and of international fame. This flora is threatened with an ecological catastrophe. The present devastation caused by *Phytophthora* in Western Australia provides an exceptional example of an introduced pathogen with a wide host range causing destruction of whole unique plant communities and the death, in some cases obliteration, of susceptible species. It is a tragedy that so many rare, endangered, endemic species should be threatened with extinction in such a short time span. Humans have dipersed the pathogen and are responsible for the irreversible loss of genetic material, species diversity and beauty. Yet the landscapers still sell sand from dunes where the fungus has killed the banksias as topsoil for suburban gardens and commercial nurseries continue to sell infected container plants (Hardy and Sivasithamparam 1988).

Tasmanian flora also contains a high percentage of endemic species. The cool temperate rainforest of the west and southwest remains as the sole intact relic of a formerly widespread Gondwanaland flora, and most of the species are susceptible, as are the rare endemic heaths of eastern Tasmania. Mining, logging and hydrological engineering introduced and spread infection. 1973 was a bad year for susceptible species. Soil temperatures and moistures suited the pathogen. Three years of above average rainfall were followed by a period of water stress (Podger *et al.* 1990). Species from the thamnic and implicate rainforests on the west coast of Tasmania grow on infertile soils much disturbed by fires, mining, logging, road and dam construction. Richeas, Celerytop Pine, King William and Pencil Pines, Leatherwood, Horizontal, White Waratah, *Blandfordia* and Mountain Laurel are all highly susceptible. Only the commercially valuable Huon Pine is resistant! At present disease only occurs in realatively small patches, but these will extend and global warming may increase the risk. The rare endemic species of *Epacris, E. limbata (ined)* and *E. grandis 2V Cyathodes* spp and *Pultenae selaginoides 2V* of the eastern forests are very susceptible and all their dependent fauna are also at risk (Kirkpatrick 1977).

The cinnamon fungus therefore poses a threat to the conservation of rare endemic species in Tasmania. It has the capacity to eliminate these from the world's flora. The island is fortunate that, because of its isolation, it has allowed the growth of species which represent the relict flora of Gondwanaland and it is an urgent priority to maintain such a flora intact. Little control is practised at present, because the mountains provide a refuge, but these are a bushfire risk, and global warming may enable *P. cinnammomi* to colonize these relatively low peaks.

Queensland growers experienced disease in Pineapple plantations due to *P. cinnamomi* probably in 1887, and certainly in 1929 (Simmonds 1966). The remedy was simple; just clear a fresh patch of the native disease-free forest. Pineapple, Avocado and Macadamias are susceptible, became infected, and the pathogen spread from these into native vegetation. Major disease centres were in the southeast coast woodlands and heaths near Cooloola, endangering *Pultenaea villosa, Eriostemon australasius* and the *Banksias* (Pegg and Alcorn 1972). The tropical rainforests of Eungella (near Mackay) and Gariwalt (near Ingham) also became infected (Brown 1976). These are simple notophyll evergreen vine forests receiving 2,500 mm rain per annum. Susceptible genera include *Cinnamomum* and *Cryptocarya.* Wallows made by feral pigs provided ideal conditions for the swimming spores of *P.cinnamomi.* These rainforests are robust and appear to be recovering.

Management of diseased forest aims to minimise disease extension and to prevent the occurrence of new infections, above all to protect from infection susceptible healthy vegetation. Rainwater and natural drainage will always carry infection downhill unless special drainage is constructed. No roads should therefore, be constructed along ridges. Gravel from infested areas is a high risk because it lacks sufficient soil microbes, and consequently the resistant spores of the fungus remain active in it. All vehicles, equipment and boots should be cleaned before leaving an infested area. Public education is required to ensure this. Public access should be restricted to guard wilderness areas with endangered species, and sealed roads with- out gravel verges pose much less risk. For such policies to be effective all diseased areas need to be defined, and the susceptibility of all endangered species must be determined. On the positive side, the occasional resistant trees of Jarrah have been cloned and such clones are genetically resistant and may eventually provide resistant Jarrah plantations. In Perth, tissue cultures, and cell cultures in liquid nitrogen, of disappearing species are being maintained.

Visitors to the Brisbane Ranges in 1992-3 will be surprised at the 'recovery' of dieback areas. Nine new plants of *Xanthorrhoea australis* have appeared on a plot 30 years after dieback killed them off. On other plots *Monotoca scoparia* and *Leucopogen virgatus* have reappeared 23 years after disease. These latter plots remain relatively bare except for sedges, but the survivor eucalypts show vigorous crown growth. We do not know whether the epidemic has abated, whether there has been a selection for avirulence in *P. cinnamomi* or for increased resistance in the host species or whether the whole phenomenon is cyclical and epidemic disease will recur when conditions dictate.

References

Briggs, J.D. and Leigh, J.H. (1988). 'Rare or threatened Australian Plants' (revised). Australian National Parks and Wildlife Service: Special Publication 14.

Brown, B.N. (1976). *Phytophthora cinnamomi*, associated with patch death in tropical rainforest in Queensland. APPS **5**: 1, 1-4.

Hardy, G.E. and Sivasithamparam, K. (1988). *Phytophthora* spp. associated with the container-grown plants in Western Australia. *Plant Disease* **72**: 435-437.

Hart, R. (1983). Dieback due to Phyophthora cinnamomi in Two Peoples Bay Nature Reserve. Report no 3 presented to the Department of Fisheries and Wildlife, W.A. by Two Peoples Bay Nature Reserve management consultants.

Kirkpatrick, J.D. and Leigh, J.H. (1977). 'The disappearing heath'. Tasmanian Conservation Trust Inc.

Pegg, K.G. and Alcorn, J.L. (1972). *Phytophthora cinnamomi* in indigenous flora in southern Queensland. *Search* **3**: 7, 257.

Podger, F.D. (1968). Aetology of Jarrah dieback and disease of dry scherophyll *Eucalyptus Marginata* (Sm) Forests in Western Australia. Msc.Thesis University of Melbourne, Victoria.

Podger, F.D., Palzer, C.B.S. and Wardlaw, T. (1990). A guide to the Tasmanian distribution of *Phytophthora cinnamomi* and its effects on native vegetation. *Tasmanian Forests* **2**: 13-21.

Shea, S.R., Gillen, K.J. and Kitt, R.J. (1978). Variation in sporangial production of *Phytophthora cinnamomi* Rands on Jarrah (*E.marginata* Sm) forest sites with different understorey compositions. *Australian Forest Research* **8**: 219-216.

Shearer, B.L and Tippett, J.T. (1989). Jarrah dieback. The dynamics and management of *Phytophthora cinnamomi* in the Jarrah *(Eucalyptus marginata)* forest of southwestern Australia. Department of Conservation and Land Management, W.A. Research Bulletin no **3**.

Simmonds, T.H. (1966). Host index of plant diseases in Queensland.

Weste, G. (1986). Vegetation changes associated with invasion by *Phytophthora cinnamomi* of defined plots in the Brisbane Ranges, Victoria 1975-85. *Australian Journal of Botany* **34**: 633-648.

Wills, R.T. (1991). The ecological impact of *Phytophthora cinnamomi* in the Stirling Range National Park, Western Australia. *Australian Journal of Ecology.*

Wilson, B.A., Robertson, D., Moloney, D.J., Newell, G.R. and Laidlaw, W.S. (1989). Factors affecting small mammal distribution and abundance in the eastern Otway Ranges , Victoria. *Proceedings of the Ecological Society of Australia* **16**.

Book Review

The Ecology of Mycorrhizae

by Michael F. Allen

Publisher: *Cambridge University Press 1991*

184 pages, (soft cover).

This book is an overview of research into the biology and ecology of mycorrhizae: the mutualistic symbiosis between plants and fungi that may be one of the most important and least understood biological associations regulating community and ecosystem functioning.

Written essentially for ecologists and mycorrhizasts, it is in eight sections: introduction, structure-functioning relationships, evolution, physiological and population biology, community ecology, ecosystem dynamics, mycorrhizae and succession and future directions for mycorrhizal research. There are 27 pages of references.

It is well illustrated with diagrams and black and white photographs, some of which are a little dark in reproduction.

The lay reader may have some difficulty with technical terms, as there is no glossary, but the vital importance of this field of research should still be clear.

Considering the paucity of Australian publications, this book should be considered essential reading by ecologists, mycologists, agricultural scientists, foresters, botanists and plant pathologists.

C.W. McCubbin

Obituary

Ercil Webb-Ware
11 September 1899 - 6 July 1992

Ercil was born in Bendigo and undoubtedly began her love of botany in its environs. She became a much respected botanist and much loved person. She attended the Melbourne Church of England Girls' Grammar School and obtained the Exhibition in Botany and First Class Honours in the Matriculation Certificate. She was awarded a scholarship to Melbourne University where she graduated B.Sc. in 1923, majoring in Physiology and Biochemistry.

Her Science course was interrupted after her second year by a planned trip with her mother around Europe, which delayed her graduation by one year but greatly enhanced her appreciation of natural history. For two years she worked with Colin MacKenzie (not yet 'Sir') on Platypus Research. She met her future husband, Roger, at Trinity College, Melbourne University, and married him at Christ Church South Yarra in 1925 and spent the next 25 years looking after her 5 children on their farm south of Yea (now managed by her son, Ken), situated amongst some tall rounded hills at the end of what is now Webb-Ware Road. She moved to South Yarra in 1956 after her husband died, and here began her active participation in the Field Naturalists Club of Victoria, and her intrepid camping tours into remote areas of the country in her Austin A40 motor vehicle. One of these trips, 'Camping in the Caves Country' near Buchan, was published in the Victorian Naturalist, Vol. 90 No. 5, May 1973. Ercil also contributed, with Laura M. White and Ian Morrison, to a paper on the 'Grampians and Little Desert Tour', published in the Victorian Naturalist, Vol. 93, No. 2.

Dr Jim Willis remembers her scaling Bluff Knoll in the Stirling Ranges during the F.N.C.V. excursion to W.A. in 1963. Mary Doery remembers Ercil taking her to see a rare stand of *Eucalyptus crenulata* on the Mt Loch Road near Noojee. Ilma Dunn has a 2½ foot hard tree-fern *(Cyathea australis)* in her garden at Brighton, which Ercil had given her years before, mistakenly believing it to be a seedling of the Bat-Wing Fern *(Histiopteris incisa)*, which she had gathered at Fernshaw. Ercil made a very detailed study of ferns and was one of three botanists asked to classify ferns in the Mt Dandenong area. Hilary Weatherhead remembers that, even after Ercil went to a Retirement Village in Croydon North, she used to go for walks daily and was thrilled to find a patch of *Brunonia* (blue pincushions) nearby.

Everyone to whom I have spoken remembers her as a delightful and enthusiastic person, and they send their sympathies to her four remaining children, 19 grandchildren and 14 great-grandchildren.

Elizabeth K. Turner

Fungal diet of the Long-nosed Bandicoot (*Perameles nasuta*) in South-eastern Australia.

A.W. Claridge*

Abstract

Information on fungi in the diet of the Long-nosed Bandicoot (*Perameles nasuta)* at two sites in south-eastern Australia is presented. Many of the fungi identified in bandicoot faecal pellets from this study are presumed to form mycorrhizal relationships with trees and shrubs. As a potential disseminating agent for these fungi, *P. nasuta* may help in the long-term health and vigor of native forests. The implications of this habit for forest management should not be overlooked.

Introduction

The ecology of many of Australia's marsupial families remains poorly understood relative to that of other taxa. One such family is the Peramelidae, or bandicoots. Many of the species within this family have been inadequately studied in their native habitats. For example, the ecology of the Long-nosed Bandicoot *(Perameles nasuta)*, a common inhabitant of the rainforests, eucalypt woodlands and eucalypt forests of eastern mainland Australia (Stodart 1983), remains largely undescribed. In one of the few studies of relevance, Claridge *et al.* (1991) described the diet and habitat requirements of a small population of *P. nasuta* in a dry sclerophyll forest site near Eden, New South Wales. At that site, animals were found to consume invertebrates, plant material and some fungi, while preferentially inhabiting gully sites with an open ground cover. The preference of *P. nasuta* for moist (gully) sites was later re-confirmed by Opie *et al.* (1990). Here, I present some additional information on the fungal diet of *P. nasuta* from two other forest sites in south-eastern Australia. This data, while sparse, is the best currently available for the species.

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Methods

Study Sites

The diet of *Perameles nasuta* was monitored in two forest sites in south-eastern Australia. The first site (here referred to as Cabbage Tree Creek) was located near the settlement of Cabbage Tree Creek, East Gippsland, Victoria (148°47'25E, 37°04'40S), while the second site (here referred to as Bruces Creek) was located in Nadgee State Forest in far south-eastern New South Wales (149°49'20E, 37°23'30S).

Details of the Cabbage Tree Creek study site have been described in another paper (Claridge *et al.* 1992). Briefly, the site comprises a forested catchment with a series of slopes of predominantly easterly-facing aspect, and slopes with a more exposed predominantly westerly-facing aspect, divided by a tributary of a small creek. Mean annual rainfall for Cabbage Tree Creek is 1113 mm, and is distributed evenly throughout the year, with slight peaks in late autumn and early winter and relatively low rainfall in summer. The highest mean monthly maximum temperature is 25.1°C (January), the lowest mean minimum temperature is 3.9°C (July) (Stuwe and Mueck 1990). Overstorey vegetation is dominated by mature Silvertop Ash (*Eucalyptus sieberi* L. Johnson), Yellow Stringybark (*E. muelleriana* Howitt) and White Stringybark (*E. globoidea* Blakely) on the slopes and ridges, and by Mountain Grey Gum (*E. cypellocarpa* L. Johnson) and Southern Mahogany (*E. botryoides* Sm.) in the gullies. Trees on the site are from a variety of age classes. Understorey vegetation is dense and species commonly contributing the cover layer to this stratum include Handsome Flat Pea (*Platylobium formosum* Sm.), Forest Wiregrass (*Tetrarrhena juncea* R.Br.), and a variety of ferns and sedges (see Stuwe and Mueck 1990).

The Bruces Creek site shares some features of the Cabbage Tree Creek site, comprising slopes with a predominantly easterly-facing aspect, slopes with a predominantly westerly-facing aspect, divided by a small creek. Mean annual rainfall recorded at Greencape Lighthouse (approx. 16km north-east of site) is 751 mm, being distributed irregularly throughout the year with peaks in January and March, and lows in winter-early spring (July and August). The highest mean monthly temperature is 22.2°C (February), the lowest mean minimum temperature 8.3°C (July) (Bureau of Meteorology 1988). The Bruces Creek study site was burned by severe wildfire in 1972-73, subsequently salvage logged and then burned again in another wildfire in 1980 (P. Moore, Forestry Commission of New South Wales, pers. comm. 1992). The predominant overstorey vegetation resulting from this disturbance regime is a regrowth stand of Silvertop Ash *(E. sieberi).* Below the eucalypt canopy, a thicket of wattle *(Acacia floribunda* (Vent.) Willd. and *A. terminalis* Salisb.) forms a dense midstorey. The understorey is also dense, with Wiregrass *(T. juncea),* a variety of ferns and sedges and large burned logs forming much of the ground cover.

Sampling of Bandicoots

Bandicoots were sampled at both sites using wire cage traps baited with a mixture of peanut butter, oats and pistachio essence (Scotts and Seebeck 1989). To avoid contamination of faeces, baits were held within a wire tea infuser suspended from the roof of each trap. Faecal pellets were collected from the floor of the traps on the first night that any individual was trapped. Bandicoots were sampled at irregular intervals during the period January 1990 to February 1992.

Faecal Analysis

Faeces collected for dietary analysis were divided into a coarse fraction containing fragments of fungal tissue, plant matter and invertebrates, and a fine fraction containing fungal spores, by washing crushed pellets through a soil sieve with mesh openings of 0.125 x 0.125 mm. Coarse material retained on the mesh was suspended in approximately 20 ml of 70% ethanol in a glass vial. For analysis, a pair of smooth-sided tweezers were placed in each vial and closed. Materials held by the closed tweezers were placed on a slide, to which a drop of glycerol was added. The fragmentary nature of the coarse fraction precluded quantitative analysis, so the abundance of different food items were estimated under light microscope (X 100 magnification), using the following subjective scoring system: 1 = item covering less than 25% of a field of view, a few small fragments; 2 = item covering between 25 and 50% of field of view; 3 = item covering between 50 and 75% of field of view; 4 = item covering greater than 75% of field of view. For each sample, fragments of food in 40 random fields of view were scored. The percentage occurrence of each food item was calculated according to the methods of Bennett and Baxter (1989). This involved adding up all scores for each food category, respectively, and then dividing that value by the total score for all food categories in the sample. These values were added, then divided by 10 (the total number of samples), to derive the average percentage occurrence of that food category.

Methods of analysis of fine fraction materials (containing fungal spores) have been described in Claridge *et al.* (1992). Briefly, a small portion of the remaining sediment from each sample was extracted and placed on a microscope slide. A drop of Melzer's reagant (McIntyre and Carey 1989) and a drop of glycerol were then added to the slide and a coverslip placed over the entire suspension. The suspension was examined using a light microscope (X 1000 magnification).

Where possible, spore types were identified to species using the descriptions of Beaton and Weste (1982, 1984) and Beaton *et al.* (1984 a; 1984 b; 1985 a; 1985 b; 1985 c; 1985 d). However, one spore type was placed into a category called 'other' (Table 1) because it did not agree with any known hypogeal taxa. The relative abundance of all spore types in each of 20 fields was assigned to one of the following categories: 1 = sparse, one or two spores; 2 = uncommon, three to five spores or; 3 = common, more than five spores present in the field of view. For all the samples, the percentage occurrence of each spore type was calculated according to the methods of Bennett and Baxter (1989) for all samples. This involved adding up all scores for each species, respectively, and then dividing that value by the total score for spores in the sample. These values were added, then divided by 10 (the total number of samples), to derive the average percentage occurrence of that spore type.

Results

A total of 10 faecal samples, from 10 individual bandicoots, were analysed for food items. In order to describe the diet of *P. nasuta,* results were pooled (averaged) from samples from both sites (9 from Cabbage Tree Creek and 1 from Bruces Creek). For the coarse fraction analysis, *P. nasuta* was found to consume mainly plant vascular material, invertebrates and plant seeds. Items of additional dietary importance were fungi, monocot leaf material and dicot leaf material (Fig. 1). For the fine fraction (fungal spores) component of the diet, 25 fungal taxa were identified from spores in faeces (Table 1). Most of these taxa were attributed to species of hypogeal (underground-fruiting) basidiomycetes that produce complex sporocarps (fruiting-bodies). On an average percentage occurence basis, the most commonly found spores were of two

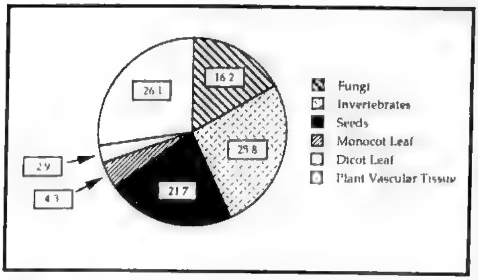

Fig. 1. Average percentage occurrence of food items in coarse fraction faeces of *Perameles nasuta* at Cabbage Tree Creek and Bruces Creek.

Table 1. Average percentage (%) occurrence of fungal taxa identified from spores in faeces of *Perameles nasuta* at Cabbage Tree Creek and Bruces Creek.

Species	Average % occurrence
Ascomycetes	
Jafneadelphus sp.	0.50
Labyrinthomyces varius	1.20
Basidiomycetes	
Gasteromycetes	
Castoreum sp.	5.80
Chamonixia vittatispora	12.90
Chamonixia sp.	0.40
Gautieria monospora	0.50
Gautieria sp. 1	1.00
Gautieria sp. 2	0.20
Hydnangium sp. (U)	0.20
Hymenogaster albus	0.40
H. atratus	8.60
H. nanus	3.30
H. zeylanicus	0.50
H. inflatum	3.70
Hymenogaster sp.	2.10
Hysterogaster sp. 1 (U)	1.50
Hysterogaster sp. 2 (U)	0.40
Mesophellia sp.	22.50
Octavianina tasmanica	4.00
Richionella pumila	6.80
Thaxterogaster scabrosus	4.10
Zelleromyces daucinus	5.20
Zelleromyces sp.	1.30
Zygomycetes	
Endogonaceae	
Endogone sp. (spore walls single layered)	2.50
Other	
Opaque black, spherical spore	5.70

Fruiting habit was either hypogeal or sub-hypogeal, except for *Jafneadelphus* sp. which was epigeal and the 'other' category, for which fruiting habit was unknown. (U) indicates uncertainty in identification of that genus.

species, *Mesophellia* sp. (22.5%) and *Chamonixia vittatispora* (12.9%). Spores of remaining species contributed less than 10% of the total of spores counted.

Discussion

The use of faecal analysis, as I used, in the qualitative and quantitative estimation of animal diet has been widely criticized on the basis of differential digestibility of food items (Calver and Wooller 1982; Ford *et al.* 1982; Batzli 1985). Soft-bodied food items, for example, are liable to complete digestion (Stoddart 1974; Bradbury 1983), whereas other items may be crushed into fragments beyond recognition. Samples are therefore likely to be biased in favour of less digestible items, precluding any accurate reconstruction of diet. Nevertheless, despite these limitations in technique, confirmation of the omnivorous feeding habit of *P. nasuta* in this study is in general agreement with the dietary habits of other bandicoot species (see Heinsohn 1966; Watts 1974; Opie 1980; Lobert 1985; Quin 1985; Claridge *et al.* 1991). In addition, I have identified that *P. nasuta* feeds on a variety of fungi. At least one other peramelid species, the Southern Brown Bandicoot *(Isoodon obesulus),* is also known to feed on fungi. In a Victorian heathland, Lobert (1985) found *I. obesulus* consumed fungi mainly in the winter months. However, Lobert (1985) was unable to describe the species of fungi being consumed. In Tasmania, Quin (1985) found that *I. obesulus* consumed the sporocarps of unidentified gasteromycete and zygomycete fungi throughout the year. More recently, Claridge *et al.* (1991) identified at least three species of fungi in the faeces of *I. obesulus* at a dry sclerophyll forest site in south-east New South Wales. One of the species found in the diet was from the genus *Mesophellia. Mesophellia* was abundantly represented by spores in the faeces of *P. nasuta* in the current study, and is a prolific sporocarp-producer in the eucalypt forests of south-eastern Australia (A. Claridge, unpubl. data 1990-2).

At Cabbage Tree Creek and Bruces Creek, *P. nasuta* is not the only medium-sized ground-dwelling marsupial known to feed on fungi. Long-nosed Potoroos *(Potorous tridactylus)* are very common at both study sites, and feed heavily on fungi throughout most times of the year (A. Claridge, unpubl. data 1990-2). Moreover, the range of fungal species consumed by *P. nasuta* and *Potorous tridactylus* show complete overlap (see Claridge *et al.* 1992; A. Claridge, unpubl. data 1990-2).

This suggests that there may be some competition for food resources between the two sympatric marsupial species. However, destructive competition may be avoided, in this case, because *P. nasuta* appears to consume far less fungi (as a proportion in faeces) than does *Potorous tridactylus.* In addition, *P. nasuta* exists at much lower population densities than *Potorous tridactylus.* A combination of these two factors (as well as other factors), may allow for two ecologically similar species to co-exist.

The consumption of fungi by *P. nasuta* is noteworthy, since many of the species found as spores in its faeces are thought to form mycorrhizal associations on the roots of a variety of trees and shrubs (see Bennett and Baxter 1989). These fungal associations are vital, among other functions, for the uptake and transfer of nutrients and water from the soil to the plant host (Trappe and Maser 1977). *P. nasuta* may play a role in the dissemination of mycorrhizal fungi by depositing spores in faeces. This role has already been attributed to at least two other species of marsupial, the Brush-tailed Bettong *(Bettongia penicillata)* and the Long-nosed Potoroo *(Potorous tridactylus)* (Lamont *et al.* 1985; Claridge *et al.* 1992).

The role of *P. nasuta* as an agent for beneficial fungi in native forests emphasises that all species within an ecosystem perform some vital role. These roles need to be fully appreciated by forest managers. Acknowledgement of the current example should take the form of practices designed specifically to enhance habitat for *P. nasuta,* and habitat for the fungi that it consumes. Such measures do not currently exist.

Acknowledgements

Bandicoots were trapped and handled under the provisions of a Victorian National Parks and Wildlife Permit (RP-90-156), and ANU Ethics Committee Permit (F-FOR-10) and a Forestry Commission of New South Wales Special Purposes Permit (03926). Tony and Martha Claridge, Karen Brisbane and Rod Avery assisted in field work at Cabbage Tree and Bruces Creek. Staff of the Victorian Department of Conservation and Environment (DCE) provided additional useful help. Rod Avery helped prepare faecal samples. Funding to carry out field work was granted by the Australian National Parks and Wildlife Service (ANPWS) and the Victorian Department of Conservation and Environment under the States Assistance Programme: particular thanks go to Dr Gerry Maynes (ANPWS) and Rod Gowans (DCE). Additionally, while the project was underway, A.W. Claridge was in receipt of an Australian Government Postgraduate Research Scholarship.

References

Batzli, G.O. (1985). Biology of new world *Microtus. Special Publication of the American Society of Mammalogists* **8:** 779-811.

Beaton, G., Pegler, D.N. and Young, T.W.K. (1984a). Gasteroid basidiomycota of Victoria State, Australia I: Hydnangiaceae. *Kew Bulletin* **39:** 499-508.

Beaton, G., Pegler, D.N. and Young, T.W.K. (1984b). Gasteroid basidiomycota of Victoria State, Australia II: Russulales. *Kew Bulletin* **39:** 669-698.

Beaton, G., Pegler, D.N. and Young, T.W.K. (1985a). Gasteroid basidiomycota of Victoria State, Australia III: Cortinariales. *Kew Bulletin* **40:** 167-204.

Beaton, G., Pegler, D.N. and Young, T.W.K. (1985b). Gasteroid basidiomycota of Victoria State, Australia IV: Hysterangium. *Kew Bulletin* **40:** 435-444.

Beaton, G., Pegler, D.N. and Young, T.W.K. (1985c). Gasteroid basidiomycota of Victoria State, Australia V-VII: Boletales, Agaricales and Aphyllophorales. *Kew Bulletin* **40:** 573-598.

Beaton, G., Pegler, D.N. and Young, T.W.K. (1985d). Gasteroid basidiomycota of Victoria State, Australia VIII: Additional Taxa. *Kew Bulletin* **40:** 827-842.

Beaton, G. and Weste, G. (1982) Australian hypogean ascomycetes. *Transactions of the British Mycological Society* **79:** 455-468.

Beaton, G. and Weste, G. (1984). Victorian hypogean gasteromycetes : Mesophelliaceae. *Transactions of the British Mycological Society* **82:** 665-671.

Bennett, A.F. and Baxter, B.J. (1989). Diet of the long-nosed potoroo, *Potorous tridactylus* (Marsupialia: Potoroidae), in southwestern Victoria. *Australian Wildlife Research* **16:** 263-271.

Bradbury, K. (1983). Identification of earthworms in mammalian scats. *Journal of Zoology* **183:** 553-554.

Calver, M.C. and Wooller, R.D. (1982). A technique for assessing the taxa, length, dry weight and energy content of the arthropod prey of birds. *Australian Wildlife Research* **9:** 293-301.

Claridge, A.W., McNee, A., Tanton, M.T. and Davey, S.M. (1991). Ecology of bandicoots in undisturbed forest adjacent to recently felled logging coupes: a case study from the Eden woodchip agreement area. *In* 'Conservation of Australia's Forest Fauna' ed D. Lunney, pp 331-345. (Royal Zoological Society of New South Wales, Mosman).

Claridge, A.W., Tanton, M.T., Seebeck, J.H., Cork, S.J. and Cunningham, R.B. (1992). Establishment of ectomycorrhizae on the roots of two species of *Eucalyptus* from fungal spores in the faeces of the long-nosed potoroo *(Potorous tridactylus). Australian Journal of Ecology* **17:** 207-217.

Ford, H.A., Forde, N. and Harrington, S. (1982). Non-destructive methods to determine the diets of birds. *Corella* **6:** 6-10.

Heinsohn, G.E. (1966). Ecology and Reproduction of the Tasmanian Bandicoots *(Perameles gunnii* and *Isoodon obesulus). University of California Publications in Zoology* **80:** 1-96.

Lamont, B.B., Ralph, C.S. and Christensen, P.E.S. (1985). Mycophagous Marsupials as agents for Ectomycorrhizal Fungi on *Eucalyptus calophylla* and *Gastrolobium bilobum. New Phytologist* **101:** 651-656.

Lobert, B. (1985). The Ecology of the Southern Brown Bandicoot in South-eastern Australian Heathland. MSc thesis (unpubl), Department of Botany and Zoology, Monash University.

Malajczuk, N., Trappe, J.M. and Molina, R. (1987). Interrelationships among some ectomycorrhizal trees, hypogeous fungi and small mammals: Western Australian and northwestern American parallels. *Australian Journal of Ecology* **12:** 53-55.

McIntyre, P.W. and Carey, A.B. (1989). 'A Microhistological Technique for Assessing the Food Habits of Mycophagous Rodents'. U.S.D.A. Forest Service, Pacific Northwest Research Station Research Paper, **PNW-RP-404.**

Opie, A.M. (1980). Habitat Selection and Diet of *Isoodon obesulus. Australian Mammal Society Bulletin* **6**(2): 56.

Opie, A.M., Gullan, P. and Mansergh, I. (1990). Prediction of the geographic range and habitat preferences of *Isoodon obesulus* and *Perameles nasuta* in Gippsland. *In* 'Bandicoots and Bilbies' Eds J.H. Seebeck, P.R. Brown, R.L. Wallis and C.M. Kemper, pp 327-334. (Surrey Beatty and Sons, Sydney).

Quin, D.G. (1985). Observations on the diet of the Southern Brown Bandicoot, *Isoodon obesulus* (Marsupialia: Peramelidae), in southern Tasmania. *Australian Mammalogy* **11:** 15-25.

Scotts, D.J. and Seebeck, J.H. (1989). Ecology of *Potorous longipes* (Marsupialia: Potoroidae): and preliminary recommendations for management of its habitat in Victoria. *Arthur Rylah Institute for Environmental Research Technical Report Series No.* **62.**

Stodart, E. (1983). Long-nosed Bandicoot *(Perameles nasuta). In* 'The Australian Museums Complete Book of Australian Mammals'. Ed R. Strahan, p 99. (Angus and Robertson, Sydney).

Stoddart, D.M. (1974). Earthworms in the diet of the red fox *(Vulpes vulpes). Journal of Zoology* **173:** 251-275.

Stuwe, J. and Mueck, S.G. (1990). Vegetation survey and classification of the Cabbage Tree Creek study area. *Department of Conservation, Forests and Lands, Lands and Forests Division S.S.P. Technical Report No.* **2.**

Watts, C.H.S. (1974). The Nuyts Island Bandicoot *(Isoodon obesulus nauticus). South Australian Naturalist* **49:** 20-24.

The Mountain Brushtail Possum (*Trichosurus caninus* Ogilby): Disseminator of Fungi in the Mountain Ash Forests of the Central Highlands of Victoria ?

A.W. Claridge* and D.B. Lindenmayer**

Abstract

Faeces collected from the Mountain Brushtail Possum (*Trichosurus caninus* Ogilby) at a forest site in the Central Highlands of Victoria contained fungal spores. Some spores were from hypogeal (underground-fruiting) fungi that form a symbiotic mycorrhizal relationship on the roots of a variety of trees and shrubs. When in symbiosis, these fungi absorb nutrients and water from the soil and donate them to the host plant, and protect its root system from deleterious root pathogens. Mycorrhizal fungi are thus integral to the survival, establishment and growth of plants. The possible functional role of *T. caninus* in dispersing the spores of mycorrhiza-forming fungi needs to be recognized formally in management practices designed to conserve the species in areas subject to land-uses such as logging. The conservation of *T. caninus* may be particularly important in the mountain ash forests of Victoria because other ground-dwelling mycophagists such as bandicoots and potoroos are rare or absent.

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Introduction

The Mountain Brushtail Possum, *Trichosurus caninus,* is a species of arboreal marsupial that is largely confined to forest habitats in eastern Australia (How 1983; Lindenmayer *et al.* 1990). It is common in the montane ash forests of the Central Highlands of Victoria (Lindemayer 1989) where the major eucalypt species are Mountain Ash *(Eucalyptus regnans)* and Alpine Ash *(E. delegatensis)* (Lindenmayer *et al.* 1991). Despite its status within this region, the general ecology of *T. caninus* remains poorly understood although there have been studies of its diet (Seebeck *et al.* 1984) and habitat requirements (Lindenmayer *et al.* 1990).

Seebeck *et al.* (1984) found that fungi was an important seasonal component of the diet of *T. caninus,* but did not specify which species were consumed. Here, we describe for the first time some of the fungal taxa consumed by *T. caninus* at

Cambarville, which was the site examined by Seebeck et al. (1984).

Methods

Study Site

The diet of *T. caninus* was examined at Cambarville (37°33'S latitude and 145°53'E longitude), in the Central Highlands of Victoria, south-eastern Australia. The area is characterised by mild summers and cool, wet winters. Further details of the climate, as well as the geology, soils, and vegetation of the study site have been described in detail by Seebeck *et al.* (1984). The predominant overstorey tree at Cambarville is *E. regnans.* In gullies, *E. regnans* is replaced by cool temperate rainforest dominated by Myrtle Beech *(Nothofagus cunninghamii),* Southern Sassafrass *(Atherosperma moschatum),* Silver Wattle *(Acacia dealbata),* Montane Wattle *(A. frigiscens),* Blackwood *(Acacia melanoxylon)* and Mountain Hickory Wattle *(Acacia obliquinerva).* Ground vegetation includes several species of ferns and herbacious plants (Seebeck *et al.* 1984). Large decaying logs are abundant on the forest floor.

Trapping and Faecal Analysis

Trichosurus caninus was trapped during June 1992 in a 14 ha area at Cambarville, using wire cage traps baited with apple. Faecal pellets were collected from the floor of the traps on the first night an individual was captured and stored at 0°C until analysis.

Faecal pellets were thawed and macerated using a pestle and mortar, to which was added a small quantity of 70% ethanol. Distilled water was then used to wash the slurry through a sieve with mesh size of 0.125 mm x 0.125 mm. The resulting suspension was then left to settle for at least 24 hours. A small portion of the remaining sediment was extracted and placed on a microscope slide. A drop of Melzer's reagant (McIntyre and Carey 1989) and a drop of glycerol were then added to the slide and a coverslip placed over the entire suspension. The suspension was examined using a light microscope (X 1000 magnification).

Where possible, spore types were identified to species using the descriptions of Beaton and Weste (1982; 1984) and Beaton *et al.* (1984 a; 1984 b; 1985 a; 1985 b; 1985 c; 1985 d). However, most of the spores were placed into a category called 'other' (Table 1) because they did not agree with any known hypogeal taxa. Most spores in the 'other' category were presumed to come from epigeal (above-ground) fruiting bodies, although some may have come from hypogeal species yet to be formally described. The relative abundance of all spore types in each of 20 fields was assigned to one of the following categories: 1 = sparse, one or two spores; 2 = uncommon, three to five spores or; 3 = common, more than five spores present in the field of view. With the exception of the 'epigeal' category, individual spore types seldom exceeded more than seven or eight spores in any field of view. For all the samples, the percentage occurrence of each spore type was calculated according to the methods of Bennett and Baxter (1989) for all samples. These values were added, then divided by 15 (the total number of samples), to derive the average percentage occurrence of that spore type.

Results

Five adult male and ten adult female *T. caninus* were trapped at Cambarville during June 1992. Faecal samples were taken from all the animals caught.

A total of ten fungal taxa (genera and species) was identified from the faeces of *T. caninus* (Table 1). The most common taxa identified were *Thaxterogaster* sp. and *Chamonixia vittatispora.* All other taxa identified had a percentage occurrence in samples of less than 1%. Most (75.1%) fungal spores could not be assigned to a genus or species, and were placed in the category 'other'. Of the ten taxa identified from spores, eight were from hypogeal basidiomycete fungi.

Discussion

The presence of spores of fungi in the faeces of *Trichosurus caninus* is consistent with the results of Seebeck *et al.* (1984) and confirms the partially mycophagous feeding habit of this species in the mountain ash forests of the Central Highlands of Victoria. Seebeck *et al.* (1984) established that *T. caninus* consume fungi throughout the year. However, it seldom constituted more than 10% of total matter in faeces, although reached a peak of approximately 25% during April (on a percentage occurrence basis). In this study, we did not attempt to identify spores of epigeal fungi in *T. caninus* faeces, although they probably represented the bulk of spores which we placed in the category 'other'. Although we did not identify any epigeal fungi at the study site, a number of taxa were seen and included agarics, cup-fungi and boletes. Also of relevance, Seebeck *et al.* (1984) noted that individual *T. caninus* sometimes eat epigeal basidiomycete fungi, but did not identify these fungi to species level. Future studies should attempt to identify the species of epigeal fungi eaten by *T. caninus* so that the foraging behaviour of the species are better understood.

Table 1: Average percentage (%) occurrence of fungal taxa identified from spores in faeces of *Trichosurus caninus* collected in June 1992 at Cambarville, Victoria.

Species	Average % Occurrence
Ascomycetes	
Jafneadelphus sp.	0.6
Basidiomycetes	
Gasteromycetes	
Chamonixia vittatispora	7.7
Hydnangium sp. (U)	0.7
Hymenogaster nanus	0.7
H. zeylanicus	0.3
Mesophellia sp.	0.3
Thaxterogaster sp. 1	13.3
Thaxterogaster sp. 2	0.6
Stephanospora flava	0.4
Zygomycetes	
Endogonaceae	
Endogone sp. (spore walls double layered)	0.3
Other	75.1

Fruiting habit was either hypogeal or sub- hypogeal, except for *Jafneadelphus* sp. which was epigeal. The 'other' category refers to miscellaneous spore types that could not be attributed to any hypogeal taxa yet described. Many of the spores in the 'other' category were probably epigeal Ascomycotina and Basidiomycotina taxa. (U) indicates uncertainty in identification of that genus.

Our results and those of Seebeck *et al.* (1984) indicate that *T. caninus* eats less fungi than ground-dwelling mammals such as potoroos (Guiler 1970; Bennett and Baxter 1989; Scotts and Seebeck 1989), bandicoots (Quin 1985; Claridge *et al.* 1991) and native rats (Cheal 1987). Leaf tissue from a variety of plants is a more important component of the diet of *T. caninus* (Seebeck *et al.* 1984).

Some of the spores identified in *T. caninus* faeces were from the sporocarps (fruiting-bodies) of hypogeal taxa. Like epigeal fungi, many hypogeal fungi are presumed to form a symbiotic mycorrhizal association with the roots of a variety of forest trees and shrubs (Trappe and Maser 1977; Beaton *et al.* 1985 d). For example, fungi in the genus *Mesophellia* that were identified in *Trichosurus caninus* faeces are known to establish ectomycorrhizal relationships on the roots of several eucalypt species (Dell *et al.* 1990), including *E. regnans* (Ashton 1976) which is the dominant species of tree at Cambarville. Within this obligate association, the fungus accumulates nutrients and water from the soil and donates them to its plant host (Harley and Smith 1983). It also protects the roots of the host from fungal pathogens such as *Phytophthora*. In return, the mycorrhizal fungus receives carbohydrates from the host plant (Hacskaylo 1973).

For most hypogeal fungi, dispersal by wind and water is negligible because the fruiting body, and hence the spores, are buried beneath the soil-litter interface. They rely on being excavated by mycophagous mammals, eaten and the spores dispersed in faeces as the animal moves throughout its home range (Trappe 1988). This contrasts with dispersal mechanisms of epigeal fungi that fruit above the ground, allowing for direct contact between the spore-bearing tissue and the surrounding atmosphere.

The presence of the spores of hypogeal fungi in the faeces of *Trichosurus caninus* suggests that it forages on the forest floor and actively excavates the soil-litter profile in search of sporocarps. This is consistent with trapping studies, where animals are regularly captured in traps set on the ground (Lindenmayer *et al.* 1991). *T. caninus* has also been detected on the forest floor and running along fallen logs during spotlighting surveys at Cambarville (Lindenmayer, unpubl. data).

It is possible that the seasonal fruiting patterns of hypogeal fungal sporocarps at Cambarville influences the seasonal foraging behaviour of *T. caninus*. A recent study in the coastal forests of south-eastern Australia, suggests that different species of fungi have different habitat requirements (Claridge *et al.* 1993). Some taxa inhabit predominantly ridges and slopes, while others are confined mainly to gullies. Species that occur in gullies tend to be ephemeral and more abundant during the wetter months, while those in other areas have adaptations that allow for their persistence in the soil regardless of seasonal climatic conditions. At these sites, mycophagous mammals such as the Long-nosed Potoroo *(Potorous tridactylus)* may alter seasonal foraging patterns to take advantage of seasonal changes in the relative abundance of different fungi (Claridge 1993). However, a major difference in the diets of *P. tridactylus* and *Trichosurus caninus*, is that the former feeds much more extensively on hypogeal fungi. Thus, movements of *T. caninus* are less likely to be directly influenced by the fungal food resource, although inclusion of hypogeal fungi in the diet suggests a deliberate search effort on behalf of *T. caninus*.

Mycorrhizal fungi are integral to the survival, establishment and growth of plants. If *T. caninus* is capable of spreading the spores of these fungi in its faeces, then its role in key ecological processes within the mountain ash forests may be more important than previously recognized. This may be important as other ground-dwelling mammals likely to fulfill this role in the ecosystem, such as bandicoots and potoroos, are either rare or absent. The importance of mycophagous mammals needs to be recognized formally in forest management and logging practices need to become more compatible with the conservation of species such as *T. caninus* (Lindenmayer 1992).

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References

Ashton, D.H. (1976). Studies on the mycorrhizae of *Eucalyptus regnans* F.Muell. *Australian Journal of Botany* 24: 723-741.

Beaton, G., Pegler, D.N. and Young, T.W.K. (1984)a. Gasteroid basidiomycota of Victoria State, Australia I: Hydnangiaceae. *Kew Bulletin* 39: 499-508.

Beaton, G., Pegler, D.N. and Young, T.W.K. (1984)b. Gasteroid basidiomycota of Victoria State, Australia II: Russulales. *Kew Bulletin* **39:** 669-698.

Beaton, G., Pegler, D.N. and Young, T.W.K. (1985)a. Gasteroid basidiomycota of Victoria State, Australia III: Cortinariales. *Kew Bulletin* **40:** 167-204.

Beaton, G., Pegler, D.N. and Young, T.W.K. (1985)b. Gasteroid basidiomycota of Victoria State, Australia IV: Hysterangium. *Kew Bulletin* **40:** 435-444.

Beaton, G., Pegler, D.N. and Young, T.W.K. (1985)c. Gasteroid basidiomycota of Victoria State, Australia V-VII: Boletales, Agaricales and Aphyllophorales. *Kew Bulletin* **40:** 573-598.

Beaton, G., Pegler, D.N. and Young, T.W.K. (1985)d. Gasteroid basidiomycota of Victoria State, Australia VIII: Additional Taxa. *Kew Bulletin* **40:** 827-842.

Beaton, G. and Weste, G. (1982). Australian hypogean ascomycetes. *Transactions of the British Mycological Society* **79:** 455-468.

Beaton, G. and Weste, G. (1984). Victorian hypogean gasteromycetes : Mesophelliaceae. *Transactions of the British Mycological Society* 82: 665-671.

Bennett, A.F. and Baxter, B.J. (1989). Diet of the Long-Nosed Potoroo, *Potorous tridactylus* (Marsupialia: Potoroidae), in southwestern Victoria. *Australian Wildlife Research* **16:** 263-271.

Cheal, D.C. (1987). The diets and dietary preferences of *Rattus fuscipes* and *Rattus lutreolus* at Walkerville in Victoria. *Australian Wildlife Research* **14:** 35-44.

Claridge, A.W. (1993). 'Hypogeal Fungi as a Food Resource for Wildlife in the Managed Eucalypt Forests of South-Eastern Australia'. PhD thesis, Australian National University, Canberra.

Claridge, A.W., McNee, A., Tanton, M.T. and Davey, S.M. (1991). Ecology of bandicoots in undisturbed forest adjacent to recently felled logging coupes: a case study from the Eden woodchip agreement area. *In* 'Conservation of Australia's Forest Fauna'. Ed. D. Lunney pp. 331-345. (Royal Zoological Society of New South Wales: Mosman).

Claridge, A.W., Robinson, A.P., Tanton, M.T. and Cunningham, R.B. (1993). Seasonal production of hypogeal fungal sporocarps in a mixed-species eucalypt forest stand in south-eastern Australia. *Australian Journal of Botany* (in press).

Dell, B., Malajczuk, N., Grove, T.S. and Thomson, G. (1990). Ectomycorrhiza formation in *Eucalyptus*. IV: ectomycorrhizas in the sporocarps of hypogeous fungi *Mesophellia* and *Castoreum* in eucalypt forests of Western Australia. *New Phytologist* **114:** 449-456.

Guiler, E.R. (1970). Food of the potoroo (Marsupialia: Macropodidae). *Journal of Mammalogy.* **52:** 232-234.

Hacskaylo, E. (1973). Carbohydrate physiology of ectomycorrhizae. *In* 'Ectomycorrhizae: Their Ecology and Physiology'. Eds G. C. Marks and T. T. Kozlowski pp 207-230. (Academic Press: New York and London).

Harley, J.L. and Smith, S.E. (1983). 'Mycorrhizal Symbiosis'. (Academic Press: London).

How, R. (1983). Mountain Brushtail Possum. *In* 'Complete Book of Australian Mammals'. Ed. R. Strahan. pp. 147-148. (Angus and Robertson: Sydney).

Lindenmayer, D.B. (1989). 'The ecology and habitat requirements of Leadbeater's Possum'. PhD thesis, Australian National University, Canberra.

Lindenmayer, D.B. (1992). Some impacts on arboreal marsupials of clearfelling on a 80-120 year rotation in mountain ash *(Eucalyptus regnans)* forests in the Central Highlands of Victoria. *The Victorian Naturalist* **109:** 181-186.

Lindenmayer, D.B., Cunningham, R.B., Tanton, M.T., Smith, A.P. and Nix, H.A. (1990). The habitat requirements of the Mountain Brushtail Possum and the Greater Glider in the montane ash forests of the Central Highlands of Victoria. *Australian Wildlife Research* **17:** 467-478.

Lindenmayer, D.B., Warneke, R.M., Meggs, R.A., Linga, T. and Seebeck, J.H. (1991). A note on the longevity of the Mountain Bushtail Possum, *Trichosurus caninus* in the montain ash forests of the Central Highlands of Victoria. *The Victorian Naturalist* **108:** 4-5.

McIntyre, P.W., and Carey, A.B. (1989). 'A Microhistological Technique for Assessing the Food Habits of Mycophagous Rodents'. U.S.D.A. Forest Service, Pacific Northwest Research Station Res earch Paper, **PNW-RP-404.**

Quin, D.G. (1985). Observations on the diet of the Southern Brown Bandicoot, *Isoodon obesulus* (Marsupialia: Peramelidae), in southern Tasmania. *Australian Mammalogy* **11:** 15-25.

Scotts, D.J. and Seebeck, J.H. (1989). 'Ecology of *Potorous longipes* (Marsupialia: Potoroidae): and preliminary recommendations for management of its habitat in Victoria'. *Arthur Rylah Institute for Environmental Research Technical Report Series No.* **62.**

Seebeck, J.H., Warneke, R.M. and Baxter, B.J. (1984). Diet of the Bobuck, *Trichosurus caninus* (Ogilby) (Marsupialia: Phalangeridae) in a mountain forest in Victoria. *In* "Possums and Gliders'. Eds A.P. Smith and I.D. Hume pp 145-154. (Australian Mammal Society: Sydney).

Trappe, J.M. (1988). Lessons from Alpine Fungi. *Mycologia* **80:** 1-10.

Trappe, J.M. and Maser, C. (1977). Ectomycorrhizal fungi: interactions of mushrooms and truffles with beasts and man. *In* 'Mushrooms and Man, an Interdisciplinary Approach to Mycology'. Ed. T. Walters pp 165-179. (Linn-Benton Community College: Albany, Oregon).

Fungus Photography

Bruce Fuhrer*

The fruiting bodies of fungi (mushrooms, toadstools and brackets) present a vast array of colours and forms, many of which are very attractive, interesting and sometimes bizarre. We may photograph them to communicate our interest to others, or to obtain permanent records of these generally ephemeral organisms. A quality fungus photograph will compliment dried herbarium specimens which usually bare little likeness to the living organism.

Photographs taken for botanical or scientific use should include a scale. A specimen should be included in the photograph and oriented to show clearly details such as gills or pores, stipe length and shape, features otherwise hidden from view. Small apertures from f.11 to f.22 are necessary to gain good depth of focus.

The Camera

The most suitable camera for nature and close-up photography is the 35 mm Single Lens Reflex (SLR), allowing easy focusing and exposure setting. The standard lens fitted to SLR cameras will focus closely enough to photograph the large- to medium-sized species or colonies.

Close-up options

For distances less than are possible with the standard lens, screw-on close-up lenses may be used. These lenses usually come in sets of three, each providing different close-up distances. Close-up lenses produce good results when used with small aperture settings and are relatively inexpensive and simple to use.

Close-up (CU) tubes

These extend the close focusing range and are used between the camera body and the lens. The tubes, used singly or in combination, give an extended range of magnification and can produce images larger than the subject. Depth of focus decreases as tube length is increased. When using flash with CU tubes, effective apertures have to be calculated, and usually reference tables are provided with the tubes. An aperture of f.16 set on the lens becomes effectively f.22 when the image is half the size of the subject, and f.32 when the image on the film is life-size.

The macro-lens

Macro-lenses are designed optically and mechanically to produce optimum image quality in the close-up range which may be further extended by using close-up tubes. Macro-lenses are much more expensive than close-up tubes and lenses, but may be used as a universal lens in place of the standard lens. A macro-lens is the best choice where close-up photography is the main aim.

Macro-zoom lenses

These are extremely versatile and perform well; the macro-setting, however, is usually limited, but they are satisfactory when extreme close-up work is not requried.

Photography in dark situations

Fungi growing in poorly lit situations require auxiliary lighting, and a small flash unit is the most convenient light source. When using flash, factors such as colour density and texture of the subject must be considered. A flash guide number (G.N. = lens aperture x distance of flash from subject) can be found by taking a series of bracketed exposures of a dryish specimen of medium tone using an aperture of f.16 and noting flash distances used for each exposure. The best exposure of the series may have been taken at f.16 with the flash 50 cm from the subject; multiplying f.16 x 50 will yield a guide number of 800. This reference number is used as an exposure guide for any photograph taken with the

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same film. If an aperture of f.22 is used, divide the G.N. 800 by 22 and a flash distance of around 36 cm is indicated; if f.11 is used, the flash distance is approximately 73 cm, and so on. For pale or white specimens the aperture should be closed 1/2 to 1 stop, or flash distance increased; for dark and/or viscid species the lens may be opened by one or two stops or the flash moved closer than indicated by the guide number, to compensate.

Holding the camera

Small camera apertures require long exposures with the risk of camera movement; the use of a tripod is advisable. As fungi usually grow at or near ground level, a suitably low operating tripod is necessary. Such tripods are available commercially and many are flexible enough for photographing specimens on logs and tree trunks. For easy camera orientation a ball-and-socket head should be used on the tripod. A small, folding Leitz table tripod is illustrated (Fig. 1 and Fig. 2). It is extremely portable and in seconds can be expanded for use.

Colour films

When colour prints are required, print films up to ISO 200 give excellent results. The choice of film brand is a matter of individual preference. Print films have lower contrast than slide films; print films have greater exposure latitude and are less sensitive to lighting variations.

For colour slides, films up to ISO 100 give best colour saturation and resolution. Greater care is required when using slower films because of their sensitivity to uneven lighting. Consistent results are best obtained by standardising on a film you are happy with and getting to know its performance by experiment and experience.

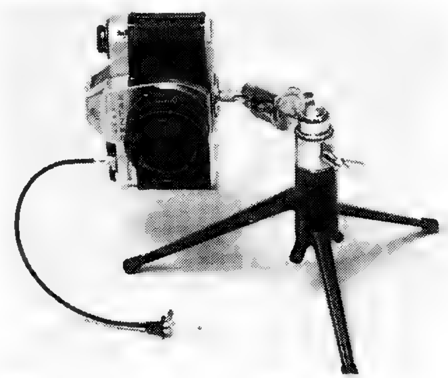

Fig. 1. Leitz table tripod, extended

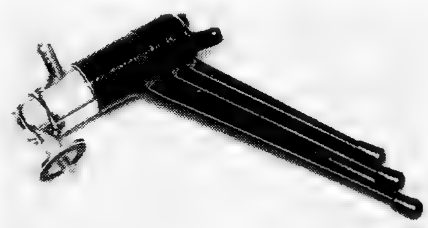

Fig. 2. Leitz table tripod, folded

Obituary

Geoffrey Richard Hughes (1922 - 1993)

It is with regret that we announce the recent death of Geoff Hughes. Geoff and his wife Joan were regular attendees of the Geology Group of The Field Naturalists and before that were keen members of the Adult Education Association Geology Group, before they amalgamated. Before Geoff retired he was a pharmacist with a Pharmacy in Toorak Road South Yarra for 37 years, and was also a very active amateur ham radio operator. We all wish to convey to Joan our deepest sympathy.

John Lee

Cordyceps or Plant eats Animal!

P. Grey* and R. Barker**

Introduction

A complete specimen of *Cordyceps gunnii* (Fig.1) was excavated by Rod Barker at the June 1992 FNCV Fungi general excursion to Mt Toole-be-Wong (lat. 37°44'S., long. 143°34'E., altitude approx 600 m). The area is re-growth mountain forest following felling operations late last century, early this century, the '39 bushfires and felling and burning in the late '60's. The trees include *Eucalyptus cypellocarpa* (Mountain Grey Gum), *E. obliqua* (Messmate), *E. macrorhyncha* (Red Stringybark), *E. viminalis* (Manna Gum), *Acacia melanoxylon* (Blackwood), *A. mearnsi* (Black Wattle), *A. dealbata* (Silver Wattle) and patches of *Euclyaptus regnans* (Mount ain Ash). Understorey shrubs consisted of *Hedycara augustifolia* (Austral Mulberry) *Cassinia aculeata, C. longifolia* (Shiny Cassinia), *Bedfordia arborescens* (Blanket Bush), *Olearia argophylla* (Musk Daisy-bush), *Pomaderris aspera* (Hazel Pomaderris), *Epacris impressa* (Common Heath, in flower) and in the disturbed areas, *Senecio linearifolus* (Fireweed Groundsel). There was also *Cyathea australis* (Rough Treefern) and *Dicksonia antarchica* (Soft Treefern), *Coprosma quadrifida* (Prickly Currant Bush) and *Dryopoa dives* (Mountain grass) (Schleiger 1992).

Fig. 1. *C. gunnii*, growing.

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Cordyceps species are curious fungi which internally parasitise the living larvae of certain insects and, when the host dies, preserves the host's outer shell in a mummified form. From this the fungus produces its long, stalk-like fruiting bodies. Cordyceps are also known to parasitise some other fungi, even other Cordyceps.

The excavated specimen, *Cordyceps gunnii*, had infected a moth larva, most probably *Oxycanus diremptus*. The caterpillar host was situated10 cm below ground. The dark club shaped stroma 2 cm in diameter and 4 cm high (not unlike a black thumb) was visible projecting above ground on a short stalk (1.5 cm) which was found, on excavation, to be connected to the host below ground. The two other Cordyceps seen were *C. taylori* (Fig. 2) and *C. robertsii* (Fig. 3). Both *C. gunnii* and *C. robertsii* were found under thick stands of *Acacia dealbata* (Silver Wattle) where the understorey consisted of *Prostanthera lasianthos* (Victorian Christ- mas-bush), *Pomaderris aspera* (Hazel Pomaderris) and *Cassinia aculeata*. In contrast *Cordyceps taylori* were found growing near *Eucalyptus cypellocarpa* (Mountain Grey Gum) in fairly thick undergrowth consisting of *Hedycarya augustifolia* (Austral Mulberry) and *Olearia argophylla* (Musk Daisy-bush).

Fig. 2. *C. taylori*, excavated.

Fig. 3. *C. robertsi*, excavated.

Questions posed by Cordyceps

This intriguing fungus has provoked a number of questions: how did the above ground spore (produced in the club shaped stroma) infect the below ground caterpillar; was it somehow able to adhere to the soft, moist body of the larva; was it swallowed when the caterpillar was eating or did the spore get swept down the larva tunnel by rain water? Having found a suitable host, what stimulated germination - humidity, temperature, the state of the larva? Do each different species of Cordyceps infect specific insects and how many species are there in Victoria?

Some answers were suggested from previous research on the genus. Since Cooke (1892), the most recent and extensive study of *Cordyceps* worldwide is that done by Korbayasi in 1941, but for Victoria the studies by J.H. Willis (1959; 1963; 1967) are particularly relevant.

About Cordyceps

The genus *Cordyceps* (meaning a swollen head) belongs to the order of Ascomycetes. Ascomycetes are so named because they produce their spores in tube-like sacs called asci which usually contain eight spores (ascospores). These asci are contained within flask-shaped perithecia, and escape through a hole at the 'top' of each perithecium. These structures are small. Some are visible on close observation, like those of our Cordyceps, while others require microscopic examination. Their shape, size and structure are important in formal identification (see Willis 1959, Alexopoulos and Mims 1979). When mature these ascospores are shot into the air to be carried by the wind. This is the Cordyceps version of sexual reproduction, but many Ascomycetes can also reproduce asexually.

Cordyceps used to be known as 'vegetable wasps' and 'plant worms' (Cooke 1892) and the most common hosts are the caterpillars of the larger Lepidoptera (butterflies and moths) but Coleoptera (beetles), Hemiptera (bugs and cicadas), Diptera (flies), Hymenoptera (ants and wasps) and Orthoptera (cockroaches and crickets) have also been recorded as hosts (Moore-Landecker 1972; Willis 1957). Cooke (1892) records that these are suitable hosts because of their life habits i.e. plant eaters and living in the soil. Cordyceps are also known to parasitise other fungi, and Lyndon (1977) reports that *C. cranstounii* parasitises *C. robertsii* as well as parasitising insect larvae. Willis (1957) and Coleman (1945) suggest that each species of Cordyceps favours some particular group of insects. However, a few species that Willis noted, including *C. militaris* (Fr.) Link, are known to have used at least 13 genera of Lepidoptera as hosts as well as the pupae of Coleoptera and cocoons of certain Hymenoptera. In contrast, a single species of insect larvae - the large Victorian Swift moth *(Oxycanus diremptus)* - has been a host to at least 4 different species of *Cordyceps,* viz *C. gunnii* (Berk.) Berk.; *C. hawkesii* G.R. Gray; *C. cranstounii* Olliff and *C. robertsii* (Hook.) Berk., but note that in these cases all of the Cordyceps were found within a few square metres. This was along the Koonung Creek at Doncaster, and in the Tarra Valley National Park (Willis 1959). Cordyceps are members of the Family Clavicipitaceae, an interesting group which also includes *Claviceps purpurea* - ergot, still occasionally responsible for hallucinations and poisoning when infected wheat or rye is used in baking (ergotism). In Australia the poisoning of animals eating fodder infected by *Claviceps paspali* is more common (Aaronson 1989). However, a number of medicinally useful alkaloids can be prepared from this fungus, for example the ergotamine group which are used to induce labour and prevent post partum haemorrhaging (Aaronson 1989). Perhaps similar uses will be found for Cordyceps themselves?

Cordyceps need to parasitise because they are unable to manufacture their own nutritional requirements, especially the thiamin (vitamin B group) needed for their metabolism. But why choose a living larva? Perhaps because the grub provides the most efficient source of food - fast food, with no need for more processing being easily digested by the Cordyceps.

Studies of the nutritional value of Cossidae grubs (witchetty grubs) show that they contain 35-70% water, 7-9% protein, 14-38% fat, 7-16% sugars as well as being a source of calcium and iron (Cherikoff and Isaacs). Another point to note is that some food plants on which the larvae feed are normally toxic. In some cases the larvae pass the toxins unchanged through their gut, in others the gut converts the toxins into non-toxic substances (Common 1990). This could suggest that the Cordyceps may avoid the gut and thus do not infect their host by food ingestion (Tisdall 1893; Moore-Landecker 1972; Dube 1983), although Willis (1963) thinks both ingestion and skin infection are feasible and it is known that bacteria infect Hepialidae grubs via the digestive tract (Common 1990). Also, examination of the gut of *Fraus simulans* Walk (Hepialidae) larvae (from Tasmania) found that a number of fungal hyphae were attached to a small proportion of the plant particles found there (Neilsen and Kristensen 1989). Another relevant fact may be that no plant material is found in the gut of larvae shortly before they pupate (Neilsen and Kristensen 1989), and this may be the stimulant for the Cordyceps to produce conidia.

De Bary (1887), Moore-Landecker (1972) and Dube (1983) describe the life cycle of *Cordyceps militaris* as a representative example of the species. The Cordyceps discharges filiform (threadlike) spores (usually smooth) which fragment transversely into even smaller pieces, each of which is capable of acting as a spore. Those that come into contact with the skin of the host become globulate. If they come into contact with another grub, not their specific host, some spores still apparently germinate - note the information regarding *C. militaris* and the *Oxycanus diremptus* grub above (Willis 1957; Coleman 1945; French 1909). Apparently, the larva's moist external body stimulates the Cordyceps spore to germinate a tube which penetrates the body by hydrolyzing the insects chitin with a cutinase enzyme. The possession of such an enzyme would argue for penetration through skin infection, although the 'Muscardine' disease *(Beauveria bassiana)* affecting silkworm larvae can infect through both the skin and the gut. However, it only germinated from the alimentary canal when the infection was scientifically introduced and the preferred method was by germ tube and enzyme penetration through the skin. Temperatures for germination range from 10 to 40 degrees C (optimum 25-35 deg. C), and a high degree of humidity - greater than 90% (Roberts and Humber 1981) - appears essential. These conditions also appear to be similar to those most favourable to the insect larva's growth and development.

Once within the soft body, the Cordyceps hyphae branch out between the muscles and fatty tissue and then break down into cylindrical segments which then pass into the blood and elongate to flow to all parts of the body. These segments divide repeatedly by transverse wall formation and budding, to form additional single-celled bodies. This process is repeated until the fungal cells replace or digest the blood and softer tissues of the larva. Thus the insect loses its substance becomes soft, relaxed and dies. A study of *C. militaris,* parasitic on Lepidoptera, showed that after infection by the conidia, death followed in 2-3 days (Tisdall 1893) or 5 days (Webster 1970), but Kobayasi (1941) thinks they live through that current year and even over winter, though rarely. After the larva dies its entire body cavity, except the alimentary canal, becomes filled with mycelium in about 2-3 days, so that the body again fills out to its former size and rigidity, thus externally appearing almost normal (Hudson 1986) (sites of infection may be indicated by small melanized spots (Roberts and Humber 1981)). The avoidance of the alimentary canal may be because it has no nutritional value or that it contains toxins harmful to the Cordyceps. Occasionally a larva reaches its pupal or imago stage before dying, but this is unusual (Lloyd 1915, Willis 1957), although a case has been recorded for the cocoon of a *Darala ocellata* moth found at Nar Nar Goon (Tisdall 1893). After the larva body has been filled with mycellium the entire fungal mass hardens and the insect body becomes decay resistant due to the presence of cordycepin, an antibiotic produced by the fungus. By this time, all the nutritional value of the larva has been absorbed (Fuhrer and Robinson 1992) and when conditions are favourable sclerotial development occurs, and fully matured spores result in about 40-60 days after infection (Webster 1940). If conditions are not favourable, perhaps dry and cold, the insect shell acts as a reservoir for the Cordyceps in a resting state (Roberts and Humber 1981).

What is the stimulus for germination? Humidity is probably the most important aspect. This seems to tie in with the life cycle of the host, for example the adult *Oxycanus diremptus* larva, one of the hosts for *Cordyceps gunnii,* emerges between March and May, at the end of summer, while the spores of *C. gunnii* mature when there are moist conditions at the end of March and April (Coleman 1945); the adult of *Trictena atripalpis* (Walk.) (=*argentata* (H-Sch.)) larva, a host for *C. taylori,* emerges after heavy rain in autumn, again when humid conditions prevail. Since many of the host species for Cordyceps appear to undergo metamorphosis, it is possible that the hormonal surge that initiates metamorphosis in the host is important.

The Cordyceps sends up a club-shaped stroma from the body of the larva, usually from just behind the head, but occasionally the anal or intermediate segments (Willis 1959) and even the hard part of the head (Cooke 1892). The fruiting body usually grows on a line with the host's body but Tisdall (1893) mentions a *Cordyceps gunnii* which grew at right angles to its host. However, this may be more common if the host is a beetle, ant or fly as shown by Harshberger (1917, fig. 21). The stem of the fruiting body is formed by groups of hyphae matted together as they emerge from the host (Tisdall 1893). The stem generally follows the insect's own burrow to the surface, its length varying according to the depth of the host below ground, but its club-headed fructification matches exactly the size of the burrow, and therefore, must have been completely formed on emergence from the larva (Coleman 1945). Coleman (1945) writes that the length of the stroma of *C. gunnii* found at Emerald on Cossidae (Wattle Goat Moths) hosts varied according to the stage of growth of the grub - from 10 to 25 cm when the host was parasitised at a young stage, but as little as 1 cm if the larva was almost fully grown and ready to pupate, presumably because the larva itself has come to the surface. Kobayasi (1941) notes that the length of the stromata is useless for taxonomic purposes because it varies depending on the depth of the host. Coleman (1945) mentioned that the fructification on larvae ready to pupate near the surface were much larger, presumably because of the greater nutrient value of the (larger) mature larva and less use of the available nutrients to form the stem to reach the surface. It may be important to note that Common (1990) states that grubs of the moths can pupate and develop when they reach at least a third of their adult size if food is not available and conditions are adverse. This may be relevant if the stimulus for the Cordyceps to mature is the hormonal change of the larva preparing to pupate. However, the evidence of Coleman (1945), which related to the different stages of larvae infected, must be taken into account. Spores form and ripen in perithecia formed in the swollen apical portion of the stroma. They are released violently in succession to be dispersed by the wind and possibly winter rainstorms. Recently (March 1993) Barker has observed on his property that before heavy rain the heads of *Cordyceps gunnii* growing there were covered in white flocules, which looked like spider webs and made the *Cordyceps* look gray (Fig. 4), but after a heavy rainfall the heads were again smooth and dark. This seems to indicate spore dispersal by water. Deacon (1980) also believes that the shapes of the spores seem to indicate their form of dispersal, and that long and thin ones are dispersed by rain-splash. It is to be noted that the spores of *C. gunnii* are long and thin (Young 1982), as are all *Cordyceps* to a greater or lesser extent (Kobayasi 1941).

There are other interesting, and as yet unresolved questions. In some areas many Cordyceps can be found, for example on Mt Toole-be-Wong there were over 10 per m. squ. of both *C.gunnii* and *C. robertsii* under Silver Wattle *(Acacia dealbata)*, and similarly at Emerald (Coleman 1945), and yet some caterpillars still manage to successfully pupate, as evidenced by their empty pupae. Cunningham (1921) also mentions that two Hepialid larvae, one infected by Cordyceps and recently dead, the other healthy, were found close together. The healthy one was successfully reared. How have these individuals managed to avoid infection?

Evidence seems to point to the possibility that the two species of Cordyceps, *C. robertsii* and *C. taylori*, may be

Fig. 4. *C. gunnii*, covered with white spores.

co-specific, their size depending on that of their host (Willis 1959), but more study is needed. Another interesting point is that both of them may produce spores over a period of several years, indicating that nutrients can be stored for a period of time. Kobayasi (1941) notes that if the whole sclerotium is not consumed when forming one stroma, then it is used to form another, whether at the same period of time, or later, is not discussed. It is hoped this question at least may soon be resolved, and in fact, new growth has appeared on the previous stroma of *C. Taylori* (Barker pers. obs. March 1993) (Fig. 5). There are questions about the fact that Cordyceps appear, on occasion, to reproduce by asexual conidia, sometimes of several types (De Bary 1887; Cunningham 1921; Lilly and Barnett 1951; Cole and Kendrick 1981). These fruiting structures are different from the more familiar perithecial structure, the club shaped stroma. Several insect-eating fungi are classified into form-genera *(Isaria, Hirsutella, Hymenostilbe* etc), which may be conidial forms of known Cordyceps, or as yet undescribed Cordyceps (Willis 1959).

Victorian Cordyceps

Cordyceps are the largest single genus of insect parasites within the Ascomycetes. There are about 200 species world-wide

Fig. 5. *C. taylori*, new growth on old stoma.

(Moore-Landecker 1972; Dube 1983). Willis (1959) listed the Australian species from collections. This included fourteen species from all over Australia. Until recently, none had been recorded in Western Australia, however, a single species *(Cordyceps* sp.) is now listed for that state (Griffiths, 1985). All except *C. dovei* (found in Tasmania) and *C.* sp (single specimen from NSW, possibly *C. aphodii)* have been recorded in Victoria, and apparently no new species have been described for this State since 1949. *C. bicephala* has only been recorded once, in its conidial form.

The Cordyceps can be recognized by their stroma (stalk) and club shaped heads (capitulum) which appear above ground. The substantial texture variations in the stromata is used for taxonomic purposes, as is the colour which is constant within a species (Kobayasi 1941). Note that several stromata are quite small, and easily confused with some of the smaller Coral fungi, particularly *Clavulinopsis* spp. and the even more similar Earth Tongues *(Geoglossum* spp. - another poorly known group). Kobayasi (1941) divided the genus into three subgenera: *Ophiocordyceps; Encordyceps* and *Neocordyceps,* some of which were further divided into groups, sections and sub-sections. These divisions are based on the taxonomic characteristics of the endosclerotium, mycels, stroma, perithecium and ascospore. Those found in Victoria are listed alphabetically below. (Abstracted largely from Willis (1959), and minus microscopic details).

Cordyceps aphodii Mathieson

Habitat:
Miner's Rest (near Ballarat). Not reported beyond Victoria.

Description:
Capitulum solitary, 3-4 mm long, ochre brown.

Host:
Aphodius howitti (Hope) a Scarabaeid

(small cockchafer beetle) larva. These are whitish grubs found in the soil feeding on plants roots. In some cases they are a pest in pastures and gardens. The adults emerge in warmer weather (spring or summer) after spending the winter in the pupal state.

Cordyceps bicephala Berk

Habitat:
Cheltenham. Also found in Africa and Brazil

Description:
Hair like stipe up to 50 mm long, simple or once forked with smooth dark brown global capitula. Only recorded in conidial from in Australia - small pink headed structures that spring from various parts of the host. Willis regards it as a doubtful species. Apparently there is only the single record in Australia, found growing on an ant trapped by a sundew plant in the late 1880's

Host:
Ant.

Cordyceps brittlebankii **McLennan & Cookson**

Habitat:
Ringwood, Tyabb. Not reported beyond Victoria.

Description:
Capitulum is a dark reddish-brown, 5-10 mm long with paler, usually acute sterile terminal beak between 4 and 8 mm long. Stipe (stalk) 1-2 mm wide.

Host:
Heteronyx spp. Coleoptera (Scarabaeidae) larvae.

Cordyceps coxii Olliff

Habitat:
Gembrook, Daylesford/Trentham, Alexandra, Johnstone's Swamp in S.W. Victoria, Little Morwell River, Mirboo North.

Description:
Glabrous (smooth, without hairs) stipe which is slender and simple or forked, longer than 30 mm and bay brown.

Host:
? Lepidoptera spp., Coleoptera (Scarabaeidae) larvae. Also Hemiptera (Cicadidae) nymphs. These live in the soil for several years sucking sap from plant roots, and climb to the surface to emerge as adults.

Cordyceps cranstounii Olliff

Habitat:
Koonung Creek Doncaster, Tarra Valley National Park.

Description:
Twisted, distorted and sinuous stipe, irregularly branched with yellow capitula each up to 10 mm and rounded or obtuse. It has a distinctive woolly appearance about the lower stroma. An easily recognized species. Fuhrer in Lyndon (1977) explains that this *Cordyceps* also parasitises *C. robertsii*, where it appears as an off-white excrescence with the most developed of these having branched or contorted bodies. It can develop anywhere along the stem, and possibly prevents the fertile structure of *C. robertsii* from developing. It may parasitise its fungal host within the caterpillar or emerge as a separate entity.

Illustrated:
Willis (1959) p. 88 Plate viii.

Host:
Mainly *Oxycanus diremptus* (Walk.) larvae (Hepialidae) - Ghost and Swift moths. The larvae of all Hepialidae are concealed feeders, and this particular species live in vertical tunnels in the soil beneath Acacia trees. At night they come to the surface to feed on leaf litter and other detritus. The adults emerge between March and May (Common 1990), after pupating in the tunnel.

Cordyceps furcata McLennan & Cookson

Habitat:
Ringwood. Only known from the type specimen.

Description:
It has 3 capitula per stipe, each 4-5 mm long and red-brown in colour, regularly ovoid and contracting into a nipple-like apical point.

Host:
Unknown larva.

Cordyceps gunnii (Berk.) Berk.

Habitat:
All over Victoria. This is the most widely distributed and most commonly found species.

Description:
The single large capitulum is a deep olive green and smooth at first, later drying to black and wrinkling. It is obtuse, with a rounded apex, often more than 10 mm long and merges gradually into a yellowish wrinkled or creased stipe often up to 10 mm wide and anything up to 300 mm long (though usually shorter) This is usually a little narrower than the capitulum. Often confused with *C. hawkesii* (see below). The fruiting bodies emerge from the vicinity of the host's head and the stroma appear above ground in early winter, mostly under Acacia trees including Silver Wattle *A. dealbata* and Black Wattle *A. mearnsii* (formerly *E. mollisima*) (Coleman 1945).

Illustrated:
Willis (1959) p. 89 Plate ix, Willis (1963) p. 86 Fig. 17, Macdonald & Westerman (1979) p. 10, Fuhrer (1985) p.155, 156, Young (1986) Plate P fig. 5 (not fig. 3), p.139, Shepherd & Totterdell (1988) p.147.

This appears to be similar to the species eaten in China (Talbot 1976). It is thought to have medicinal value and to be an aphrodisiac! However, Kobayasi (1941) cites this useful fungus as *C. sinensis* (Berk.) Sacc. and says it is known as 'Tatsou Kaso'.

Host:
Oxycanus diremptus larvae (see *C. cranstounii* above) and Cossidae (Wattle Goat Moth larvae (Coleman 1945). The latter were found emerging from tunnels under Black Wattles.

Illustrated:
D'Abrera (1974) p. 41 (*Oxycanus* spp, not *diremptus*), p. 43 (Cossidae)

Cordyceps hawkesii (G.R. Gray) Cooke

Habitat:
Koonung Creek Doncaster, Perrin's Creek Olinda, Olinda Creek at Mt Evelyn Recreation Reserve, Tarra Valley National Park, Snowy River Orbost, near Killara, Big River near Eildon Reservoir, near Cowwarr, Cockatoo. It is found in mountain gullies and is uncommon.

Description:
Capitulum coffee-brown, remaining smooth and unaltered on drying. (See C. gunnii above). Sharp demarcation between the capitulum and paler brown stipe.

Illustrated:
Fuhrer (1985) p.156, Shepherd & Totterdell (1988) p. 147

Host:
Oxycanus diremptus larvae (see *C. cranstounii* above) and some *Trictena* spp larvae (Hepialidae, Ghost and Swift moths). *T. atripalpis* (Walk.)(=*argentata* (H-Sch.) larvae excavate tunnels in the soil and live off the roots of Red Gum *(Eucalyptus camaldulensis* Myrtaceae). The adults emerge after heavy rain usually in late autumn. (Common 1990).

Illustrated:
D'Abrera (1974) p. 39 *(Trictena argentata)*

Cordyceps meneristitis F. Meull. & Berk.

Habitat:
Mouth of Yarra River, Creswick, Kalorama, Boronia, Carrum, near Stawell, Daylesford

Description:
Stipe smooth and undivided, less than 3 mm wide. Capitulum rarely longer than 5 mm, brick red or sepia and rounded or

obtuse.

Host:
Meneristes laticollis Boisd. (Coleoptera, Tenebrionidae - Darling Beetle) larvae. The larvae feeds on wood, bark, fungi and other plant material.

Cordyceps militaris (Fr.) Link.

Habitat:
Apollo Bay, Turton's Track near Beech Forest.They inhabit fern gullies and mountain gullies and like *C. hawkesii* are uncommon in Victoria, but is the most cosmopolitan of the Cordyceps, being found almost world-wide.

Description:
The fertile portion of the stroma is terminal, orange, obtuse and unbranched, between 2 and 20 mm long. The host is normally a chrysalis.

Illustrated:
Young (1986) Plate P fig 3 (not 5), p. 140.

Host:
Various genera of Lepidoptera, occasionally Coleoptera and Hymenoptera.

Cordyceps robertsii (Hook.) Berk.

Habitat:
Tyrendarra near Portland, Koroit, Koonung Creek Doncaster, Rye, Tarra Valley National Park, Warrandyte, Wonga Park, Kalorama, near Cowarr.

Description:
The thin, dark (brown) and pointed stroma is single or slightly branched (2 - 3), with a thick matted covering of hairs towards base, lighter towards tip. Stipe never more than 3 mm wide where it leaves host.This was the first species of *Cordyceps* to be noted from Australasia (1831). The Type is from New Zealand, where the fungus is found under the Rata Trees and collected for food by the Maoris. Like *C. gunnii*, a true 'vegetable caterpillar'. Sadly, this is apparently a 'tall' story, however, C. robertsii was burnt and pulverised to make a black paste used for tatooing (Cunningham 1921).

Illustrated:
Fuhrer (1985) p. 156, Fuhrer & Robinson 1992 p.90

Host:
Oxycanus diremptus.

Cordyceps scottiana Olliff

Habitat:
Erskine River near Lorne

Description:
Similar to *C. meneristitis*, except capitulum is yellow brown and about 10 mm long.
There is some doubt as to the status of this species, as the Type may have been lost.

Host:
Rhyssonotus nebulosus Kirby (Coleoptera, Lucanidae - Brown Stag Beetle) larvae. Apparently cicada larvae (Cicadidae) are also used as hosts.

Cordyceps taylori (Berk.) Sacc.

Habitat:
Gerangamete, Otway Ranges also Apollo Bay, Beech Forest, Forrest, Cape Otway, South Gippsland (Strezelecki Ranges), Snowy Creek between Omeo and Tallangatta, Ovens River, Harrietville, Sherbrook Forest, Korrumburra, Thorpdale.

Description:
Stroma dark brown to black, usually much branched, antler like and massive (up to 300 mm above ground). Unbranched specimens are always more than 3 mm wide as stipe leaves the host. This is certainly the largest Cordyceps in Australia, and possibly in the world.This was the first species to be recorded from Australia (1843), and is known only from Victoria and S.E. New South Wales. As previously indicated, they could be monstrous *C. robertsii.*

Illustrated:
Willis (1963) p. 84

Host:
Trictena spp. (Lepidoptera, Hepialidae - Ghost moth), probably *T. argentata* (=T.

atripalpis (Walk.)) larvae.

Conclusion

In the time honoured tradition of science, we have asked many more questions than we have answered. We now have a picture of the overall life-cycle of these fungi, but many of the details elude us still. Perhaps we will all examine the forest floor more carefully for these inconspicuous fungi that have turned the tables on the animal world. As Willis (1963) indicates, there are no doubt more, as yet unrecorded species, awaiting discovery by eager field naturalists.

So this ends our investigation of one of the strangest groups of fungi - or does it? One of the authors (Barker) intends to further investigate Victorian *Cordyceps* as an M.Sc., and would be pleased to hear from anyone in the State who finds *Cordyceps* this year - especially some of the smaller varieties. Specimens may be exhumed and kept in a dry place - with appropriate details, of course!, or (preferably) their localities noted, and he will arrange to collect them.

Please contact Rod Barker, Phone 03 762 4044 (Work), leave name and contact number, or 059 623 159 (Home). Leave name and number on answering service if necessary. Write to Bunyip House, C/- P.O. Healesville, 3777.

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References

Aaronson, S. (1989). Fungal parasites of grasses and cereals: their role as food or medicine, now and in the past. *Antiquity* **63**: 247-257.

Alexopoulos, C.J. and Mims (1980). 'Introductory Mycology' (3rd Ed). (John Wiley: New York).

Cherikoff, V and Isacs, J. 'The Bush Food Handbook.' (Ti Tree Press: Sydney.)

Coleman, E. (1945). Autumn Fungi at Emerald. *The Victorian Naturalist* **62**: 4-5.

Common, I.F.B. (1990). 'Moths of Australia'. (Melbourne University Press: Australia.)

Cooke, M.C. (1892). 'Vegetable Wasps and Plant Worms'. (London.) Cunningham, G.H. (1921). The Genus Cordyceps in New Zealand. *Transactions and Proceedings of the New Zealand Institute* **53**:372-382.

D'Abrera, B. (1974). 'Moths of Australia'. (Lansdowne.)

Deacon, J.W. (1980). 'Introduction to Modern Mycology'. (Blackwell Scientific Publications: Melbourne.)

De Bary, A. (1887). 'Comparative Morphology and Biology of the Fungi, Mycetozoa and Bacteria'. (Clarendon Press: Oxford.)

Dube, H.C. (1983). 'An Introduction to Fungi'. (Vikas Publishing House Pty Ltd.)

Fuhrer, B. (1985). 'A Field Companion to Australian Fungi. (The Five Mile Press: Melbourne.)

Fuhrer, B. and Robinson, R. (1992). 'Rainforest Fungi of Tasmania and S.Eastern Australia'. (CSIRO: Melbourne, Victoria.)

Griffiths, K. (1985). 'A field Guide to the Larger Fungi of the Darling Scarp & South West of Western Australia'. (Kevin Griffiths: Australia.)

Harshberger, J.W. (1917). 'A Text-book of Mycology and Plant Pathology'. (D. Blakinston's Son & Co.: Philadelphia.)

Hudson, H.J. (1986). 'Fungal Biology' (Edward Arnold: London.)

Kobayasi, Y. (1941). The genus *Cordyceps* and its allies. *Science Reports of the Tokyo Bunrika Daigaku* **84**: 53-260.

Lilly, V.G. and Barnett, H.L. (1951). 'Physiology of the Fungi'. (McGraw- Hill Book Co.Inc.:New York.)

Lyndon, E. (1977). Complications among Vegetable Caterpillars. *The Victorian Naturalist* **94**:78-79.

M'Alpine, D. (1895). Entomogenous Fungi. *The Victorian Naturalist* **12**: 63- 64.

Macdonald, R. and Westerman, J. (1979). 'Fungi of South-eastern Australia - A Field Guide'. (Thomas Nelson: Melbourne, Victoria.)

Moore-Landecker, E. (1972). 'Fundamentals of the Fungi'. (Prentice-Hall Inc.: New Jersey.)

Neilsen, E.S. and Kristensen, N.P. (1989). 'Primitive Ghost Moths'. (CSIRO: Australia.)

Roberts, W. and Humber, R.A. (1981). Entomogenous Fungi. *In* 'Biology of Conidial Fungi', Vol 2. Eds. Garry T. Cole and Bryce Kendrick. (Academic Press: U.S.A.)

Shepherd, C.J. and Totterdell, C.J. (1988). 'Mushrooms and Toadstools of Australia'. (Inkata Press: Melbourne and Sydney.)

Talbot, P.H.B. (1971). 'Principles of Fungal Taxonomy'. (Macmillan: London.)

Tisdall, H.T. (1893). On a species of Isaria. *The Victorian Naturalist 10:* 90-96.

Von Meuller, Baron (1887). Notes on Rare Victorian Fungi. *The Victorian Naturalist* **3**:140.

Webster, J. (1970). 'Introduction to Fungi'. (Cambridge University Press: England.)

Willis, J.H. (1934). "Vegetable Caterpillars". *The Victorian Naturalist* **50**:302-304.

Willis, J.H. (1959). Australian Species of the Fungal Genus Cordyceps. *Meulleria* **1**: 67-89.

Willis, J.H. (1963). 'Victorian Toadstools and Mushrooms' (2nd ed.). (The Field Naturalists Club of Victoria: Melbourne, Victoria.)

Willis, J.H. (1967). Further Cordyceps Collections in Australia. *Meullaria* **1**: 223-224.

Young, T. (1982). 'Common Australian Fungi'. (New South Wales University Press: Sydney.)

The Field Naturalist Club of Victoria

In which is incorporated the Microscopical Society of Victoria
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Registered Office: FNCV, c/- National Herbarium, Birdwood Avenue, South Yarra, 3141, 650 8661.
OBJECTS: To stimulate interest in natural history and to preserve
and protect Australian fauna and flora.
Members include beginners as well as experienced naturalists.

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The Victorian Naturalist

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FNCV Calendar of Activities

July	
Sat 3	General FNCV Excursion. Anakies by Bus. Book on 435 8408 by June 18.
Tues 6	Fauna Survey Group Meeting. Native Fish - George Paras. Herbarium Hall 8 p.m.
Thurs 8	Botany Group Meeting. The Kimberleys - Stephen Forbes. Herbarium Hall 8 p.m.
Sun 11	**General FNCV Meeting.** Attracting Butterflies and Moths to your garden - Pat and Mike Coupar. **Herbarium Hall 2 p.m.**
Wed 21	Microscopical Group Meeting. Confocal Microscopy - Martin Harrison. Astronomer's Residence 8 p.m.
Sat 24	Botany Group Excursion. Long Forest, Bacchus Marsh. Leader Janet Leversha. Meet 10.30 a.m. southern end Long Forest Road, just off Western Highway, east end of Bacchus Marsh.
Sat 24-Sun 25	Fauna Survey Group Campout. Reconnoitre of Goldfields area. Contact Ray Gibson 874 4408.
Wed 28	Geology Group Meeting. Geological History of the Yarra Valley and related streams - Dr Noel Schleiger. Herbarium Hall 8 p.m.
August	
Sun 1	**General FNCV Excursion.** Royal Zoological Gardens. Leader John Arnott. Contact Dorothy Mahler 435 8408.
Tues 3	Fauna Survey Group Meeting. Effects of Fragmentation on Woodland Birds - Doug Robinson. Herbarium Hall 8 p.m.
Mon 9	**General FNCV Meeting.** A Marine Science Criuse to Antarctica - Mark O'Loughlin. Herbarium Hall 8 p.m.
Thurs 12	Botany Group Meeting. Psilosiphon, a peculiar aquatic plant - Tim Entwisle. Herbarium Hall 8 p.m.
Wed 18	Microscopical Group. The Morphology of Primitive Angiosperm Pollens - Don Forman. Astronomer's Residence 8 p.m.
Tues 24	**Geology Group Meeting.** Benambra Copper Mine, background to development, mining and general isues - George Buckland. Herbarium Hall 8 p.m.
Sat 28	Botany Group Excursion. The Brisbane Ranges. Leader Dr Gretna Weste. Contact Joan Harry 850 1347.

PLEASE NOTE . The calendar printed in the last newsletter (issue 16, June/July) contained some incorrect information. Check the calendar printed above for the correct information.

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The Victorian Naturalist

F.N.C.V.

Volume 110 (3) 1993 June

Editor: Robyn Watson
Assistant Editors: Ed and Pat Grey

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ISSN 0042-5184

Cover Photo: Victorian Funnel-web Spider *Hadronyche modesta* (Simon), *photographed by Ian Morrison.* See book review page 137.

An Australian Tragedy of Errors

Amendment No RL 105 to the Geelong Regional Planning Scheme

Members of The Field Naturalists Club of Victoria will know that privately owned coastal heathland and heathy woodland on the western flank of the town of Anglesea is proposed for rezoning. The proposal is to zone the eastern and northern part of the block (49.4 ha) for urban development; an additional area of 7.9 ha is for water storage and a fire break, while the rest of the land (168.3 ha) would be given to the State to add to the existing Mount Ingoldsby Flora Reserve.

There have been many objections to this proposal because of the loss of biodiversity and habitat as well as the overall loss of quality of the natural communities which presently occupy the land. Because of the strength of the objections, the Minister for Planning has established a Review Panel to consider the proposal and the objections and report back in the next few weeks. The FNCV has objected strongly to the proposal and was represented at the inquiry by Malcolm Calder as President of the Club.

The land being considered for rezoning is an exceptionally good example of a cool-temperate, coastal heathland and heathy woodland which we have claimed is the victim of tragically inappropriate past alienation and subsequent planning zonation. We stated that field naturalists consider that the natural vegetation surrounding Anglesea is some of the most diverse and ecologically important coastal vegetation in Australia. Much of the characteristic coastal heath and heathy woodland has been destroyed in the development of the town; that which remains is particularly precious and should be protected and managed for conservation.

The heathland being reviewed contains some five plant communities, including a form of heathy woodland dominated by the rare and, as yet undescribed, Victorian Grey Gum (*Eucalyptus* sp. aff. *alaticaulis*). The heathy communities have great biodiversity and are internationally known for the great number of terrestrial orchids which grow there. The species diversity of these heathlands is only exceeded in Australia by the heathlands in the southern corner of Western Australia; they are of national significance.

In our evidence we claimed that the proposed development has the potential to bring about major environmental changes such as changes in ground water tables; increased nutrient flow to ground water; the spread of soil pathogens; and invasion by environmental weeds and domestic animals. All of these, we said, would have a severe detrimental impact on the adjacent natural environment.

We concluded by saying that we consider the proposed rezoning to be in complete ecological disharmony and a serious threat to currently recognised botanical and ecological values. Field naturalists throughout Australia (and from overseas) come to Anglesea to view the wildflowers, and especially the orchids. Incremental land clearing and urban settlement destroy the native communities and increase the pressure on the remaining land. We also advised the Panel that the Victorian Field Naturalists Clubs Association (representing over 40 member clubs throughout Victoria) at its annual General Meeting on March 6th were unanimously opposed to the Proposed planning amendment and had passed the following motion "**That the Association strongly opposes development of any kind on this land, as it is of such high conservation value**".

The club believes that the history of this block of land is an Australian Tragedy of Errors. It is a tragedy and error that the land was ever alienated; it is a tragedy and error of planning that the land is zoned in part for future urban development. It is a potential tragedy and it would be an error if we allowed the current proposals to go ahead.

Malcolm Calder
President FNCV

Design and use of Planting Zones at the Organ Pipes National Park

Notes on research and planning for the first 20 years

Barry Kemp* and Robert Irvine**

Abstract

The planning of this pioneering revegetation project is described showing the use of 'planting zones' for different indigenous plant species. Historical literature, geological surveys and regional observations are used as criteria for the design of these zones. The success of the Organ Pipes National Park restoration can be measured by the increased number of species present, the more diversified faunal habitat created and the appearance of the Park, which has now begun to resemble descriptions of the area given by early settlers.

Introduction

Since 1973, planting of indigenous species has been carried out at Organ Pipes National Park following guide-lines designed to preserve the existing gene pool and re-create the pre-European plant communities. An overview of the project can be found in Edwards (1974) and Anon (1982).

While many people have been involved in planting, most of the research, planning and collection of propagation material has been done by a volunteer group known as the Friends Of Organ Pipes National Park (FOOPS), a sub-group of the Victorian National Parks Association. Support work and advice have been provided by the Department of Conservation and Natural Resources.

This report outlines the research and planning carried out for the revegetation of Organ Pipes National Park. Propagation and planting techniques are not covered; nor weed and vermin control (conducted by Park staff).

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** 11 Mudie Ave., Sunbury, Vic. 3429

Guidelines

When the Park was declared in March 1972 there was no documented policy on indigenous plantings in national parks. The Organ Pipes National Park project was to become the first Australian restoration using solely indigenous species (J. Willis pers. comm.).

An interim policy on revegetation of Organ Pipes National Park was put in place in August 1972 until guide-lines for revegetation in National Parks were developed fully (National Parks Service 1988). This required that only local propagating material (eg. seed and cuttings) should be used; this material should be collected from within the Park and seedlings should be planted where they would have naturally occurred.

In cases where the population of a species is small, the guide-lines allow for the collection of material outside the Park. This should maintain the genetic diversity of the species and prevent in-breeding. At Organ Pipes National Park most of the material has been collected within 20 km of the Park (Fig. 1).

The Site

Organ Pipes National Park covers an area of 85 ha, 32 km north-west of Melbourne, Victoria (37° 40'S, 144° 45'E). Initially, 65 hectares were donated to the National Parks Service to preserve geological features exposed by Jacksons Creek, including the so-called Organ Pipes. The land was proclaimed a National Park in 1972.

At that stage it had been a much neglected farm in a long-settled area. About 90% of the site was covered with weeds, including African Boxthorn (*Lycium ferocissimum*) and Spanish Artichoke (*Cynara cardunculus*). It was

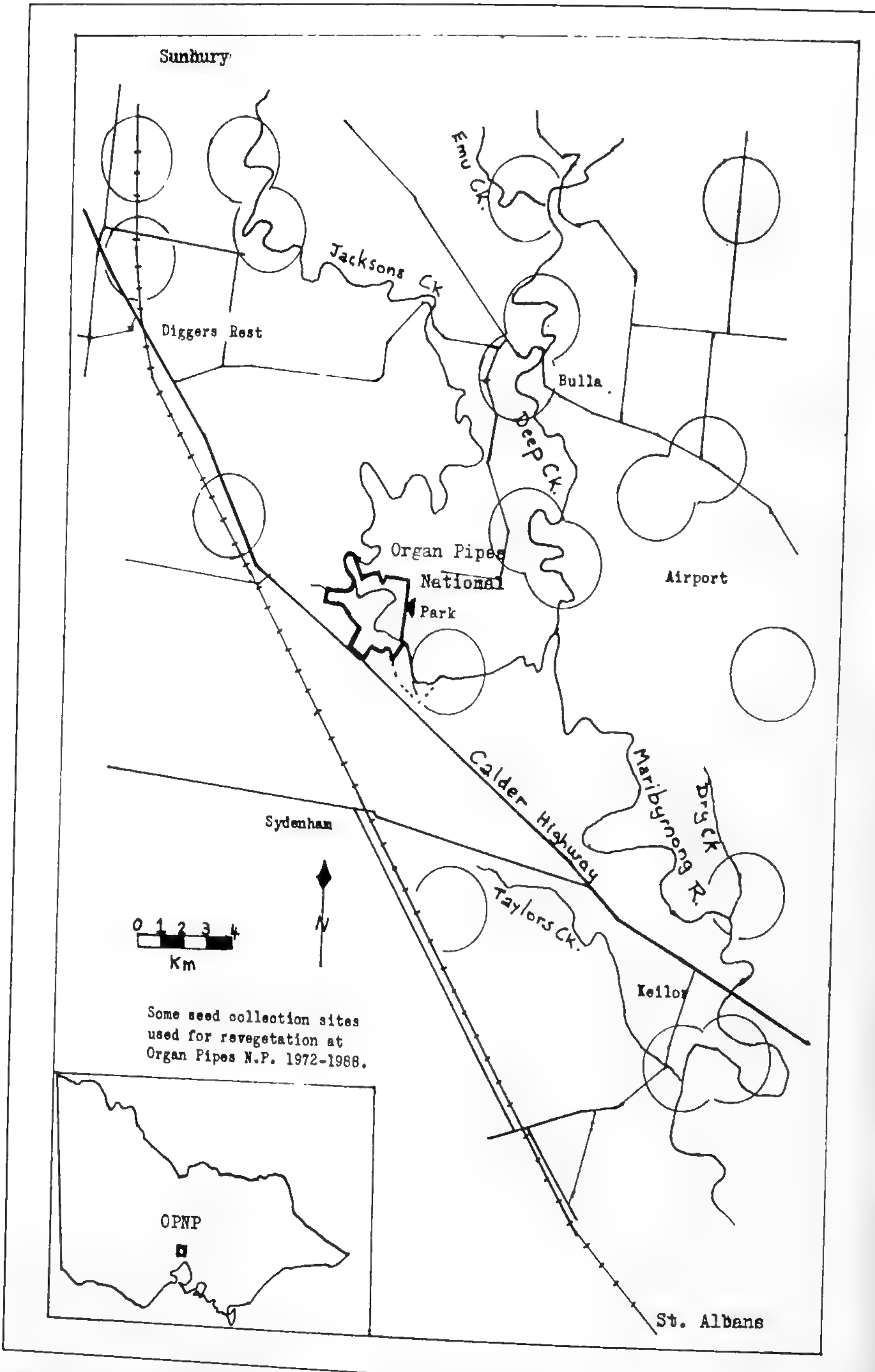

Fig. 1. Some seed collection sites used for revegetation at Organ Pipes National Park 1972-1988.

Photo 1. Organ Pipes National Park photographed in 1978.

Photo 2. Organ Pipes National Park photographed in 1990.

Photo 3. Spanish artichoke infestation photographed in 1978.

infested by rabbits and other vermin, and the soil was badly eroded (Edwards 1974). Few native plants or animals survived except where some protection was provided by rock crevices or creek banks. Several adjacent properties with similar weed and vermin problems have since been added. Future planned additions will bring the area of the Park to 250 ha.

Geology

The geology and geomorphology of the area are important determinants of vegetation (Wilk *et al.* 1978). They were studied carefully by FOOPS to ensure that the areas planted in the Park had growing conditions similar to those areas which served as seed sources.

The geology is characterised by a series of upper-Tertiary basaltic flows overlaying a sedimentary basement of Ordovician to Silurian sandstone shale and conglomerate beds (Sutton 1916; Wilk *et al.* 1978) (Fig. 2). Along the valley of Jacksons Creek, the sedimentary basement is exposed with the basalt commonly forming steep cliffs above (Sutton 1916). Recent alluvial deposits occur in broad flats along the valley floor and there are higher level terrace and colluvial deposits (James 1920; Wilk *et al.* 1978).

Basalt-derived soils are formed *in situ* on the plains and on low to moderate gradient slopes (Sutton 1916). In the valley, basalt soils locally overlay sandstone as a result of slumping and creep. Sandstone- derived soils are generally shallow and of limited extent whereas deeper soils of mixed origin are present on alluvial flats (Forster *et al.* 1975, 1976).

All soils in the Park have undergone erosion to some extent and much of the colluvium is recent (Wilk *et al.* 1978).

Climate

The site is strongly affected by alternating cyclonic/anticyclonic weather systems. Typically, strengthening north winds are followed by a front, with a rapid change to south-westerly winds. Meteorological records at nearby Melbourne Airport indicate that strong north winds are more common in winter, and south-westerlies more common in summer (Bureau of Meteorology 1990). When north winds do occur in summer, they are very hot and dry. The average annual rainfall at Melbourne Airport is 575 mm. This is 87% of the average annual rainfall for Melbourne and is

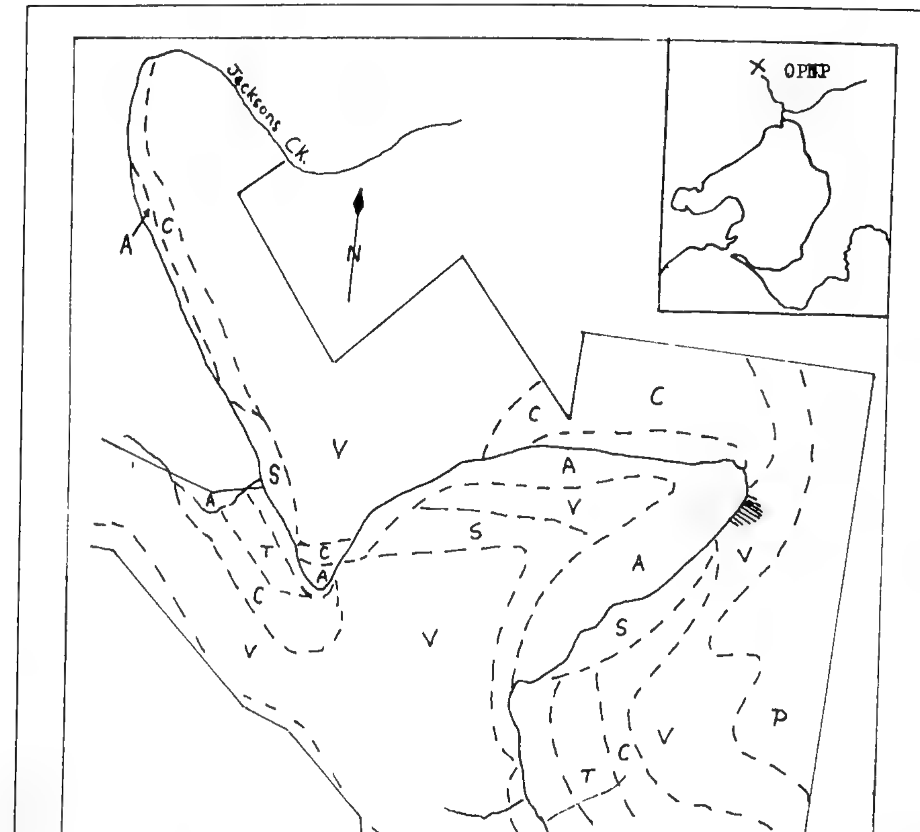

Fig. 2. Organ Pipes National Park Geological Map.

indicative of the relatively low rainfall on the Keilor Plains. Rainfall occurs throughout the year but there is normally a peak in spring. In summer and late spring, evaporation exceeds rainfall (Willis 1964). Moderate frosts occur during winter. An account of the region's climate is given by McDougall (1987) and Wilk *et al.* (1978).

Because of the steep slopes along Jacksons Creek, aspect is an important factor in the degree of exposure encountered by plants. Some slopes receive little winter sun while others receive full sun and are exposed to strong drying north winds.

Vegetation

The vegetation on the Keilor plains described by Sutton (1916) and Willis (1964) was an open tussock grassland, dominated by Kangaroo Grass (*Themeda triandra*), interspersed with small herbs, and scattered small woody species. Along watercourses, such as Jacksons Creek at Organ Pipes National Park, the vegetation would have been more luxuriant. Trees and shrubs were common because of better soil drainage and protection from strong winds (Sutton 1916).

Because of their open grassy nature and proximity to Melbourne, the Keilor Plains and the nearby valleys were rapidly exposed to grazing and agriculture following settlement in 1835 (Sutton 1916). By 1973, only fragments of native vegetation existed, often on railway easements or on steep valley escarpments (Edwards 1974; Rayner *et al.* 1984).

Planning for Revegetation

The aim of the project was to restore the vegetation of the site to a near-natural condition. The restored vegetation would display examples of the regional flora, provide a reserve for locally or nationally threatened species, maintain a seed source for future work and increase the diversity of fauna habitat.

Indigenous Flora

Little of the original vegetation of the site remained as a guide to revegetation efforts (Edwards 1974; Rayner *et al.* 1984). To determine the natural distribution and structure of the vegetation for the Park a study was made by the FOOPS of historical accounts, scientific papers and notes by early botanists. This guided initial planning and subsequent amendments or additions.

Sutton (1916) recorded 440 species for the region, but Willis (1964) used a figure of 330 'true basaltic species' by not including those intruding from marginal areas or on inliers of granite or sandstone. Recent surveys and newly described taxons have added a number of other, mainly herbaceous species. Some historical accounts contained only a few brief references to the flora, but were still helpful. Excursion and research reports (Patton 1935) in *The Victorian Naturalist* (Hall 1900; Sutton and Armitage 1911; Nichols 1942; Garnet 1961) were invaluable. Early surveyors' maps, such as those of Wedge-Darke and Hoddle, occasionally contained botanical information (e.g. direct evidence of *Banksia marginata*, Silver Banksia, close to the Park). Often only vernacular or obsolete botanical names were used.

Some examples follow: (modern botanical names are inserted in square brackets)

'....encamped among native honeysuckle *[Banksia marginata]* and oak trees *[Allocasuarina verticillata]*....The plains are extensive, firm, grassy and skirted by light timber'. Alexander Fullerton Mollison, 1st August, 1837 (Mollison 1980), believed to be in the valley of Jacksons Creek, near the present town of Sunbury.

Isaac Batey (1907b) writing about the first years of settlement, recalled '....a belt of sheoaks *[A. verticillata]* about 4 miles in length, in parts a mile wide, and forming a dense forest....' The site has been identified, within 5 km of the Park.

'The country through which we travelled today consists of green hills and valleys with a verdure of transparent green.... covered with rich and thick herbage and the trees she-oak *[A. verticillata]* and cherry tree *[Exocarpos cupressiformis]* and stunted gum *[Eucalyptus spp]*'. George Augustus Robinson, 10th January, 1840, on a route which is believed to have been close to the Park (Robinson 1840).

'....the charming Desert Cassia, *(C. eremophila) [Senna artemisioides].* This plant, which is said to have occurred freely along the creek just here, is now only to be seen in situations where it is out of reach of stock', (Sutton and Armitage 1911).

Photo 4. Early plantings showing use of wire frames and hessian (1978).

Seed Collection Sites

In addition to searching through the available literature, the surrounding areas were explored for remnant plants to be used as seed sources. Small pockets of original flora were found at Taylors Creek, Dry Creek and Horseshoe Bend in Keilor, the banks and spurs of Deep Creek near the Melbourne Airport, the wooded Radar Hill, parts of Jacksons Creek south of Sunbury, at the Holden Flora Reserve, and along railway easements particularly from Tottenham to Sunbury (Fig. 1).

In the process, it became obvious that, even within the valleys the vegetation was not uniform, but varied greatly according to soil, drainage and aspect. For instance, *Senna artemisioides* (Desert Cassia), recorded in the Park area as late as 1961 (Garnet 1961) but absent in 1972, could be found only on north-facing sandstone slopes. The few remaining Yellow Gum *(Eucalyptus leucoxylon),* including a single survivor in the Park, were on similar sites. It was apparent that both of these species should be planted on the warm sandstone areas of the Park. Further observations were made of the habitat preferences of many other indigenous species, some like the streamside association being fairly obvious, others more subtle.

Planting Zones or 'What Goes Where'

Sutton and Armitage (1911) suggested that the plants in this area fell roughly into two categories, those on exposed basalt plains and those in the river gorges. To FOOPS the emerging patterns of areas, each with a more or less distinct plant association suggested the Park could be divided into zones by relating the soils, drainage and aspect to other sites with remnant native vegetation. As well as helping to correctly place seedlings, this would simplify management of the planting process, which required two years forward planning. A number of simple habitat zones were delineated and prominent plants selected to give their names to each zone. With experience, changes were made. The system could apply directly to Park extensions or other local areas.

Details of zones currently in use are as follows: (Fig. 3).

Red Gum Zone

This zone consists of the alluvial flats and narrow creek banks which have deep soil and sheltered conditions.

Red gum *(Eucalyptus camaldulensis)* '....has almost undisputed possession of the water-courses, often extending in that way right up on to the open plain...' (Sutton 1916).

In 1972 investigation of the creek banks in the Park showed that they had been mostly cleared and vegetation was heavily suppressed by grazing. Despite this, reseeding by floodwaters meant that many original species persisted. Original spe-

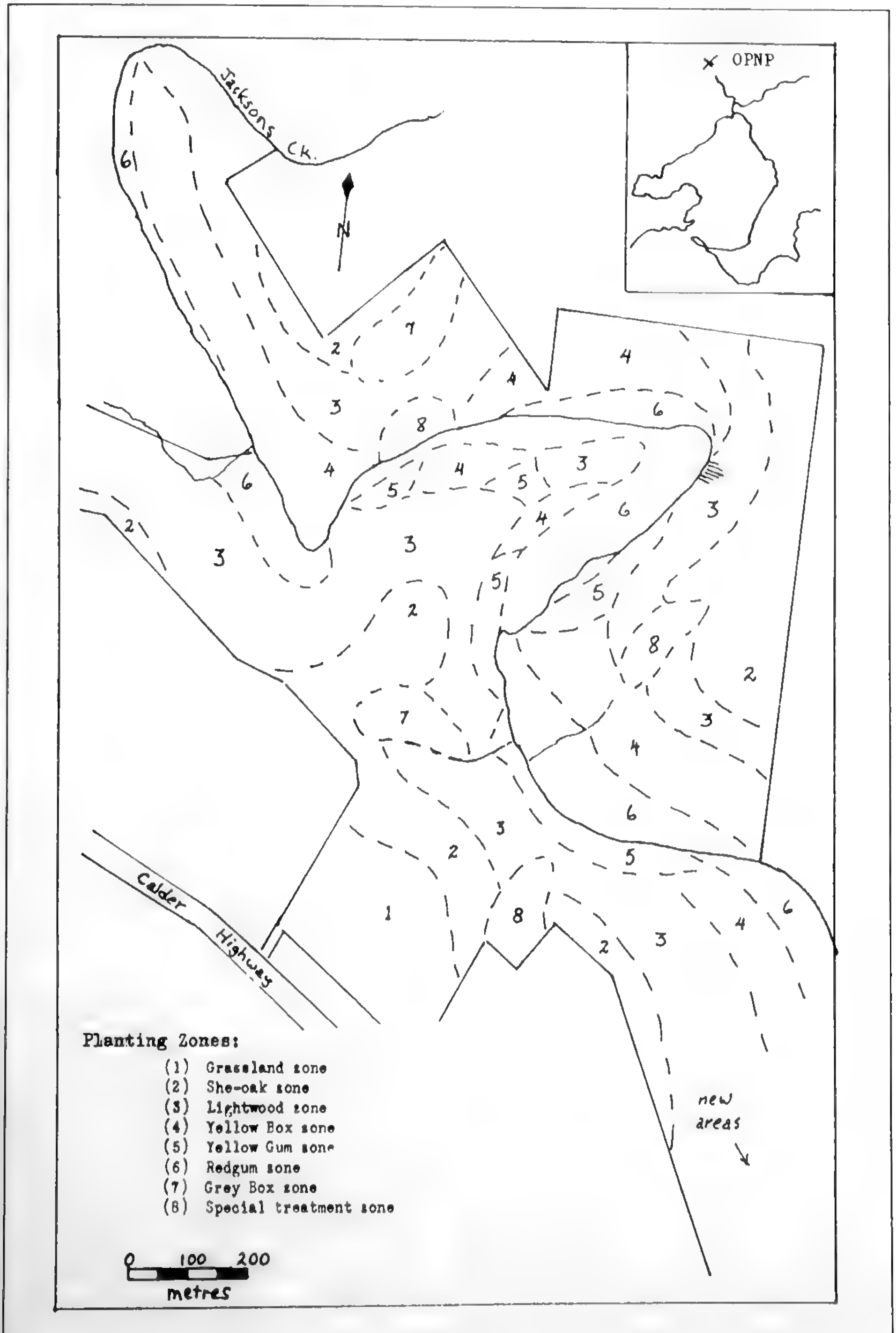

Fig. 3. Organ Pipes National Park Planting Zones.

cies, in addition to Red gums, were *Acacia dealbata* (Silver Wattle), *Acacia melanoxylon* (Blackwood) a few *Acacia verticillata* (Prickly Moses) and a single surviving *Acacia mearnsii* (Black Wattle), as well as *Hymenanthera dentata* (Tree Violet), *Callistemon sieberi* (River Bottlebrush), *Leptospermum lanigerum* (Woolly Tea-tree) and one *Viminaria juncea* (Golden Spray) (the only known survivor in the region).

Eucalyptus viminalis (Manna Gum) and *Acacia retinodes* (Wirilda) were found locally beside streams and on slopes close to streams, so were included for use in this zone. A sub-division of the planting zone could have been made, as *C. sieberi, L. lanigerum* and *A. dealbata* proved to be dependent on a steady supply of moisture from the creek. However, these were simply positioned closer to moist areas at planting time. To a large extent, the aquatic and semi-aquatic plants associated with the creek appear to have survived the sites agricultural history and have been given little attention.

Yellow Box Zone

This zone takes in the areas in the Park between the moist flats and the dry, crumbly slopes. These sites are relatively dry alluvial and colluvial soils over sandstone.

Two Yellow Box *(Eucalyptus melliodora)* trees were found in the Park on these soils and most other local examples of the species were on similar soils with varied exposure, surviving mainly as single trees on the slopes. Few other native plants survived in this zone in the Park; mainly *Danthonia* spp (Wallaby-grasses), and a single *Bursaria spinosa,* (Sweet Bursaria).

Outside the Park, similar areas had *Hymenanthera dentata, Acacia implexa* (Lightwood), *Acacia acinacea* (Gold dust Wattle), *Acacia mearnsii* (Black Wattle), *Myoporum viscosum* (Sticky Boobialla), *Myoporum insulare* (Coast Boobialla), *Eremophila deserti* (Turkey Bush) and occasionally *Cassinia longifolia* (Shiny Cassinia). *Themeda triandra* (Kangaroo Grass) was present on one site.

Banksia marginata (Silver Banksia) appears frequently in old reports (usually as 'Honey suckle') and surveyors' maps, with records in the valleys and on the plains. The closest survivors in 1972 were 20km north of the Park. We have successfully re-established this species in this zone.

Some species have appeared in this zone that were not obvious in 1972 including *Dichanthium sericeum* (Silky Blue-grass) and the saltbushes *Enchylaena tomentosa* (Barrier Saltbush) and *Einadia nutans* (Nodding Saltbush).

Yellow Gum Zone

This zone is on the lower slopes, on sandstone with shallow soil, and mainly on north-facing aspects.

Yellow Gum *(Eucalyptus leucoxylon)* 'climbing well up the steep rocky banks.... has not been noticed on the plains' (Sutton, 1916).

Willis (1964) excluded this species from his basalt plains list. All surviving examples known including a single tree in the Park and a stump confirmed to be of the species are on warm sandstone slopes. In the Park, a single *Zygophyllum glaucum* (Pale Twin-leaf) grew near the Yellow Gum, and on similar sites there were a few *Ptilotus spathulatus* (Pussy-tails), *Maireana enchylaenoides* (Wingless Bluebush), *Enneapogon nigricans* (Pappus Grass) and *Dichanthium sericeum.*

Beyond the Park, other species accompanying Yellow Gum included *Senna artemisioides* (Desert Cassia), *Eremophila deserti, Acacia pycnantha* (Golden wattle), *Rhagodia parabolica* (Fragrant saltbush), *Acacia acinacea, Einadia hastata* (Saloop), *Einadia nutans* and *Exocarpus cupressiformis.*

Grasses that have been established or naturally recolonised include *Enneapogon nigricans, Dichanthium sericeum* and some *Danthonia* species.

Grey Box Zone

In the Park this zone is on basalt soils that allow good drainage without drying out too rapidly in summer.

Grey Box *(Eucalyptus microcarpa)* ,'....not found on the sands or Silurian, is next in importance to the redgum, and is somewhat exclusive. It is sparingly distributed over the eastern part (of the plains) but .... near Melton and Bulla it forms open, pure forests of limited extent' (Sutton 1916).

No Grey Box remained in the Park, but it is still well represented near Bulla and a group survives in the valley within 1km of the park. Good drainage and at least moderate soil depth seem important for the Grey Box (Wilk *et al.* 1978). Two selected areas of dark basalt soil with moderate southerly slope have proved successful whilst a third, on heavier soil, has resulted in slow growth.

Except for some *Danthonia* spp, no native plants are recorded as survivors in this zone. But near Bulla, Grey Box is accompanied by a few *Allocasuarina verticillata* (Drooping She-oak), *Acacia implexa, Acacia pycnantha, Acacia acinacea, Acacia paradoxa* (Hedge Wattle), and *Bursaria spinosa*. A wide variety of grasses and forbs may be found with the Grey Box at Bulla, including *Themeda triandra, Danthonia* spp. and *Stipa* spp. (Spear-grasses), *Dianella* spp (Flax-lilies), saltbushes (Chenopodiaceae), *Brachyscome dentata* (Lobe-seed Daisy) and *Wahlenbergia communis* (Tufted Bluebell).

Lightwood Zone

This zone occurs on the harsh, windswept rocky slopes of the upper parts of valleys where there is often little soil. There may be many cracks in the basalt or loose rubble.

Lightwood *(Acacia implexa)* is still fairly widespread on the Keilor Plains in this habitat. In the Park, there were still a few Lightwoods, and in places *Dodonaea viscosa* ssp. *cuneata* (Wedge-leaf Hopbush), *Clematis microphylla* (Small-leaf Clematis), *Wahlenbergia communis, Dianella revoluta* (Black-anther Flax-lily), *Pleurosorus rutifolius* (Blanket Fern), *Cheilanthes distans* (Bristly Cloak-Fern) and *Pellaea falcata* (Sickle Fern). Sutton (1916) noted ferns in the basaltic columns and amongst rocks. More recently, following weed control, *Nicotiana suaveolens* (Austral Tobacco) became evident as did grasses including *Dichanthium sericeum, Bothriochloa macra* (Redleg Grass), *Stipa* spp, and *Danthonia setacea* (Bristly Wallaby-grass).

Plants noted on similar sites outside the Park (Nicholls 1942) include *Bursaria spinosa, Hymenanthera dentata* and the Murray Pine *(Callitris glaucophylla). Correa glabra* (Rock Correa) is sometimes found tucked under rock outcrops and *Clematis microphylla* is common, scrambling over rocks and shrubs.

She-oak Zone

Our selected zone includes the shallow soils of the upper valley-slopes and extends a short distance onto the plains.

'....belts of sheoaks *[A. verticillata]* on the uplands above, extend along each side of the river....' Batey (1907a).

'The Casuarina *[A. verticillata]* were undoubtedly more numerous in the past .... 'Sutton (1916).

A. verticillata was a widespread but unevenly distributed component of the plains flora (Batey 1907a; Sutton 1916). Early survey maps show the immediate vicinity of the Park to have been thinly wooded with She-oak and there were extensive stands 5-10 km to the north. Not many She-oaks have survived ['being a principal timber tree... have almost disappeared' (Batey 1907a)], none closer to the Park than about 3 km (Kemp 1987). The evidence suggests they preferred well-drained areas on low hills and the edges of valleys, occasionally in the gorges and sparsely over the plains (Sutton 1916).

In this habitat within the Park, few native plants except *Danthonia* spp, and *Dichondra repens* (Kidney-weed) survived. *Dichanthium sericeum* is now spreading into the zone.

Outside the Park, no good examples of *Allocasuarina* woodland could be found. With the exception of *Callitris glaucophylla* and *Correa glabra,* plants from the Lightwood zone were sometimes seen on sites similar to the She-oak zone in the Park.

We believe this zone is the transitional area bordering the largely herbaceous tracts dominating the plains, and thus would have included areas where *Allocasuarina* and other woody plants were scattered, and *Themeda* grassland was prominent.

Grassland Zone

This zone comprises the heavy-soiled, poorly-drained surface of the basalt plains.

The Keilor plains are described as having always been open, dry tussock grassland with many herbs and few woody species (Sutton 1916; Willis 1964).

'..from early October....the grassland is transformed into carpets of colour - chiefly yellow or white from the massed blooms of *Bulbine, Anguillaria, Goodenia, Brachycome, Calocephalus, Craspedia, Podolepis, Leptorhynchos* and *Helichrysum* species.' (Willis 1964).

Even on these apparently featureless plains there are subtleties of plant distribution caused by drainage patterns and other factors that require further research. Plants which favour the better drained areas include *Pimelea glauca* (Smooth Rice-flower), *Kennedia prostrata* (Running Postman), *Ptilotus* spp., *Chrysocephalum semipapposum* (Clustered Everlasting), *Dillwynia cinerascens* (Grey Parrot-pea), *Convolvulus erubescens* (Blushing Bindweed), *Eryngium ovinum* (Blue Devil) and *Vittadinia cuneata* (New Holland Daisy). Among plants which favour wetter sites are *Mentha diemenica* (Slender Mint), *Craspedia glauca* (Billy Buttons), *Helichrysum rutidolepis* (Pale Everlasting), *Brachyscome basaltica* (Basalt Daisy), *Haloragis heterophylla* (Varied Raspwort), *Calotis* spp (Burr Daisies), *Eryngium vesiculosum* (Prickfoot), and *Juncus flavidus* (Yellow Rush).

Increased efforts are now being made to re-establish the wide range of herbaceous and small woody plants which still precariously survive on the plains. In the original Park few areas were suitable. Early attempts with transplants and seedlings were unsuccessful due to problems such as moisture stress in the first summer and competition from weeds that germinate when the soil is disturbed. Newly established areas of *Themeda triandra* (Kangaroo Grass) are providing a more suitable environment for further re-introductions (McDougall 1989). There is also natural recovery of native grasses notably *Danthonia* spp. on the selected site.

A cultivated plot containing some of the grassland species has been established to secure a seed source, and there are plans to focus more attention on re-creating an area of grassland vegetation, with particular emphasis on rare species. Some expected additions to the Park may allow extension of this work.

Special Zones

These zones are areas where there are unusual conditions or a range of conditions within a small area. Not all of these have been defined on the plan (Fig. 3), but their special nature is self evident, e.g. the features known as Rosette Rock and the Tessellated Pavement. Surviving precariously on Rosette Rock are *Helipterum anthemoides* (Chamomile Sunray) and *Pelargonium australe* (Austral Stork's-bill). Their survival there is believed to be not solely because they are out of reach of grazing animals, as both have been noted on similar rocky slopes, but not on rail reserves or other 'plains' areas. *Bulbine bulbosa* appears on basalt cliffs in the Park, both of northerly and southerly exposure, and is also found on the plains. The rocky pavements are home to several interesting plants, including *Calytrix tetragona* (Fringe Myrtle), found locally on only a few similar creek-side basalt outcrops, and *Tripogon loliiformis* (Rye Beetle-grass) a diminutive 'resurrection' grass, which is regarded as being rare in Victoria.

Twenty Years of Revegetation

Discussion

The visual changes have been so dramatic that visitors to the Park are surprised when told that twenty years ago the site was covered with boxthorn, thistles and rubbish. To a large extent, the natural appearance of the Park is due to the zoning system which guided selection and placement of seedlings. It is interesting to note that in some areas where spacing plants too closely was suspected, self sown seedlings are filling the gaps.

Animals which frequented the area in the past are returning, including species no longer recorded in the area by 1846 (Batey 1907b) such as Eastern Grey Kangaroo *(Macropus giganteus)*, Swamp Wallaby *(Wallabia bicolor)* and Short-beaked Echidna *(Tachyglossus aculeatus)*. The recent successful re-introduction of Sugar Gliders *(Petaurus breviceps)* is an indication of the extent to which fauna habitat has been restored. There have been large increases in bird sightings, which now number eighty five species. FOOPS have installed bird and bat boxes to encourage further increases in fauna numbers.

The planting zones would have failed without the continuous weed control work done by the Park staff. The soil seed-bank is such that the above-ground removal of one weed such as Artichoke Thistle is usually followed by germination of another such as Phalaris *(Phalaris aquatica)* and Serrated Tussock *(Nassella trichotoma)*.

In total 124 native plant species, including 17 classed as rare in the Melbourne area (Beauglehole 1983), have been recorded in the Park since it was proclaimed; 58 other indigenous species (propagated from local material) have been re-established since and persist.

A high survival rate has been achieved even though the plants are left to themselves after planting in wire and hessian frames. A number of species are self-seeding including *Acacia paradoxa, Eucalyptus microcarpa, Einadia nutans, Themeda triandra, Dichanthium sericeum* and *Acacia retinodes*. The FOOPS are currently studying species which are not self-seeding. For the last two years a detailed analysis has been undertaken to discover why *Allocasuarina verticillata* has produced only a few seedlings in the Park.

The planting zones have proved worthwhile for planning restoration of plant communities in Organ Pipes National Park as they enabled simple locating of plants rather than complex individual plans for hundreds of different species. The understorey in the planting zones must be now added. It was neglected in the first plantings and will be a great challenge over the coming decades. Further work is also needed in the grassland zone. New techniques will have to be developed to successfully replace the abundant perennial weed grasses by the natural native herbs of each planting zone.

Conclusion

When the Organ Pipes National Park was declared in 1972 it had long been famous for its geological significance (Rosengren 1987). Today the Park could be seen as equally valuable for its botanical significance and as an example of restoration of an indigenous plant community. The age of the project and its pioneering policy of using solely indigenous species is an excellent model for other revegetation projects.

The revegetation project at the Organ Pipes has been an outstanding success as indicated by the diversity of indigenous species now found in the Park.

A complete list of plant species in the Organ Pipes National Park compiled by Barry Kemp, Rosemary Myers, Lindsay Jolley and Keith McDougal was published in 'A guide for teachers and visitors' 1992 by the Department of Conservation and Environment.

Woodlands of trees and shrubs now provide excellent habitat for native fauna where 20 years ago noxious weeds and rabbits prevailed. Natural regeneration of trees and shrubs is now occurring where the rabbit population has been controlled, but these pests are still a major problem. Native grasses particularly *Dichanthium sericeum, Bothriochloa macra* and *Danthonia* spp. are naturally spreading, whilst *Themeda triandra* and a growing list of herbs have been re-established. Recently added properties will allow scope for many more re-introductions.

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References

Anon (1982). Organ Pipes National Park-10 years on. *Trees and Victoria's Resources* **24 (1)**: 5-9.

Batey, I. (1907a). The animal life of the Sunbury district sixty years ago. *The Victorian Naturalist* **24**: 69-74.

Batey, I. (1907b). On 15,000 acres in the Sunbury district, its bird life sixty years ago. *The Emu* **7**: 1-17.

Bureau Of Meteorology, Australia (1990). 'Climatic Averages,Victoria'. (Australian Government Publishing Service: Canberra.)

Beauglehole, A.C. (1983). 'The distribution and conservation of vascular plants in the Melbourne area,Victoria'. (Western Victorian Field Naturalists Clubs Association: Portland.)

Edwards, G. (1974). Organ Pipes National Park - a study in applied conservation. *Victoria's Resources* **16 (1)**: 21.

Forster, G. Hallam, M. and Moore, R.M. (1975). 'Vegetation in an Urban Environment. A Study of the Western Surrounds Of Melbourne for the Department of Urban and Regional Development'. (CSIRO Division of Land Use Research: Canberra.)

Garnet, J.R. (1961). The Sydenham Organ Pipes. *The Victorian Naturalist*, **77**: 333-334.

Hall, T.S.(1900). Excursion to Sydenham. *The Victorian Naturalist*, **17**: 120-122.

Kemp, B. (1987). The Sheoaks of Glencoe Station. *FOOP Newsletter* **11**: March

James, A.V.G. (1920). The physiography and geology of the Bulla-Sydenham area. *Proceedings of the Royal Society of Victoria* **32**: 323-349.

McDougall, K.L. (1987). 'Sites of Botanical Significance in the Western Region of Melbourne.' (Melbourne Western Region Commission Incorporated: Melbourne.)

McDougall, K. (1989). 'The re-establishment of *Themeda triandra*: Implications for the restoration of grassland', *Arthur Rylah Institute for Environmental Research Technical Report Series* No. 89. (Department of Conservation, Forests and Lands: Melbourne.)

Mollison, A.F. (1980). 'An Overland Diary from Uriana Station on the Murrumbidgee to Port Phillip, 1837'. (Mast Gully Press.)

Nicholls, W.H. (1942). The lone pines of Jacksons Creek. *The Victorian Naturalist* **58**: 139.

Patton, R.T. (1935). Ecological studies in Victoria Part IV: Basalt Plains Association. *Proceedings of the Royal Society of Victoria*. **48**: 172-191.

Rayner, C., Marsh, D.W., and Kemp, B. (1984). Keilor Plains flora - a battle against extinction. *Parkwatch* **139**: 12-14.

Robinson G.A. (1840/1841), 'Journals of George Augustus Robinson' ed N.J.B. Plomley.

Rosengren, N.J. (1987). 'Sites of Geological and Geomorphological Significance in the Western Region of Melbourne.' (Melbourne Western Region Commission Incorporated: Melbourne.)

Smith, L.H. (1972). Re-vegetation Of Organ Pipes National Park, Interim Policy. Un-published letter by National Park Service Victoria.

Sutton, C.S. (1916). A sketch of the Keilor Plains flora. *The Victorian Naturalist* **33**: 112-123.

Sutton, C.S. (1917). A sketch of the Keilor Plains flora. *The Victorian Naturalist* **33**: 128-143.

Sutton, C.S. and Armitage, R.W. (1911). Excursion to Sydenham, Bulla and Diggers Rest. *The Victorian Naturalist* **28**: 51-56.

Wilk R., Rennick, P. and Jolley, L. (1978). 'Inventory of Geology, Soils, Climate, Water resources and Physiography of Organ Pipes National Park'. Unpublished Report to National Parks Service: Victoria.

Willis, J.H. (1964). Vegetation of the basalt plains in Western Victoria. *Proceedings of the Royal Society of Victoria* **77**: 397-418.

Government printer (1975). National Parks Act.

Government printer (1988). National Parks Policy and Procedures Manual 2.2.3p. Planting in parks.

Further reading

Bibliography Organ Pipes National Park, Historical, Flora, Fauna (in preparation).

FOOPS Journal. Bender R. (ed) (in preparation).

Fauna Survey Group Contribution No. 16

Notes on the Fauna of a Small Western Plains Woodland Remnant near Winchelsea, Victoria.

L.E. Conole*

Abstract

Casual and limited observations were made of fauna occurring in a small woodland remnant on the western plains near Winchelsea, Victoria. The woodland includes one of the last identifiable remnants of the Drooping She-oak *(Allocasuarina verticillata)* community that previously occurred along the coastal plains/volcanic plains ecotone east to Port Phillip Bay at Williamstown (Damien Cook pers. comm.). The remainder is grassy woodland of Manna Gum *(Eucalyptus viminalis)* and Sweet Bursaria (*Bursaria spinosa* var. *macrophylla*). A total of 16 species of ants, eight species of butterflies, five species of frogs, two species of reptiles, 37 species of birds and six species of mammals were recorded. These preliminary results indicate the potential value of small, isolated, native vegetation remnants for biological conservation, and point to the continuation of natural ecological processes in such small remnants.

Introduction

The landscape between Geelong and Winchelsea has been comprehensively cleared for agriculture since European settlement. Areas of remnant natural vegetation are few, and are clustered around natural topographical features such as the Barwon River, and constructed features such as rail lines and roads. These remnant natural vegetation communities are valuable sites for the continued survival and conservation of indigenous plant and animal species. Native grassland and grassy woodland are the most threatened ecosystems in Australia, and only 0.5% of the original extent of these grassy ecosystems remain in Victoria (Lunt 1991).

The brief investigation of biological resources of a block of grassy woodland near Winchelsea reported herein, was conducted in support of a local community's desire to see the privately owned block transferred into public ownership as a conservation and education reserve.

This 2.8 hectare linear block of grassland and grassy woodland lies 6 kilometres east of Winchelsea on the Princes Highway, at the junction with Buckley School Road at the base of the road bridge over the Geelong-Warrnambool rail line. At the western end, a large area now covered with Kangaroo Grass *(Themeda triandra)* (similar to the adjacent rail reserve) was scraped during the building of the road bridge. Progressing east through an area of Manna Gum *(Eucalyptus viminalis)* woodland with scattered Sweet Bursaria *(Bursaria spinosa* var. *macrophylla)*, Black Wattle *(Acacia mearnsii)* and Silver Wattle *(A. dealbata)*, the eastern end has denser woodland in the form of an almost pure stand of Drooping She-oak *(Allocasuarina verticillata)*. An ephemeral wetland on the rail reserve encroaches slightly onto the block, and contains such characteristic aquatic species as Water-milfoil *(Myriophyllum elatinoides)*. A more exhaustive description of the vegetation can be found in Conole, Cook, Lynch and Stewart (in preparation).

Survey Methods

Casual observations and brief searches for fauna in the block were conducted on 21 July, 13 October and 22 November 1991, 22 November 1992 and 28 January 1993 (Table 1). Birds seen and heard in

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Table 1. Species Recorded

CLASS INSECTA
ORDER HYMENOPTERA
FAMILY FORMICIDAE
SUB-FAMILY MYRMECIINAE
Myrmecia cf. *rectidans* (*'mandibularis'* GROUP)
Myrmecia pyriformis Bulldog Ant
Myrmecia 'pilosula' Jumping Jack
SUB-FAMILY PONERINAE
Rhytidoponera tasmaniensis
Rhytidoponera victoriae
Trachymesopus sp.
SUB-FAMILY MYRMICINAE
Crematogaster sp.
SUB-FAMILY FORMICINAE
Campanotus 'consobrinus' Sugar Ant
SUB-FAMILY DOLICHODERINAE
Dolichoderus "australis"
Dolichoderus "scabridus"
Iridomyrmex sp.
Iridomyrmex "purpureus" Meat Ant
**Iridomyrmex humilus* Argentine Ant
Iridomyrmex "bicknelli"
Iridomyrmex "foetans"
Technomyrmex sp.
ORDER LEPIDOPTERA
FAMILY NYMPHALIDAE
Vanessa itea Australian Admiral
Vanessa kershawi Australian Painted Lady
Junonia villida Meadow Argus
Heteronympha merope Common Brown
FAMILY PIERIDAE
**Pieris rapae* Cabbage White
Anaphaeis java Caper White
FAMILY LYCAENIDAE
Paralucia aurifera Bright Copper
Zizina labradus Common Grass Blue

CLASS AMPHIBA
ORDER SALIENTA
FAMILY HYLIDAE
Litoria ewingii Southern Brown Tree-frog
FAMILY MYOBATRACHIDAE
Crinia signifera Common Eastern Froglet
Limnodynastes dumerilii Pobblebonk
Limnodynastes tasmaniensis Spotted Marsh Frog
Limnodynastes peronii Striped Marsh Frog

CLASS REPTILIA
ORDER SQUAMATA
FAMILY SCINCIDAE
Tiliqua scincoides Common Blue-tongued Lizard
Pseudemoia extrecasteauxii Tussock Skink

CLASS AVES
White-faced Heron *Ardea novaehollandiae*
Straw-necked Ibis *Threskiornis spinicollis*
Great Cormorant *Phalacrocorax carbo*
Little Pied Cormorant *Phalacrocorax melanoleucos*
Australian Shelduck *Tadorna tadornoides*
Black Swan *Cygnus atratus*
Brown Falcon *Falco berigora*
Australian Kestrel *Falco cenchroides*
Black-shouldered Kite *Elanus notatus*
Stubble Quail *Coturnix novaezelandiae*
Yellow-tailed Black-Cockatoo *Calyptorhynchus funereus*
Sulphur-crested Cockatoo *Cacatua galerita*
Long-billed Corella *Cacatua tenuirostris*
Galah *Cacatua roseicapilla*
Red-rumped Parrot *Psephotus haematonotus*
Crimson Rosella *Platycercus elegans*
Eastern Rosella *Platycercus eximius*
Welcome Swallow *Hirundo neoxena*
*Skylark *Alauda arvensis*
Black-faced Cuckoo-shrike *Coracina novaehollandiae*
*Blackbird *Turdus merula*
Willie Wagtail *Rhipidura leucophrys*
Grey Shrike-thrush *Colluricincla harmonica*
Superb Fairy-wren *Malurus cyaneus*
Yellow-rumped Thornbill *Acanthiza chrysorrhoea*
White-plumed Honeyeater *Lichenostomus penicillatus*
Yellow-faced Honeyeater *Lichenostomus chrysops*
Red Wattlebird *Anthochaera carunculata*
Noisy Miner *Manorina melanocephala*
Red-browed Firetail *Emblema temporalis*
*House Sparrow *Passer domesticus*
*European Goldfinch *Carduelis carduelis*
*Common Starling *Sturnus vulgaris*
Australian Magpie-lark *Grallina cyanoleuca*
Australian Magpie *Gymnorhina tibicen*
Australian Raven *Corvus coronoides*
Little Raven *Corvus mellori*

CLASS MAMMALIA
Common Brushtail Possum *Trichosurus vulpecula*
*Brown Rat *Rattus norvegicus*
*European Rabbit *Oryctolagus cuniculus*
*Fox *Vulpes vulpes*
*Cat *Felis catus*
White-striped Mastiff-bat *Tadarida australis*

the block were noted, as were those flying overhead. Mammals were detected both directly and by indirect signs such as skeletal remains, scats and vocalisation recognition. Reptiles and amphibians were found under rocks and timber, or by vocalisation recognition. Butterflies were hand caught or recognised in flight, and identified using the standard reference of Common and Waterhouse (1982). Collections of ants were made in October 1991 and November 1992, and identified using Anderson (1991) for most taxa, and Clark (1951) for finer resolution of the Myrmeciinae. Some reference was also made to Greenslade (1979).

Discussion

These results are clearly an incomplete inventory of the fauna of the block, as comparatively little survey effort was expended, and no spotlight survey or live trapping was included. It is equally clear though that a number of native fauna species utilise this 2.8 hectare block in some way, including some that only visit for foraging purposes. Little can be concluded from these results other than that the block represents an important island of semi-natural habitat in a vast agricultural area.

The total of 37 species of birds recorded is higher than the average of 30 species for blocks of 2 to 20 hectares in the Geelong area (Conole in preparation). However, the proportion of farmland and wetland birds is higher at this block than at others surveyed.

Birds such as Yellow-tailed Black-Cockatoos visit from the Otway Ranges to the south to feed on fruit of the Drooping She-oak, and other parrots roost in trees on the block. The Common Brushtail Possum is probably a resident, although the aerial feeding White-striped Mastiff-bat and Welcome Swallow may only forage overhead, perhaps roosting elsewhere. The White-faced Heron and Straw-necked Ibis forage in the small wetland, and like other transient visitors such as the Grey Shrike-thrush and Red Wattlebird, are not resident there. White-plumed Honeyeaters are present most of the time, as are the ubiquitous Noisy Miners. The frogs and reptiles are resident, as are most of the insects. There are ongoing natural ecological processes occurring within the remnant grassy woodland ecosystem of the block.

The element of the fauna that has the greatest potential as an indicator of the degradation of the ecosystem, and of monitoring its condition in future, is the ant fauna. I recorded 16 epigaeic species in approximately 2.5 hours of searching on the ground for worker ants, but made no attempt to survey nocturnal, arboreal or cryptic species. Using methods such as those described by Anderson (1990) to evaluate change in terrestrial ecosystems would be a viable technique for evaluating and monitoring environmental change at the Winchelsea block, as ants are easily collected and lend themselves especially well to the monitoring task. Two species of *Rhytidoponera* were detected during the survey, and this genus is a particularly sensitive indicator of disturbance (Anderson 1990). However, *Myrmecia* which seems less suited to highly disturbed environments is still represented by at least three species *(M. rectidans, M. pyriformis, M. pilosula).*

A co-ordinated effort by local residents (with support of the landowner), Colac region of the Department of Conservation and Natural Resources and the Victoria Conservation Trust is proceeding to have the block acquired as a Crown Land nature conservation reserve. The Fauna Survey Group assisted this effort by surveying the biota on the block.

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References

Anderson, A.N. (1990). The use of ant communities to evaluate change in Australian terrestrial ecosystems: a review and a recipe. *Proceedings of the Ecological Society of Australia* **16**: 347-357.

Anderson, A.N. (1991). *'The Ants of Southern Australia'* (CSIRO: Melbourne.)

Clark, J. (1951) *'The Formicidae of Australia, Volume 1, Subfamily Myrmeciinae'* (CSIRO: Melbourne.)

Common, I.F.B. and Waterhouse, D.F. (1982) *'Butterflies of Australia (Field Edition)'*. (Angus & Robertson: Sydney.)

Conole, L.E. (in prep.). Birds of grassy woodland remnants in the Geelong area, south-west Victoria.

Conole, L.E., Cook, D., Lynch, P. and Stewart, J. (in preparation). Notes on the flora of a small western plains woodland remnant near Winchelsea, Victoria.

Greenslade, P.J.M. (1979) *'A Guide to Ants of South Australia'* (South Australian Museum: Adelaide.)

Lunt, I.D. (1991). Management of remnant lowland grasslands and grassy woodlands for nature conservation: a review. *The Victorian Naturalist* **108**(3): 56-66.

A Short Flora Conservation History of Waverley, A South Eastern Suburb of Melbourne, Victoria

A. Salkin*

The south eastern suburbs of Melbourne have a diverse flora, this is partly due to a slightly higher than average rainfall, but also to a variety of soil types and the dissected nature of the topography.

My first introduction to Waverley was in June, 1949 shortly after I arrived in Australia as a migrant from Britain. My brother and I had brought our lightweight bicycles with us and were on our way to the Dandenongs. We had cycled from St. Kilda, where we were boarding, one Sunday morning and had ridden past Warrigal Road while on Waverley Road. A short way after leaving Warrigal Road a man was building a house on Waverley Road and we wondered why anyone would build a house so far from the trams and trains. Little did I realise 10 years later I would buy a house four kilometres further along this quiet country road.

In 1949 Waverley was predominantly rural with some housing and a few shops at the nodes of the single line railway. Waverley Road was lined with trees and shrubs and there were few weeds. The main land-use was market gardens on the sandy soils that capped some of the hills and ridges, and orchards, and a few dairies on the clay soils derived from Silurian mudstones. At that time having been in Australia less than a month we were only just aware of the complexity of the bush; indeed when told on the ship by an Australian returning from Europe, that the 'bush' started five miles out of Melbourne we had a mind picture of a city encircled by some small bushes. We were therefore not prepared for the complexity of the sclerophyll woodland. The main impression we had of Waverley was the variety of wattles which were flowering at that time of the year.

* 38 Pinewood Drive, Mt. Waverley, 3149.

In early 1960 when my wife Esma and I moved to Mt. Waverley it could still be termed rural with many orchards and market gardens still in operation. But as the price of land increased the incentive to sell the farm became greater. There was also pressure to 'develop' land that was still under natural vegetation. Living close to these complex natural systems we sought to increase our knowledge about them. Our first introduction to the network of native plant growing and conservation was at a Nature Show which at that time was a joint effort by the Victorian Field Naturalists and the Society for Growing Australian Plants. The outcome of this was that we became members of The Society for Growing Australian Plants (S.G.A.P.) because our interest was mainly in growing plants and it was not until 1976 that we became members of the Field Naturalists.

Shortly after joining SGAP we started the Waverley group. Most of the members like ourselves appreciated the local flora and as part of our study we began a census of plants of the area. I recall that on our first local field trip we invited a young lady botanist who was a member of the Victorian Field Naturalists, to assist with the identification of specimens. On her advice we established the method for collecting and recording plants, of pressing duplicate specimens and numbering them, one specimen we kept for our own herbarium and the other was sent for identification to the Victorian National Herbarium. It was by sending plants to be identified that I first came in contact with Jim Willis, who must be the most generous of botanists. Our own herbarium now has 250 mounted specimens to which new species are still being added.

The first area we surveyed was at the end of Charles Street, north of the railway line.

Some of this area is still a reserve - the Portsmouth Street Reserve - which still has a good collection of original vegetation including a rich ground flora (Fig. 1 Map of City of Waverley Reserves).

In 1964 I joined the staff of the embryonic Mt. Waverley High School, in the sense that we spent 2 years in portable class rooms in the grounds of Glen Waverley High School. The site chosen for Mt. Waverley High School was one of the head waters of Damper Creek. In 1964, because of its topography, it was a place where most of the common plants of the district could be found. It was also a place where some of the rarer plants grew including *Sphaerlobium vimineum*, *Brunonia australis*, and the rare and unusual Elbow Orchid *Cryptostylis subulatus*. Most of the vegetation disappeared under fill which was used to make the playing fields, but a narrow strip of rich vegetation was retained along the northern boundary and still has many of the original plants.

As the local plant group developed the suburb began to change. The Waverley golf course which had many species not found elsewhere was sold for housing. It became very clear that unless we took political action there would be little left of the native vegetation. Much of the campaign to retain natural bushland was conducted through the local paper, the 'Waverley Gazette', and with letters to councillors. We also formed a study group within the Waverley S.G.A.P. called FLOWA, this being an acronym for Flora of Waverley.

Members were given the task of monitoring the various reserves and the first of our plant lists was produced. Members were also encouraged to grow plants from seed and cuttings from the local area and a recording sheet was designed for this purpose. A number of members still have plants from this early period and at least two of these plants are different from the normal forms. *Spyridium parvifolium* from Dandenong Creek is more elongated than the usual form and *Tetratheca ciliata* from the Deviation has a whorl of four leaves on the stems instead of the usual three. These plants as well as many other local forms are still being propagated by members and are being returned to local bushland.

Our first list of plants from surveys between 1960-67 was published in the Waverley S.G.A.P. Newsletter in May 1974. In 1979 we published a Supplement to the Waverley SGAP Newsletter entitled 'A Survey of Areas in the Waverley District Where Indigenous Vegetation Still Remains', this listed 172 plants from 7 areas, and included a map and a summary of where the plants could be found. In 1989 we revised this list as a computer print out, an alphabetical list of 233 species. The latest list of 1992 is also a computer generated list with common names as well as Latin binomials and includes the reserves in which they are found and has 288 species (Table 1, Fig. 1).

In 1982 we became concerned with the deterioration of the Valley Reserve, one of the largest reserves, and proposed to the Waverley Council that a group should be formed to work in the reserve on a program of erosion control, weeding and replanting. The Waverley Council agreed that the group to be known as 'The Friends of the Valley Reserve', should weed and replant in the Valley Reserve as well as undertake minor erosion control work.

One of our major concerns was the mowing policy of the council. The mowing was done usually in early summer as a measure to prevent grass fires. We tried to persuade the council to leave areas of at least a couple of metres around trees, but although the council appreciated the need for this, the mower drivers had conditioned reflexes about how their job should be done, and the mowing was as close as ever. Eventually we persuaded the council that a large area should be left unmown until the Chocolate Lily *Arthropodium strictus* had produced seeds. The Chocolate Lily was the floral symbol of Waverley and the council was interested

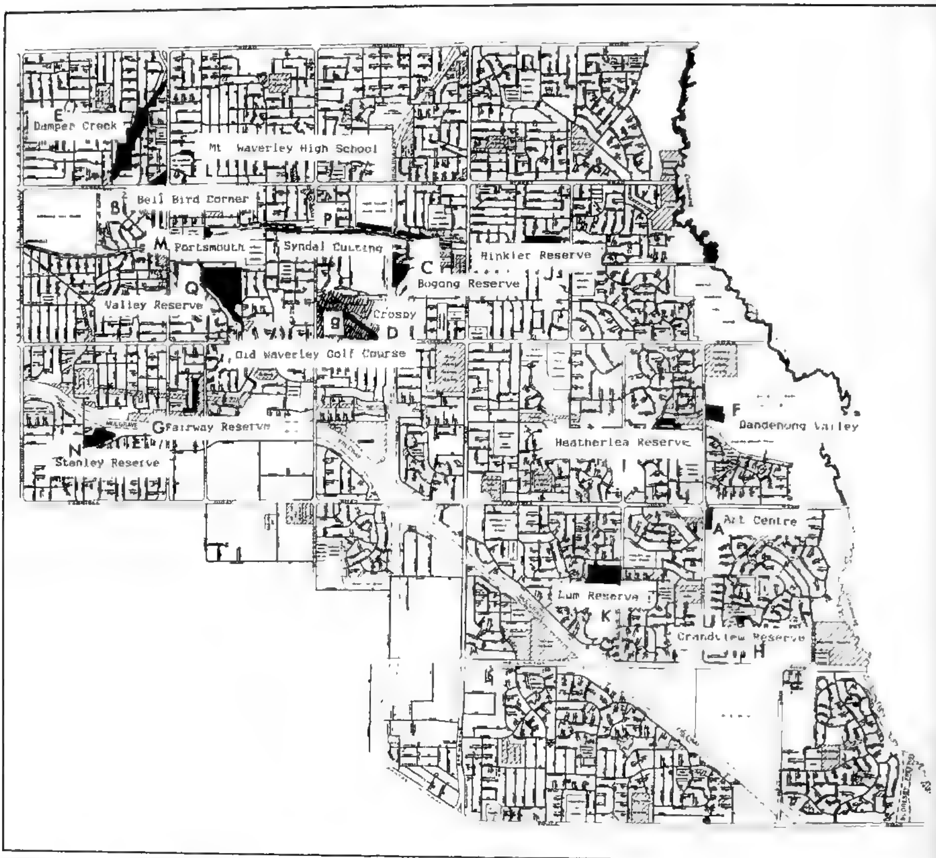

Fig. 1. City of Waverley Reserves.

in seeing it propagated from seed so, an area, where the boundary trees were marked with green paint, was set aside and no mowing took place. In fact no mowing occurred where there was natural ground flora. This was almost entirely due to the appointment of Michael Grant to the council workforce. His main objection to mowing areas of natural bushland was one of economics, it was simply not cost effective. Apart from this new philosophy from the gardens department a Group Manager for Works and Engineering was appointed who was sympathetic to the views of environmentalists.

The most important single event for the conservation of the Valley Reserve and the other areas of natural vegetation in Waverley was a grant from 'Go Green' of $15,000 to The Friends. The grant was from The Eastern Area Improvement Program and was for community participation in determining and implementing improvements to the reserve. This enabled us to fence off a number of areas to help regeneration as well as provide a large tree planting program in areas that were badly weed infested. The council matched this grant by allocating $53,000 for major works on erosion control, planting, and fencing of sensitive areas. At present the car park and entrance are being redesigned and a gardener who has training in conservation and regeneration has been assigned full time to the reserve.

Whilst the Valley Reserve is a major reserve the cost of restoring it and the effort that has been put into it gives some idea of what needs to be done to some of the other large reserves. It is true that

Melbourne Water has a friends group for the Dandenong Valley, and the capacity to fund large improvement programs, but for many of the other reserves it would appear that in any community there are only a certain number of people who are willing, sensitive enough, and have time to work at the gentle art of habitat restoration.

Bibliography

Bridgewater, P.B. and Wellington, B. (1976). Vegetation in the south-eastern suburbs, Melbourne. 2. Native and introduced plant communities in a Mount Waverley reserve. *The Victorian Naturalist* **93:** 113-117.

Costerman, L. (1981). 'Native Trees and Shrubs of South-eastern Australia'. (Rigby: Adelaide.)

Farr, F., Salkin, A. and Salkin, E. (1983). 'The Valley Reserve, Plants History, Birds'. Friends of Valley Reserves and City of Waverley.

Indigenotes (1990-1992). Newsletter of the Indigenous Flora and Fauna Association.

Willis, J.H. (1962-1972). 'A Handbook to Plants in Victoria' Vols. 1 and 2. (Melbourne University Press: Melbourne.)

A CHECKLIST OF THE INDIGENOUS FLORA OF THE WAVERLEY DISTRICT

Revised 1993 by Alf Salkin.

This table lists plants recorded in the Waverley area by location:

A Arts Centre	G Fairway Reserve	L Mt Wvly 2ry College
B Bellbird Corner	g = old Waverley Golf Course	M Portsmouth St
C Bogong Ave	H Grandview Ave	N Stanley Ave
D Crosby Drive	I Heatherlea Res	O Sunnybrook Dr
E Damper Creek	J Hinkler Reserve	P Syndal Rly Cutting
F Dandenong Vly	K Lum Reserve	Q Valley Reserve

o= occurred '93, *= ?disappeared, r= reintroduced, s= sp. unidentified, g= old golf course

LOCALITY

	Genus	Species	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	Acacia	aculeatissima	o					o										o	o
2	"	*armata* (syn. A. paradoxa)																	
3	"	dealbata						o											
4	"	genistifolia						o					o	o					o
5	"	implexa		o		o	o				o		o				o	o	o
6	"	leprosa						o											
7	"	mearnsii	o	o	o	o	o	o	o		o		o	o		o	o	o	o
8	"	melanoxylon		o	o	o	o	o	o	o	o		o	o		o	o	o	o
9	"	myrtifolia						o					o	o				o	o
10	"	oxycedrus*											o	o					
11	"	paradoxa	o		o	o	o	o	o					o	o	o	o	o	o
12	"	pycnantha					o	o			o		o					o	o
13	"	sophorae?																o	
14	"	verticillata var. ovoidea						o	o							o			o
15	Acaena	novae-zelandiae			o	o	o	o	o				o			o			o
16	"	echinata						o											
17	"	ovina	o		o		o	o			o				o				o
18	Acianthus	exertus																	o
19	Acrotiche	serrulata				o		o										o	o
20	Adiantum	aethiopicum	o			o		o	o					o		o			o
21	Agrostis	avenacea					o	o											o
22	Alisma	plantago-aquatica						o											o
23	Allocasuarina	littoralis	o					o		o	o		o			o			
24	"	paludosa						o											

	Genus	species	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
25	Alternanthera	denticulata																	
26	Amperea	xiphoclada*																	
27	Amyema	pendulum				s		o	s	s			s			s			o
28	Aotus	ericoides*																	
29	Aphelia	gracilis						o											
30	Astroloma	humifusum				o	o	o			o							o	
31	Banksia	marginata						o											
32	"	spinulosa var. cunninghamii	*																
33	Billardiera	scandens var. scandens			o			o			o		o	o	o			o	o
34	Bossiaea	cinerea	o			o													
35	"	prostrata					o	o	o					o					o
36	Brachyscome	cardiocarpa*																	o
37	"	decipiens*																	
38	"	multifida var. multifida												o					o
39	Brunonia	australis						o										o	
40	Burchardia	umbellata	o	o	o	o	o	o	o	o	o		o	o	o	o	o	o	o
41	Bursaria	spinosa var. spinosa	o	o	o	o	o	o	o	o	o		o	o	o	o	o	o	o
42	Caesia	parviflora var. parviflora				o		o						o					o
43	"	calliantha				o		o											o
44	Caledenia	carnea*	*			g													
45	"	catenata*				g													
46	"	dilatata*	*			g													
47	"	patersonii*				g													
48	Caleana	major																	
49	Calystegia	sepium						o											
50	Carex	appressa				o		o											o
51	"	breviculmis				o													o
52	"	fascicularis						o											
53	"	gaudichaudiana						o											
54	"	inversa						o											
55	Cassinia	aculeata	o					o						o				o	o
56	"	arcuata			o	o	o	o	o				o		o		o	o	
57	"	longifolia																	o
58	Cassytha	glabella		s										s					
59	"	melantha						o											
60	"	pubescens						o	o					o	o				
61	*Casuarina* (syn. Allocasuarina sp.)		o								o								
62	Centella	cordifollia						o						o					o
63	Centipeda	minima						o											
64	Centrolepis	strigosa																	o
65	Chamaescilla	corymbosa						o											o
66	Chilogottis	valida																	o
67	Chionochloa	pallida																	
68	Chrysocephalum	semipapposum						o											o
69	Cladium	glomeratum					o												
70	Clematis	aristata				o		o	o				o	o					o
71	"	microphylla						o						o					o
72	Comesperma	volubile						o											o
73	Coprosma	quadrifida				o		o	o										o
74	Correa	reflexa	o					o			o		o	o				o	o
75	Cotula	australis						o											o
76	Craspedia	glauca						o										o	

	Genus	species	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
77	Crassula	helmsii						o											
78	Cryptostylis	subulata*				g	*												
79	*Culcita*	*dubia* (syn. Calochlaena dubia)						o											
80	Cyperus	subulatus																	o
81	Danthonia	caespitosa		s	s	g		o	s	s	s		s	s	s	s	s		o
82	"	geniculata	o			g	o											o	o
83	"	laevis				g	o											o	o
84	"	linkii var. fulva				g		o											
85	"	penicillata				g													o
86	"	*pallida* (syn.Chionochloa pallida)				g		o											o
87	"	pilosa				g													
88	"	semiannularis				g		o											
89	"	racemosa				g						o		o					o
90	"	setacea				g												o	o
91	"	tenuior				g													o
92	Daucus	glochidiatus						o											
93	Daviesia	corymbosa?																	
94	"	latifolia				g		o			o			o	o			o	o
95	"	leptophylla			o	o		o			o			o				o	o
96	Deyuxia	quadriseta																	o
97	*Dianella*	*laevis* (syn. longifolia var. longifolia)				g								o					
98	"	longifolia var. longifolia				g		o											o
99	"	revoluta var. revoluta	o	o	o	o	o	o	o				o		o	o	o	o	o
100	Dichelachne	crinita				g	o	o											o
101	"	sieberiana					o	o											o
102	Dichondra	repens				g		o			o								o
103	*Dichopogon*	*strictus* (syn. Arthropodium strictus)	o		o	o	o	o.		o	o		o	o	o	o	o		o
104	Dillwynia	cinerascens				o	o	o						o				o	o
105	Dipodium	punctatum*	*			g													
106	Diuris	corymbosa				g													
107	"	lanceolata				g													
108	"	pardina				g													
109	"	*maculata (syn. D. pardina)*																	
110	Drosera	peltata ssp. auriculata	o		o	o	o	o	o		o				o	o	o	o	O
111	"	whittakeri			o	g	o	o	o				o		o	o		o	o
112	Echinopogon	ovatus				g		o											
113	Egeria	canadensis?						o											
114	Eleocharis	gracilis							o										
115	"	sphacelata						o	o										
116	Epacris	impressa				g		o						o				o	o
117	Epilobium	billardierianum ssp. billardierum				g		o											
118	"	" spp cinereum						o											
119	Eucalyptus	aromophloia																	
120	"	cephalocarpa	o	o	o	o	o	o	o	o	o		o	o	o		o	o	o
121	"	goniocalyx			o	o	o	o											o
122	"	ignorabillis						o											
123	"	macrorhyncha	o	o	o	o	o	o	o		o		o	o		o	o		o

	Genus	species	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
124	"	melliodora		o		o	o	o	o				o				o		o
125	"	obliqua		o	o	o	o	o	o				o					o	o
126	"	ovata		o		o	o	o	o							o			o
127	"	pryoriana	o																
128	"	radiata	o		o	o	o	o	o	o	o		o			o	o	o	o
129	"	rubida						o											
130	"	viminalis				g		o	o							o			o
131	"	yarraensis						o											
132	Exocarpus	cupressiformis	o		o	o	o	o	o		o		o			o	o	o	o
133	Gastrodia	sesamoides*	*			g													
134	Geranium	solanderi				g									o				o
135	Gahnia	radula		o	o	o	o	o	o		o		o		o	o	o	o	o
136	Glossodia	major				g													
137	Glycine	clandestina						o			o								
138	*Gnaphalium*	*involucratum* (syn. Euchiton involucratus)				g		o							o				o
139	"	*sphaericum* (syn. Euchiton sphaericus)				g		o											o
140	Gonocarpus	micranthus			o	g		o											o
141	"	tetragynus				o	o	o		o	o		o		o		o		
142	Goodenia	humilis						o											
143	"	ovata				o		o	o					o		o			o
144	Goodia	lotifolia									r								
145	Gynatrix	pulchella						o	o										
146	Hakea	nodosa											r	o					o
147	"	sericea (syn. Hakea sp.)						o					r						o
148	"	ulicina												o					o
149	Haloragis	aspera				g													
150	"	heterophylla				g		o											
151	Hardenbergia	violacea				o	o	o	o									o	o
152	Helichrysum	dendroideum (syn. Ozothamnus ferrugineus)			o	g	o	o	o					o		o			o
153	"	scorpiodes				g		o						o					o
154	Helichrysum	semipapposum (syn. Chysocephalum semipapposum)						o						o					o
155	Hibbertia	stricta (var. stricta) (syn. H. riparia)																	
156	"	riparia	o			g		o						o				o	
157	Hovea	linearis				o		o							o			o	
158	Hydrocotyle	laxiflora				g		o											o
159	Hymenanthera	dentata						o								o			
160	Hypericum	gramineum			o	g		o											o
161	Hypoxis	glabella			o	g		o			o				o		o		o
162	"	hygrometrica				g													o
163	Indigofera	australis	o			g	o				r		r	o					
164	Isolepsis	cernua				g													o
165	"	inundata				g													o
166	"	nodosa				g		o											o
167	"	platycarpa				g	o	o											o
168	Juncus	amabilis				g	o	o											o
169	"	australis				g	o	o											o
170	"	bufonius				g	o	o											o
171	"	gregiflorus				g	o	o											o
172	"	holoschoenus				g	o	o											o
173	"	pallidus				g	o	o											o
174	"	pauciflorus				g	o	o											o

	Genus	species	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
175	"	planifolius				g	o	o											o
176	"	polyanthemos?																	o
177	"	prismatocarpus				g	o	o											o
178	"	procerus				g	o	o											o
179	"	sarophorus				g	o	o											o
180	"	subsecundus				g	o	o											o
181	"	usitatus				g	o	o											o
182	Kennedia	prostrata	o			g		o							o			o	o
183	Kunzea	ericoides	o		o	g		o	o										o
184	Lagenifera	gracilis				g													o
185	"	stipitata																	
186	Lastreopsis	acuminata						o											
187	Lemna	disperma						o											
188	"	minor*						o											
189	Lepidosperma	concavum				g													o
190	"	laterale *var. laterale* (syn. L. gunnii)				g		o											o
191	"	" *var. angustum* (syn. L. gunnii)				g		o											
192	Leptorhynchos	tenuifolius				o								o					
193	Leptospermum	continentale		o	o	g	o	o	o					o	o	o	o	o	o
194	"	*juniperinum* (syn. L. continentale)						o											
195	"	*phyllicoides* (syn. Kunzea ericoides)																	
196	Lindsaea	linearis				g		o											o
197	Lobelia	alata				g		o											o
198	Lomandra	filiformis	o	o	o	o	o	o	o	o	o		o		o	o	o	o	o
199	"	longifolia	o	o	o	o	o	o	o							o	o	o	o
200	"	multiflora						o											
201	"	nana	o		o	o	o	o	o							o			o
202	Luzula	meridionalis				g		o											o
203	Lycopus	australis						o											
204	Lythrum	hyssopifolia				g		o											
205	Melaleuca	ericifolia				o	o	o	o							o			o
206	Microlaena	stipoides				g	o	o	o					o					o
207	Microseris	scapigera*						*											
208	Microtis	parviflora				g		o							o				
209	Monotoca	scopara																	
210	Muellerina	eucalyptoides				g													o
211	Myosotis	australis						o											
212	Olearia	lirata						o											o
213	Opercularia	ovata						o											
214	"	varia						o											
215	Ottelia	ovalifolia						o											
216	Oxalis	perennans				g													o
217	Ozothamnus	ferrugineus						o											
218	Paspalum	distichum*						o											
219	Patersonia	*longiscarpa* (syn. P. occidentalis)																	
220	"	occidentalis				g		o						*					o
221	Persicaria	descipiens				g		o											
222	"	lapathifolia				g		o	o										o
223	Phragmites	australis						o											
224	"	*communis* (syn. P. australis)																	
225	Pimelia	humilis	o			o		o			o			o	o		o	o	o

	Genus	species	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
226	Plantago	varia				g		o											o
227	Platylobium	obtusangulum	o		o	o	o	o			o			o	o			o	o
228	Poa	labillardieri				g		o							s			o	
229	"	morrisii		o	o	o	o	o	o	o	o		o		o	o	o	o	
230	"	sp. aff. rodwayi						o											
231	Pomaderris	aspera						o											o
232	"	racemosa						o											
233	Poranthera	microphylla				g		o						o					o
234	Prostanthera	lasianthos			o		o	o											o
235	Prunella	vulgaris*				g		o											o
236	Pteridium	esculentum		o	o	o	o	o	o							o		o	o
237	Pterostylis	longifolia*				g		*											r
238	"	nutans			o	g		o					o		o				o
239	"	parviflora				g													
240	Pultenaea	paleacea var. sericea											o						
241	Pultenaea	gunnii				o		o											o
242	Ranunculus	lappaceus				g		o							o				o
243	Ricinocarpus	pinifolius						o					*						
244	Rorippa	laciniata						o											
245	Rubus	parvifolius				o		o											
246	Rumex	brownii						o											
247	Schoenus	apogon				g		o											o
248	Senecio	glomeratus				g													o
249	"	hispidulus				g					o		o						o
250	"	linearifolius				g		o											
251	"	quadridentatus				g		o			o								o
252	Solanum	aviculare					o	o	o										o
253	Solenogyne	gunnii				g													o
254	Sphaerolobium	vimineum*					*							*					
255	Spiranthes	sinensis																	o
256	Spyridium	parvifolium						o											
257	Stackhousia	monogyna				g		o										o	o
258	Stipa	*elatior* (syn. S. flavescens)				g		o											
259	"	flavescens				g	s				s		s		s	s	s		
260	"	pubinodis				g		o	o										o
261	"	rudis				g		o	o										
262	"	semibarbata				g													o
263	Stylidium	graminifolium				g								o		o	o	o	o
264	"	inundatum						o											
265	*Stypandra*	*caespitosa* (syn. Thelonema caespitosa)				g		o											
266	Tetragona	implexicoma				g		o											
267	Tetratheca	ciliata	*			g												*	r
268	Thelymitra	aristata				o		o											o
269	"	pauciflora				g													o
270	Thelionema	caespitosa				g		o											r
271	Themeda	*australis* (syn. T. triandra)																	
272	"	triandra		o	o	o	o		o	o	o			o	o	o	o	o	o
273	Thysanotus	tuberosus	*			g													
274	"	patersonii				g								o					o
275	Tricoryne	eliator				g	o	o	o					o					o
276	Triglochin	procerum						o											
277	"	striatum				g		o											o
278	Typha	domingensis						o											

	Genus	species	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
279	Utricularia	dichotoma						o											
280	Veronica	gracilis		*				o						o					o
281	Viminaria	juncea				g		o						o					o
282	Viola	hederacea				g		o		o				o	o				o
283	Wahlenbergia	communis				g													
284	"	gracilis	o	o	o	o	o	o	o	o	o		o	o	o	o	o	o	o
285	"	stricta				g													o
286	Wurmbea	dioica	o		o	g	o	o			o				o	o	o		o
287	Xanthorrhoea	minor		o		g	o	o						o					o
288	Xanthosia	dissecta													o			o	

Thank you to Rupert Barnett for maintaining the database.

Book Review

Spiders
Commonly Found in Melbourne and Surrounding Regions

by Ken L. Walker and Graham A. Milledge

Published by: *Royal Society of Victoria*
Available from The Publisher, 8 LaTrobe Street, Melbourne 3000
Cost $9.75 (including postage)

Why, amongst all of the invertebrates, do Spiders seem to evoke most horror amongst the general public? It must have more basis than just being hirstute, possessing fangs, or containing a few lethal species. The Museum of Victoria receives thousands of specimens for identification and it is questions of toxicity rather than biology that predominate. It is one of this State's minor tragedies that the position of Arachnology Collection Manager at the Museum has recently been abolished.

The twenty species of spider that are most frequently presented to the Museum staff are now described in a book published by the *Royal Society of Victoria* and funded by the Lynette Young Bequest. A full page is devoted to each species together with a line drawing by Graham Milledge. Sections cover Identification, Habits and Biology, and Bites. One of the book's strengths is that the information that it contains is both authoritative and current, resulting from the high standing that the authors have in their field. Sixteen colour plates depict portraits and aspects of thirteen of the species.

Introductory remarks give an overview of spider biology, their webs, reproduction, dispersal, and a little on legends and myths.

Australian spider books that have been published in the past contain similar information, but most of them are out of print. For the unfortunate or careless few, instructions on the treatment for spider bite are included. Perhaps the most original contribution that this volume makes is to classify the spiders by the locality where they are generally found: inside the house, on the verandah, in the shed, or in the garden; and whether they are web builders or hunters. Read the section on *Lampona cylindrata* and realise that there are reasons other than tidiness for hanging up your clothes at night.

The sorts of people who have been buying this book include field naturalists, teachers, bushwalkers, health inspectors, librarians and loyal friends. Every one of them will gain something from it. Many will wish that its scope was greater, with more species, a wider geographic range, and additional colour plates, particularly of species not previously seen. Curators are anxious to help but invariably over-worked. Perhaps a letter to the Museum administration containing subtle requests for more staff might be a good way to show your appreciation.

As one who saw the first draft and now the final product I can appreciate the fine contribution towards design made by final year students at the Swinburne Design Centre. Everyone connected with the production of this volume is to be commended: authors, illustrator, editor, referees, designer, *Royal Society of Victoria*. And what can we expect next in this genre: more spiders, scorpions, cockroaches, mantids? I will vote for all of those and live in hope!

Ian Endersby

Some Thecamoebians from South Gippsland

K.N.Bell*

Freshwater streams, ponds and dams contain a large and varied invertebrate fauna. Parts of this fauna are well known and well studied e.g. the molluscs (Smith and Kershaw: 1979), whereas other groups have been little studied in Australia. One of these little known groups is the testate amoebae, sometimes called testate rhizopoda or thecamoebians.

The thecamoebians are among the simplest forms of animal life. They have an amoeba-like single celled body but also have the ability to form a covering or test to enclose the protoplasm. This may take one of several forms. The animal may form the test by secreting material in the shape of rods or plates (idiosomes) - an autosomous test, or by cementing sediment particles such as quartz grains or diatom frustules together - a xenosomous test, or by a combination of each method. In the past this test material was used as a method of distinguishing species but after recent work on laboratory clones it is found to be unacceptable since the animals will use whatever is present to form their tests (Medioli, Scott and Abbott; 1987). The test is usually a single chamber, either flask-shaped or discoidal but many variations occur. There is normally only one aperture.

Thecamoebians are mainly inhabitants of freshwater regimes but a few forms from brackish water have been reported; records from shallow marine environments are most likely to have been due to washed-in specimens. Thecamoebians can be found living in the surface mud of pools, lakes and streams, among damp and submerged mosses and also in damp soil.

They are small in size, ranging from about 0.02 mm to 0.4 mm. Like amoebae they move using pseudopoda which may be either stout and trunk-like or relatively thin and straight. The form of the pseudopoda is important in differentiating some genera.

Little is known of their reproductive habits but for those species which have been studied they are found to be like amoebae and reproduce by means of binary fission - that is, daughter cells form by cellular division of the adult nucleus and protoplasm, which separate to grow to maturity. Grell (1973) stated that binary fission is the only means of reproduction, but Plaskitt (1926) stated that conjugation also occurred - that is, spores are produced by a permanent or temporary union of two individuals of the same species and an encysted resting period is undergone before final development. Lena (1982) reported cysts of *Difflugia mitriformis* from Lake Washington, U.S.A., and Medioli and Scott (1983) those of *D. urceolata*. Whether these are the same as Plaskitt's cysts is not known. Ogden and Hedley (1980) considered that cysts form usually as protection against adverse environmental conditions.

The smaller testate amoebae feed mainly on bacteria, algae and microfungi while the larger forms may also feed on smaller species of rhizopods and on rotifers.

To collect specimens from a sediment a small sample of the top ooze can be removed and washed either through a set of fine sieves or concentrated by decanting off the fine clays. For species living on mosses, the moss sample can be carefully broken into small pieces and well dispersed in water. In each case specimens can then be picked using a fine brush and then mounted on microfossil slides.

* Stony Creek, South Gippsland, Victoria, 3957.

The study of this group of protozoans has been almost totally neglected in Australia. The only detailed work is that of Playfair (1918) dealing with the rhizopods (both testate and non-testate) of Sydney and Lismore, N.S.W., wherein he recorded a total of 118 species. In an earlier paper (Playfair: 1914) he recorded several species from the Richmond River, N.S.W. The Victorian thecamoebian fauna appears not to have been studied at all, although Stickland (1923) mentioned five species found in ponds in the Melbourne area.

In this note I will deal only with the more common arenaceous (xenosomous test) species from South Gippsland. All other forms will be dealt with in a later report on the complete Victorian fauna.

Samples were taken from the ooze at the edge of several farm dams at Stony Creek (still water); from a sandy silt on the Tarra River (slow flowing) from the fine mud bottom of Turton's Creek (slow flowing) and from the bank of Bennison Creek, Foster (fast flowing); (Fig. 1). Samples were washed through a set of sieves, retaining for study that which was left on 0.072 mm mesh, and then floating the thecamoebians off with carbon tetrachloride.

Identification of the thecamoebians is beset with many difficulties. In the past, authors have described as a new species or variety any specimens which differed only marginally from their concept of the type specimen (which was often poorly described or figured). This has lead to a plethora of names and immense confusion. Recently some effort has been made to overcome this taxonomic problem (Medioli and Scott: 1983; Medioli, Scott and Abbott: 1987) by consideration of the variation within large natural populations or within clonal experimental groups. This has led to a great reduction in names e.g. Medioli, Scott and Abbott (1987) placed at least 98 taxa within their concept of *Cucurbitella tricuspis*.

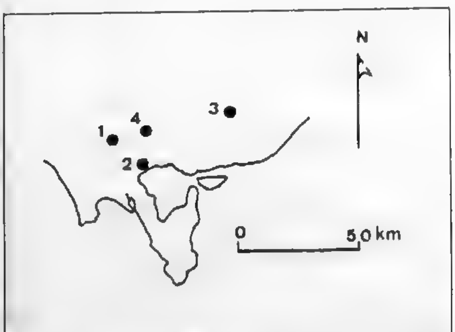

Fig 1. Localities mentioned in text from which thecamoebians were studied: 1. Stony Creek 2. Bennison Creek 3. Tarra River 4. Turton's Creek.

Description of species.

All the described species are shown in Fig. 2, and their distribution given in Table 1.

Difflugia protaeiformis Lamarck 1816. Fig. 2.3, 2.7. Test cylindrical to sub-

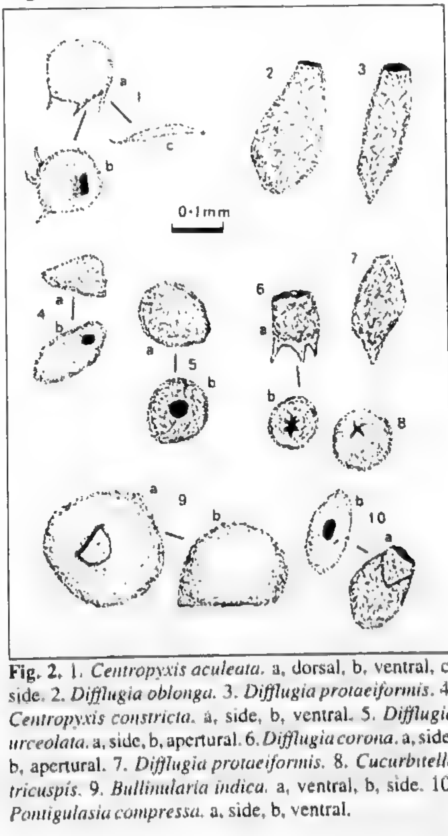

Fig. 2. 1. *Centropyxis aculeata.* a, dorsal, b, ventral, c, side. 2. *Difflugia oblonga.* 3. *Difflugia protaeiformis.* 4. *Centropyxis constricta.* a, side, b, ventral. 5. *Difflugia urceolata.* a, side, b, apertural. 6. *Difflugia corona.* a, side, b, apertural. 7. *Difflugia protaeiformis.* 8. *Cucurbitella tricuspis.* 9. *Bullinularia indica.* a, ventral, b, side. 10. *Pontigulasia compressa.* a, side, b, ventral.

Table 1. Distribution of Gippsland Species.

	Stony Creek	Bennison Creek	Tarra River	Turton's Creek
D. protaeiformis	x	x	x	x
D. corona	x	x		
D. oblonga	x	x	x	x
D. urceolata		x	x	
C. tricuspis	x	x		
P. compressa	x	x		
B. indica	x	x	x	x
C. aculeata	x	x	x	x
C. constricta	x	x	x	
Cysts	x	x		x

cylindrical, widest at aboral end; sides slightly tapering to the apertural end; aboral end conical, but may be sharply pointed or more gently rounded, with or without a spine; aperture circular, about 3/4 maximum test diameter, no apertural rim; test surface usually rough.

Remarks: This is a very common species in most Victorian waters. Two forms are shown - Fig. 2.3 is the more typical form with an aboral spine and rough test, while Fig. 2.7 shows an unusual rounded form with the aperture placed at the end of a narrow produced neck.

Distribution: Stony Creek, Bennison Creek, Tarra River, Turton's Creek.

Difflugia oblonga Ehrenberg 1832. Fig.2.2. Test has a cylindrical to amphora-like shape, tapering to an extended neck at the apertural end; widest at the aboral end which is smoothly rounded, with may be one or more rounded, stumpy spines present; aperture circular; surface rough; test may be compressed.

Distribution: Stony Creek, Bennison Creek, Tarra River, Turton's Creek.

Difflugia corona Wallich 1864. Fig. 2.6. Test spherical, with 2 - 6+ spines on the aboral end; aperture circular, rimmed by a variable number of teeth; test smooth.

Remarks: This species is easily recognized by its globose form with spines. The number of spines is highly variable within a population (Jennings, 1916).

Distribution: Stony Creek, Bennison Creek.

Difflugia urceolata Carter 1864. Fig. 2.5. Test ovoid to subspherical, slightly produced at the apertural end; aperture circular, the full width of the test, often with a very narrow rim, otherwise the aperture is sharp-edged; test is very finely arenaceous.

Remarks: This species is placed in *D. urceolata* sensu Medioli and Scott (1983) who amended the diagnosis to include forms without the enrolled apertural rim considered by most authors as characteristic of *urceolata*. None of the several hundred specimens from Gippsland showed any evidence of an enrolled apertural rim. In this they seem to be identical with the *'lebes'*-form of Medioli and Scott (1983, pl.3, fig. 1-5). The form described by Playfair (1918, p.652, pl.37, fig.16) as *D. mitrata* is most likely the same as the Gippsland species.

Distribution: Bennison Creek, Tarra River.

Cucurbitella tricuspis Carter (1856). Fig. 2.8. Ovoid to spherical test; apertural end slightly produced; aperture varied, from circular to lobate, the number of lobes varies from 3 to about 9; test surface smooth, may be entirely arenaceous (xenosomous) or with greater or lesser amounts of autosomes; aperture may or may not have a finer rim.

Remarks: Although Medioli, Scott and Abbott (1987) described *C.tricuspis* as usually having a lobate aperture they do mention specimens with a completely circular opening. But Harman (1986) has disputed this saying that the apparently circular apertures are actually finely lobed. The present forms all had an aperture of four narrow lobes set at right-angles. This form was described as *lismorensis* by Playfair (1918) but placed in the synonomy of *tricuspis* by Medioli, Scott and Abbott (1987). In all cases in the Gippsland forms the test is entirely arenaceous with no idiosomes.

Distribution: Stony Creek, Bennison Creek.

Centropyxis aculeata (Ehrenberg 1832). Fig. 2.1. Test discoidal, flat, somewhat beret-shaped; dorsal surface rounded, ventral flat to concave; aperture ventral, may be circular to uneven but displaced towards one end; fine spines present on edge, may be at one end only or all around the periphery; surface smooth, dorsally with many quartz grains and little cement, ventrally polished-looking due to more cement and much smaller grains in test.

Remarks: This species is quite variable in shape, thickness, aperture size and number of spines. Specimens without spines are not considered to be a separate species.

Distribution: Stony Creek Turton's Creek.

Centropyxis constricta (Ehrenberg 1843). Fig. 2.4. Test elongate, cap-shaped; widest aborally; rounded; aperture round, on an inclined face on the ventral surface, no rim to aperture; test smooth, evenly arenaceous.

Remarks: This species can be distinguished from *C.aculeata* in basic shape, having no peripheral spines and that the test surface is evenly arenaceous. Specimens vary in degree of elongation and size of the apertural face. Distribution: Bennison Creek, Tarra River, Turton's Creek.

Pontigulasia compressa (Carter 1864). Fig. 2.10. Test small rounded in outline but compressed in thickness, with a short neck; aperture oval; shows a V-shape at the junction of the neck shoulders and the main body, the neck often of finer grains than those composing the body; surface smooth.

Distribution: Stony Creek, Bennison Creek.

Bullinularia indica (Penard 1907). Fig. 2.9. Test domed, flattened on the apertural wall; aperture a slit on the flattened side, may be invaginated; test wall very thin, finely arenaceous, smooth.

Distribution: Stony Creek, Bennison Creek, Tarra River, Turton's Creek.

Difflugia species cysts.

In several samples there occurred spherical arenaceous bodies similar to the foraminiferal genus *Psammosphaera*. These were coarsely arenaceous and without apparent apertures, and internally were quite smooth. They appear to be similar to the cysts described by Lena (1982) which she referred to *D. mitriformis*. The cysts were brown and ranged in diameter from 0.04 to 0.06 mm. As none were found attached to any of the *Difflugia* species present in the samples it is not possible to associate them with any particular species.

Distribution: Stony Creek, Bennison Creek, Turton's Creek.

References

Grell, K.G. (1973). 'Protozoology'. (Springer-Verlag: Berlin.)

Harman, D. (1986). Testacealobosa from Big Bear Lake, California, with Comments on *Difflugia tricuspis* Carter 1856. *Revista Espanola de Micropal.* **18:** 47-54.

Jennings, H.S. (1916). Heredity, Variation and the Results of Selection in Uniparental Reproduction of *Difflugia corona*. *Genetics* **1:** 407-533.

Lena, H. (1982). Cysts of *Difflugia mitriformis* (Testacealobosia) with the external characteristics of *Psammosphaera* (Foraminifera). *Revista Espanola de Micropal.* **14:** 151-152.

Medioli, F.S. and Scott, D.B. (1983). Holocene Arcellacea (Thecamoebians) from Eastern Canada. *Cushman Foundation for Foraminiferal Research*, Special Publication **21**.

Medioli, F.S., Scott, D.B. and Abbott, B.H. (1987). A case study of protozoan intraclonal variability: Taxonomic implications. *Journal of Foraminiferal Research* **17:** 28-47.

Ogden, C.G. and Hedley, R.H. (1980). 'An atlas of Freshwater Testate Amoebae'. (British Museum (Natural History) and Oxford: University Press.)

Plaskitt, F.J.W. (1926). 'Microscopic Fresh Water Life'. (Chapman and Hall, Ltd.: London.)

Playfair, G.I. (1914). Contribution to a knowledge of the Biology of the Richmond River, N.S.W. *Proceedings of the Linnean Society of New South Wales* **39:** 93-151.

Playfair, G.I. (1918). Rhizopods of Sydney and Lismore. *Proceedings of the Linnean Society of New South Wales* **42:** 633-675.

Smith, B.J. and Kershaw, R.C. (1979). 'Field Guide to the Non-Marine Molluscs of South Eastern Australia'. (Australian National University Press.)

Stickland, J. (1923). The aquatic protozoa of the Melbourne district, Part 1. *The Victorian Naturalist* **40:** 65-74.

An Observation of a Tiger Quoll *Dasyurus maculatus* in the Coastal, Eastern Otway Ranges, South-west Victoria

L.E. Conole*

On 25 April 1993, approximately 16:00 hours, at Boggaley Creek (AMG 7620 [OTWAY]: YC535218) in the Angahook-Lorne State Park I observed a large, male Tiger Quoll *Dasyurus maculatus* in the bed of the creek about 500-600 metres upstream from the beach. Prior to the sighting, I had observed tracks and scats indicating that a *D. maculatus* had probably travelled up the creek from the beach earlier that day or during the previous night. When disturbed by my approach up the creek bed the Tiger Quoll, about 0.8-0.9 metres total length came out from beneath a log and bounded off into the scrub on the east side of the creek.

Boggaley Creek runs through a small catchment to the sea from its source *circa* 200 metres above sea level in the eastern Otway Ranges, between the townships of Wye River and Lorne. The creek had dried up into widely spaced pools as a consequence of negligible rainfall since the end of summer. Open-forest of Blue Gum *Eucalyptus globulus* is predominant on the hillslopes, but along the creek occurs a scrub of Hazel Pomaderris *Pomaderris aspera,* Prickly Moses *Acacia verticillata,* Blackwood *A. melanoxylon,* Blanket-leaf *Bedfordia arborescens,* Austral Mulberry *Hedycarya angustifolia* and Prickly Currant-bush *Coprosma quadrifida*. Weather conditions at the time of the sighting were overcast, mild (*circa* 18-20° C) and calm.

Tiger Quolls are infrequently sighted in the eastern Otway Ranges, and are regarded as having their stronghold in the Mountain Ash *Eucalyptus regnans* tall open-forests of the central range around Beech Forest (Conole and Baverstock 1983; Emison *et al* 1975).

* 2/45 Virginia Street, Newtown, Vic., 3220

References

Conole, L.E. and Baverstock, G.A. (1983). The mammals of the Angahook-Lorne Forest Park, Victoria. *The Victorian Naturalist* **100:** 224-231.

Emison, W.B., Porter, J.W., Norris, K.C. and Apps, G.J. (1975). Ecological Distribution of the Vertebrate Animals of the Volcanic Plain - Otway Range Area of Victoria. *Fisheries and Wildlife Paper, Victoria* **No. 6.**

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Conservation Notes

Helmeted Honeyeater

A hopeful sign that conservation projects are paying off comes in a report in 'The Age' of 20th April 1993, which says that the Helmeted Honeyeater *(Lichenostomus melanops),* Victoria's avian emblem, has been rescued from imminent extinction and has apparently not suffered any significant genetic ill effects.

Mallee fowls in W.A.

A report in 'The Albany Advertiser' of 1st April 1993 notes that after 40 years Mallee fowls *(Leipoa ocellata)* have re-appeared in the Karri Forests of south-west Western Australia.

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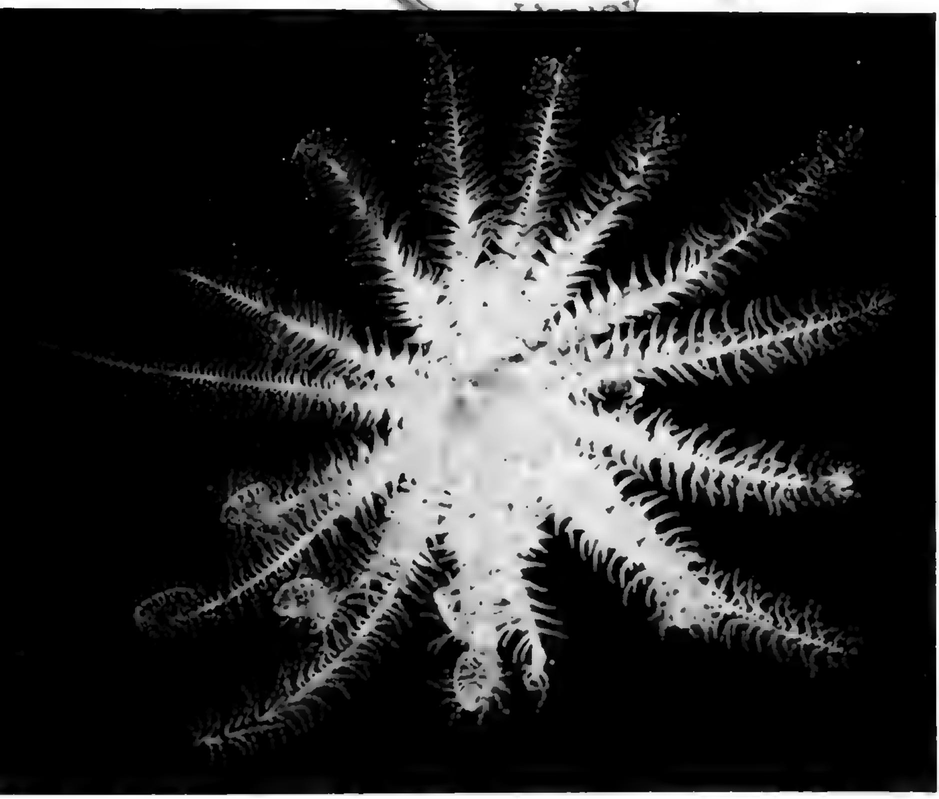

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FNCV Calendar of Activities

September

Sat 4	General FNCV Excursion. **A walk into the Brisbane Ranges.** Leader John Stewart. Contact Dorothy Mahler 435 8408.
Tues 7	Fauna Survey Group Meeting. **Marine Fish Diversity in Victoria Waters** - Martin Gomon. Herbarium Hall 8 pm.
Thurs 9	**Botany Group Annual Meeting.** Members slides and exhibits. Herbarium Hall 8 pm.
Sat 11	Fauna Survey Group Field Survey. **Leadbeaters Possum Survey.** Contact Ray Gibson 874 4408.
Mon 13	General FNCV Meeting. **Interesting Developments in the Minin Industry in Australia** - Bob Dalgarno. Herbarium Hall 8 pm.
Wed 15	Microscopical Group Meeting. **Sand and rocks under the Microscope** - Dan McInnes. Astronomer's Residence 8 pm.
Wed 22	Geology Group Meeting. **Bass Strait Basin Oil.** Herbarium Hall 8 pm.
Thurs 23 - Sun 26	**Fauna Survey Group Field Survey. Camp at Kinglake.** Contact Ray Gibson 874 4408.
Sat 25	Botany Group Excursion. **Currawong Bush Park, Doncaster East.** Leader Cecily Falkingham. Meet main car park 10.30 am (Melways 34H7). Contact Joan Harry 850 1347.

October

Sat 3	General FNCV Excursion. **Willum Buluk Fauna and Flora Reserve.** Leader Ilma Dunn. Meet at reserve in Courtney's Road, South Belgrave 10.30 am (Melways 84D7).
Tues 5	Fauna Survey Group Meeting. **The Wandering Albatross** - David Nicholls. Herbarium Hall 8 pm.
Sat 9	Fauna Survey Group Field Survey. **Leadbeaters Possum Survey.** Contact Ray Gibson 874 4408
Mon 11	General FNCV Meeting. **Nudibranch Molluscs - Jewels of the Sea** - Robert Burn. Herbarium Hall 8 pm.
Thurs 14	Botany Group Meeting. **Victorian Lilies** - Geoff Carr. Herbarium Hall 8 pm.
Wed 20	Microscopical Group Meeting. **Desmids** - Joan Powling. Astronomer's Residence 8 pm.
Sat 23	Botany Group Excursion. **Wildflowers at Langwarrin.** Meet at car park, McLellan Drive, Langwarrin 10 am (Melways 103D9). Contact Joan Harry 850 1347.
Tues 26	Fauna survey Group Meeting. **Status of the Red-tailed Black Cockatoo in Western Victoria** - Bill Emison. Astronomer's Residence 8 pm.
Wed 27	Geology Group Meeting. **The Noddy Programme (Demonstrating Structural Geology)** - Mark Jessell. Herbarium Hall 8 pm.
Sat 30 - Tues 2/11	Fauna Survey Group Field Survey. **Wilson's Promontory (post fire ecology study).** Contact Russell Thompson 434 7046.

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The Victorian Naturalist

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Assistant Editors: Ed and Pat Grey

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Cover Photo: The Crinoid *Cenolia Trichoptera* see page 149, photographed by Timothy O'Hara.

Studley Park Revegetation

Dear Editor

Having grown up in the Studley Park area, I have long been familiar with the weed invasions and history of degradation in this fascinating and important piece of bushland. As I now live in Qld, the opportunities to visit are few and far between. It was with absolute delight then, to be able to visit last March and see the enormous changes at Galatea Point and Dickinson Reserve.

The work of the community and the Yarra Bend Trust has recreated an indigenous vegetation, not just over a small area, but over a whole landscape. This can only be the result of a concerted effort, over a long period of time, by many people. I would like to congratulate you all. Your work is a demonstration of the power and achievement that can arise from community action. It is an inspiration to all who are interested in local conservation action.

Bush management is a never-ending and demanding task in urban areas. To those who may feel frustrated with the size of the job, rest assured that you are making a difference and it is noticed.

Yours sincerely

Sue McIntyre
CSIRO Division of Tropical Crops and Pastures,
306 Carmody Rd, St Lucia, QLD.

The Hawthorn Junior FNC is 50 Years Old

The FNCV congratulates the Hawthorn Juniors on reaching 50 years

The Hawthorn Junior FNC celebrated its 50th anniversary this August. The club is an organisation for young people and their families, running meetings and excursions every month as well as camps at Easter and in summer. Since its inception in 1943 the HJFNC has been active all over Victoria and has had a wide spectrum of members.

The HJFNC General Meetings are on the last Friday of every month at the Balwyn Primary School Hall, Balwyn Road, Balwyn. Contact telephone (03) 725 8923.

ANGAIR WILDFLOWER SHOW
18-19 SEPTEMBER 1993 AT ANGLESEA

Angair Inc. (Anglesea and Aireys Inlet Society for the Protection of Flora and Fauna) will hold its Annual Wildflower Show on Saturday 18 September from 10 am to 5.30 pm, and Sunday 19 from 10 am to 5 pm at the Anglesea Hall in McMillan Street. There will be excursions to selected locations in Anglesea's renowned heathland and woodland wildflower areas.

Displays of wildflowers, local native plants and natural history books for sale, art and craft sales, a special stage display and a children's section are among other attractions. There will be paintings by Australian artists in the art show sponsored by Alcoa.

Admission is $4.00 for adults, $2.00 for pensioners and students, children 12 and under are free.

Further information may be obtained from Mr Fred Wright, 5 Fourth Av Anglesea 3230, phone (052) 631843 or Ms Evelyn Jones, 9 Hopkins St Aireys Inlet 3221, phone (052) 896046.

Echinoderms of Victoria

Timothy D. O'Hara*

Introduction

Everyone who has browsed amongst rock pools on the sea shore, or strolled along a beach after a storm, would have seen an echinoderm at some time. The dark crimson six-armed Sea-star, *Patiriella brevispina,* often stands in sharp contrast to the red, green and brown algae of the rockpool. The purple or green Sea urchin, *Heliocidaris erythrogramma* (Fig. 1), densely covered in sharp spines, is common under rocks, often in a specially carved out hollow. After death, stripped of its spines and colour, the egg-like Sea-urchin skeleton or 'test', with its beautiful patterned surface, is rolled up onto the beach with other shell debris.

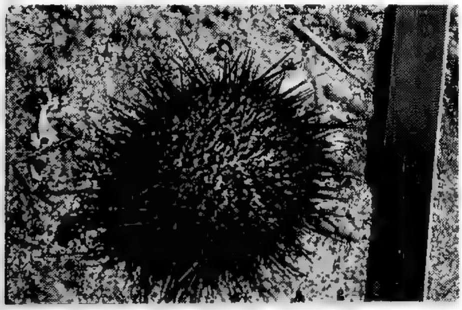

Fig. 1. The echinoid, *Heliocidaris erythrogramma.*

Echinoderms are a common and important component of our local marine fauna. There are probably over 500 species living in the southern waters of Australia, from the intertidal reef to the abyssal depths.

The name echinoderm means 'spiny-skinned', and the calcareous skeleton with its associated processes and spines, is a common feature of the group. Another shared characteristic is the unusual radial symmetry. Most animals are bilaterally symmetrical: the left and right sides are broadly similar to each other. Most echinoderms, on the other hand have no left and right side. They have many arms, often in multiples of five, that radiate from a central point. Even the internal organs are radially symmetrical. For example, there is no central brain, just a neural ring that circles the main body.

Echinoderms also possess tube feet, small flexible suckered appendages that occur for example in the furrow under a Sea-star's arm or massed around the mouth of a Sea-urchin. These organs, unique to echinoderms, are used for many purposes, feeding, cleaning, movement or clinging to rocks.

Local Echinoderms

There are five main types of echinoderms. A Sixth group, the Sea Daisies, has been recently discovered in deep water off New Zealand.

The Sea-stars, or Asteroids, are the most familiar (the inappropriate name, 'starfish', has now gone out of fashion). They have a central disc with the mouth underneath, anus on top, and five or more relatively stiff arms. They tend to move slowly, relying almost totally on the tube feet under each arm. Familiar Victorian species include the Biscuit Star, *Tosia australis* (Fig. 2), that has a rigid flat five-sided body. The upper surface is covered in distinct plates. The common Sea-star, *Patiriella calcar* (Fig. 3) has eight short arms. The upper surface is covered in many tiny plates and is usually coloured mottled blue, green, orange or brown. *Allostichaster polyplax* (Fig. 4)

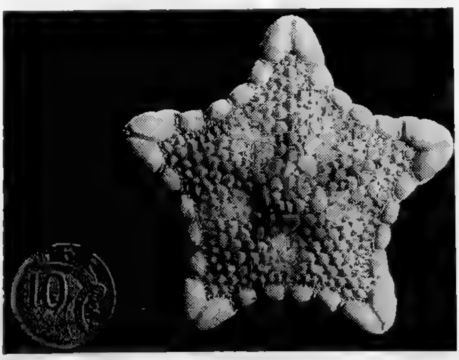

Fig. 2. The asteriod, *Tosia australis.*

* 62 Highett Street, Richmond 3121.

Fig. 3. The asteriod, *Patiriella calcar*.

usually has four large arms on one side and four tiny arms on the other. The largest of the shallow-water sea-stars is *Coscinasterias calamaria*. It has up to eleven long spiny arms which can grow up to 250 mm in length. The species is well known from mussel and scallop beds. The powerful tube feet are attached to each side of the mussel and relentless pressure is applied until the two shell valves are prised apart. The stomach is then pushed out of the sea-star into the shell and food is digested externally.

Brittle-stars, or Ophiuroids, have a central disc and five (rarely more) spiny, flexible, sinuous arms. Many of the species found under rocks can move quite quickly. Two opposite pairs of arms act as oars and propel the disc and the other arm forward. There is no anus; waste is expelled via the mouth that is in the centre of lower disk surface. Ophiuroids are detritus feeders. Common larger species include the chocolate brown *Clarkcoma canaliculata* (Fig. 5), the red or green *Ophiomyxa australis* and *Ophionereis schayeri* with arms cross-banded black, grey and white. These species can have arms as long as 150 mm. There are many other smaller species that live in sediment or on algae or sponge. Basket-stars, another group of Ophiuroids that live in deeper water, have branched arms.

The Sea-urchins, or Echinoids have no arms, but rather have a ridgid spherical or ovoid body that is covered in spines. The mouth is a very complex structure at the bottom of the body called the 'Aristotle's lantern'. The most common southern Australian species is *Heliocidaris erythrogramma* (Fig. 1) mentioned earlier. It can grow up to 90 mm in diameter, and is usually found under rocks or amongst algae. Encrusting algae is a common source of food. *Helopneustes porosissimus* is densely covered in rows of tiny green spines with red tips. It is often found attached to algal fronds.

Sea-cucumbers or Holothurians are flexible sausage shaped animals with a mouth surrounded by a ring of tentacles at one end and an anus at the other. They have no arms, but are generally covered in rows of tube feet. The tube feet on the underside of the body assist the animal to grip the substrate. Food is scooped into the mouth by the tentacles. There are many species of Holothurians on our coastline, but none approach the size of the animals well known from the tropics. Larger species include *Stichopus mollis* which has a brown lumpy appearance and grows up to 120 mm in length. The reddish brown *Lipotrapeza vestiens* (Fig. 6)

Fig. 4. The asteriod, *Allostichaster polyplax*.

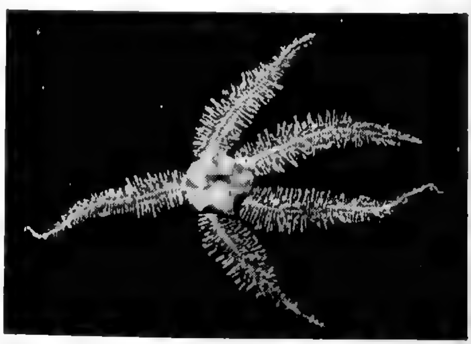

Fig. 5. The ophiuroid, *Clarkcoma canaliculata*.

is densely covered in tube feet, which are used to hold sand or pieces of shell against the body.

Feather-stars, or Crinoids, have ten or more delicate finely branched arms arising from a small central disk. The mouth is on top of the disk between the arms. Food, mainly plankton, is filtered by the arms from water currents and transported to the mouth by external ciliated grooves. Underneath the disk is a special ring of hooked appendages that help the animal grip the substrate. Feather-stars are less commonly observed than the other echinoderms. They can be found in areas of strong current, for example at Pope's Eye in southern Port Phillip Bay, in crevices or under rocks. *Cenolia* species are brown, green or orange with between twenty and thirty-five arms. Arms can measure more than 100 mm in length. The smaller *Antedon* species are pale brown or grey with ten arms.

Fig. 6. The holothurian, *Lipotrapeza vestiens*.

Reproduction

The majority of Echinoderms reproduce sexually. Sperm and eggs are released by separate animals and the resulting larvae spend some time drifting at sea as plankton before settling down to live their adult lives on the sea floor. There are exceptions to this life history, however, and many local species are proving to be of international interest.

Echinoderms are well known for their ability to regenerate arms. Some species of Asteroids, Ophiuroids and Holothurians can use this ability to reproduce asexually by dividing in two by fission. The usual arrangement of four small arms in the Sea-star *Allostichaster polyplax* (Fig. 4) is the result of fission. Young animals of *Coscinasterias calamaria* can also divide. They seem to lose this ability with age.

A new species of Holothurian, recently discovered off Victoria, is only the seventh Holothurian known to divide, and the first from the southern hemisphere. The process starts with a deep constriction around the centre of the body. The two ends continue to pull apart until the connection is reduced to a long thread. The two ends finally separate. The anal end grows a tentacle ring and mouth, and the mouth end grows a new anus. This small species (maximum length 10 mm) also appears to reproduce sexually. When and why it mixes these two forms of reproduction are still unknown.

Quite a few echinoderms also brood their young. The young can be reared within the body, in special external brood pouches, or simply amongst the spines on the body surface. Brooding is usually considered typical of polar marine animals. However, the number of local species that have been recently discovered to brood, from all echinoderm groups, indicates that it is a phenomenon of southern Australia as well. The most extraordinary brooder is an Asteroid called *Smilasterias multipara*. The females of this species lay eggs externally in September. After fertilization, the eggs are swallowed and nurtured in the stomach. For over a month, the sea-star appears not to eat. Indeed it is impossible to see how it could, because the several hundred juveniles swell the stomach to many times its normal size. In early November the juveniles are released from the mouth. They are placed in a group under a rock, in pools near the low tide mark.

Finally some echinoderms can be hermaphrodites. However, instead of possessing both male and female gonads at the same time, some species are males when young, later turning to females, and then even sometimes back to males again.

Distribution

Many species of echinoderm that occur

off Victoria are also found along the entire southern Australian coastline, from south-west of Western Australia to southern Queensland. There are some interesting regional variations, however. Several Ophiuroids occur off western and south Australia and from Wilsons Promontory to Queensland, but not in between from western Victoria or Tasmania. It is tempting to suggest that this discontinuous distribution reflects the ancient connection of Tasmania to the mainland. There are also clusters of endemic species in the Gulfs of South Australia, and off the south-eastern tip of Tasmania, south of Hobart. Researchers have speculated that the Tasmanian species evolved in the isolation caused by run off from ancient glaciers. Echinoderms are exclusively marine and a fresh water source can limit their distribution.

Most shallow water echinoderms can be found from the shallow subtidal (water that is never exposed by a low tide) to 20 m or beyond. One exception is the tiny blue green Asteroid *Patiriella exigua* that only lives high up in the intertidal zone. Other echinoderms exhibit enormous depth ranges. A very common, cosmopolitan Ophiuroid, *Amphipholis squamata*, can live from zero to 1000 m.

Most of the commonly known echinoderms are found on the many rocky reefs and outcrops that occur off the coast. Other species prefer living on the sea bottom in mud or sand, amongst seagrass roots, on algae, or even inside sponges. The distribution of many species is determined by the distribution of these habitats. Ophiuroids in particular live in soft sediments or epizoically on sponges. The number and diversity of Ophiuroids increase dramatically from the coastline into deeper water. The bottom of Bass Strait is predominantly covered in mud or vast sponge 'gardens' - ideal Ophiuroid territory! Off the east coast of Australia, at the edge of the continental shelf, the sea floor plunges rapidly down to the abyssal plain of the Tasman Sea several kilometres below. This narrow region, known as the continental slope, again harbours vast numbers or ophiuroids. Some species live (for unknown reasons) in massive aggregations consisting of several million animals, lying on top of each other many layers deep. Many of these deep water species are very widespread, sometimes worldwide.

Conservation

There is evidence from the last twenty years to suggest that many of our coastal areas have become degraded. Seagrass dieback has been extensive. Over seventy percent of the Seagrass cover in Western Port Bay has been lost since 1973. This would have had a large impact on the epiphytic echinoderms.

Rocky reefs have suffered from trampling, disturbance and the 'collecting' of large colourful animals. The common Sea-star, *Patiriella calcar* (Fig. 3) has all but disappeared from the popular Shoreham Reef in Western Port Bay. Most books on the coastal fauna used to have chapters on how to collect and preserve animals. This is now being replaced with information on how to 'look but not disturb'.

Assessing the conservation status of our marine animals is a difficult and controversial problem. The sea is notoriously hard to survey. Access is often difficult. The sea is both continuous and mobile. Many creatures have wide-ranging planktonic stages as part of their life cycle. It is very difficult to determine whether a rare animal is endangered by being restricted to a certain locality. Nevertheless, by the nature of their biology, some animals are more vulnerable than others. Species that brood have more restricted dispersal mechanism, and would be more vulnerable to localised destructive pressures.

The obvious general answer is to protect representative habitats. Unfortunately much of the marine environment is unprotected. This situation is similar to that on land 20 years ago.

Echinoderms are occasionally accused of being environmental pests. The notorious Crown of Thorns Sea-star, *Acanthaster planci*, is a well-known predator of corals from the Great Barrier

Reef (although recent evidence indicates that its presence is natural and probably even beneficial, promoting diverse new growth - the marine equivalent of fire).

There is one, possibly two, exotic introductions in Tasmania. The most recent is a Japanese Sea-star, *Asterias amurensis,* which has been found in great numbers this year in the Derwent River, near Hobart, and from the east coast near Triabunna. It has probably been introduced via expulsion of ship ballast water. One of its favourite foods is scallop, and it has already been found on scallop longlines offshore. The other is the New Zealand Asteroid, *Patiriella regularis,* which occurs in S.E. Tasmania. It is now very common and yet was only first reported in the 1960s. Although, there is no conclusive proof, it has been speculated that it was introduced sometime after 1930, from live New Zealand oyster cargoes.

Future research

There is still much to be learned about out echinoderms. While there has been a lot of taxonomic work over the past 20 years, there are many species that have still to be scientifically described and named. Only about 50% of the Holothurian species have been described. The deep water fauna of all the groups requires much more study. Some habitats, Seagrass beds and Mangroves, have been poorly sampled. In addition the life history, anatomy, physiology and ecology of the vast majority of species remains a complete mystery.

Further reading

Marine Research Group of Victoria, (1984). 'Coastal invertebrates of Victoria. An atlas of selected species'. (Marine Research Group in association with the Museum of Victoria: Melbourne.)
The well-researched descriptions and line drawings in this volume should assist any field naturalist to identify the more common marine animals. Known distributions are mapped. This work is now out of print. However, a larger, updated, colour edition is due for release in late 1993.

Shepherd, S.A. and Thomas, I.M. (eds) (1982). 'Marine invertebrates of southern Australia. Part (1). (Government Printer: Adelaide.)
This work presents a more scientific, taxonomic account of the southern Australian marine fauna. There are detailed diagnostic diagrams and keys are provided for many groups.

Quinn, G.P., Wescott, G.C. and Synott, R.N. (1992). 'Life on the Rocky Shores of South-Eastern Australia. An illustrated Field Guide'. (NPA: Melbourne.)
A new edition of this handy 'pocket sized' book has recently been published by the VNPA. A few echinoderm species are included.

Daiken, W.J. (1987). 'Australian Seashores'. (Angus and Robertson: Sydney.)
This 'classic' has been thoroughly updated by Isobel Bennett of the Australian Museum in Sydney. A new cut down paperback version has been recently (1992) published by Collins, Harper and Robertson. Although both books have a strong New South Wales bias, many of the photographed species are also present in Victoria.

O'Toole, M. and Turner, M. (1990). 'Down under at the Prom'. (Field Naturalist Club of Victoria and Department of Conservation and Environment: Melbourne.)
This book has photographs of some of the deeper water echinoderms assessible to divers.

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A Brief History of Palaeontological Investigations at the Lancefield Megafaunal Site, Victoria.

Sanja Van Huet*

The Lancefield Quaternary Megafaunal Site has a history of palaeontological investigation that goes back over one hundred years The site is currently acknowledged as being of major palaeontological significance because it was the third megafaunal locality to be discovered in Australia and also provided the first historical record for the extinct giant bird *Genyornis* on the Australian continent (see page 157).

There are three separate sites so far located at Lancefield: the Classic, located in 1974, the South, located in 1983 and Maynes Site, first discovered in 1843 and subsequently relocated in 1991.

Location

The Lancefield megafaunal site is situated on the outskirts of the township of Lancefield, 70 km NNE of Melbourne, 37°16'S, 144°44'E. The bone bed is located in swamp deposits at the head of the drainage line of a natural spring that has eroded into the Pliocene basalts that surround the swamp. These basalts extend to the south and southwest and are surrounded to the east by outcrops of Cambrian cherts, shales (part of the Mt. William Group) and Ordovician quartzites, and to the north and west by sandstones (including greywackes) and slates. A large granodiorite batholith of Devonian age is located to the north, as well as a variety of Recent gravel, clay and sand deposits that are associated with the river flats of Deep Creek, in the upper reaches of the Maribyrnong River basin.

Palaeoenvironmental history of the location

The Quaternary (palaeo) environmental history of the Lancefield area has been determined using palynological evidence from Ladd (1976a) and studies of Quaternary southeastern Australia by Hope (1984) and Bowler (1987). Ladd's pollen analysis at Lancefield, in 1974, identified several aquatic herbs and plants in the swamp sediments. These included Water-ribbon (*Triglochin* sp.), sedge varieties (*Cyperaceae* sp.) and duck weed (*Lemna* sp.). As these plants require an aquatic habitat it suggests that water from the spring was feeding into the swamp at the time of the deposition of the sediments and that the site was, at least seasonally, under water when the bone bed was deposited.

Radiocarbon dating of two samples of charcoal collected from the bone bed during the 1976 excavation returned a date of 26,000 ± 650 years and 25,2000 ± 800 respectively. These results were published by Gillespie et al in 1978.

Workers (including Horton 1984; Rich 1984; Hope 1984; Ladd 1976b; Frakes, McGowran and Bowler 1987 and Gillespie *et al.* 1978) have discussed the changing climate of the Australian continent during the Late Quaternary. There is general consensus that S.E. Australia between 40,000 and 30,000 years B.P., was more humid than at present. The formation of glaciers and icecaps in the northern hemisphere between 30,000 and 26,000 years B.P. resulted in a gradually drying climate due to free water being locked up in ice. Between 26,000 to 10,000 years B.P. a worldwide arid period occurred, with the peak being reached between 17,500 to 16,000 years B.P.; at the time of the last glacial maximum. Frakes, McGowran and Bowler (1987) suggests that the winds associated with climatic pressure systems helped enhance this seasonality.

Ladd contended that the dominant vegetation surrounding the swamp approximately 26,000 years ago was mainly made up of herbs and grasses which confirms the presence of a dry climate at the

* 2 Park Road, Aspendale, 3195.

time of the deposition of the bone bed at Lancefield.

The drying of the Australian continent is suggested as one of the possible reasons for the demise of the megafauna during the Late Quaternary.

History of the Location.

In 1843 James Patrick Mayne was digging a well in the swamp when he discovered the 'fossil bones of a number of extinct animals...about five feet beneath the surface, embedded in a layer of dark alluvium about a foot in thickness'. (Orchiston *et al.* 1977). Mayne transported these bones to Melbourne early in 1844.

E.C. Hobson and A.F.A. Greeves were the newly appointed Honorary Curators of the Museum of the Mechanics Institute in Melbourne. When the bones that Mayne had collected were made available to the Insititute, both Hobson and Greeves showed immediate interest. Working independently (due to professional differences) both reached the same conclusion that several of the teeth and bones belonged to a very large kangaroo (later identified as *Macropus titan;* (see page 157); two of the incisors were from a 'huge rodent' and another assortment of bones as that of a 'large animal resembling a mastadon [sic]' (Orchiston *et al.* 1977). This 'mastadon-like' creature was later identified as *Diprotodon* sp.

In December 1844 Hobson paid a one day visit to Lancefield and managed to recover 'the long bones of some cursorial bird which may prove to be a gigantic emu' (Orchiston *et al.* 1977). These bones later provide positive evidence for extinct, giant dromornithid birds (*Genyornis* sp.) in Australia (Orchiston *et al.* 1977). Excavation of the fossil site at Lancefield was eventually abandoned; with the over abundant flow of ground water recorded as the cause. The final recorded work on the site last century was a geological survey of the area in 1858 by the Government Surveyor, Norman Taylor.

In 1973, geologist Rob Glenie sunk a number of auger holes in the swamp deposits at Lancefield in his search to relocate the fossil site and found fossil bone. A large amount of skeletal material was recovered during this excavation, the most abundant belonging to the extinct species *Macropus titan.* The site of the Glenie excavation in 1973 is now known as the 'Classic' Lancefield Site, as it was believed to be the original 1843 fossil location.

From 1975 to 1976 an archaeological team from Sydney University and palaeontologists from the National Museum of Victoria (now Museum of Victoria), Monash University and the Institute of Aboriginal Studies in Canberra, continued excavation at the Classic Site. Several papers resulted from these investigations including Ladd 1976; Horton 1976; Orchiston *et al.* 1977; Gillespie *et al.* 1978 and Horton and Samuel 1978. Over three thousand bones were found and ninety percent of these were identified as belonging to the species *Macropus titan.*

In 1983 a second fossil deposit in the area was discovered and has since become known as the Lancefield 'South' Site. Three major excavations have been undertaken at the South Site: the first in 1983 by a group under the direction of Ms. Elizabeth Thompson of the Museum of Victoria; in 1984 by a team from Brigham Young University, Provo, Utah, under the direction of Dr. Wade Miller and in February 1991, under the direction of Sanja Van Huet from Monash University, with support from the Museum of Victoria, Monash University, the Department of Manufacturing, Industry and Development and The Field Naturalists Club of Victoria.

Re-writing History

There is some confusion regarding the rediscovery of James Mayne's original 'well' site at Lancefield. When fossil bones were located at the Classic Site in 1973, those concerned with the project believed that Mayne's original Site, as recorded by E.C. Hobson last century, had been relocated. The second bone deposit, the South Site, discovered to the east of the Classic Site in 1983, was considered to be a new location in a previously unexplored area of the swamp.

During investigations in 1991, several 'wildcat' augers were sunk some distance from the bone bed at the South Site. It was using this method of exploration that located a third fossil deposit. A pit was dug and the fossil bones were found to be isolated in a layer at a depth of approximately 1.3 meters. Eighteen to twenty centimeters above this bone layer were relics of previous European settlement, in the form of old leather boots, china plates and glass bottles (Fig. 1).

This third site, from now referred to as the Mayne Site, (after the original discoverer) is very likely the original position in which Mayne and Hobson conducted their excavations last century. Evidence for this conclusion includes:

Historical documentation describing the facies in which the bones were originally found differs from the facies profile at the South and Classic Sites but is very similar to that of the Mayne Site. Hobson, in an extract of a letter to Mr. Ronald C. Gunn of Launceston, describes the original bone bed as being '...discovered in a small marsh about five feet below the surface...' (Hobson, 1845) '...covered by a peaty looking vegetation and the soil itself has the appearance of peat for three or four feet below the surface. Under the peat is a bed of gravel, in which the bones are deposited in vast quantities...' (Hobson 1846b). This description compares very favourably with the profile of the Mayne Site from the 1991 excavation. The facies from the Classic and South Site excavations are not similar to this historical documentation.

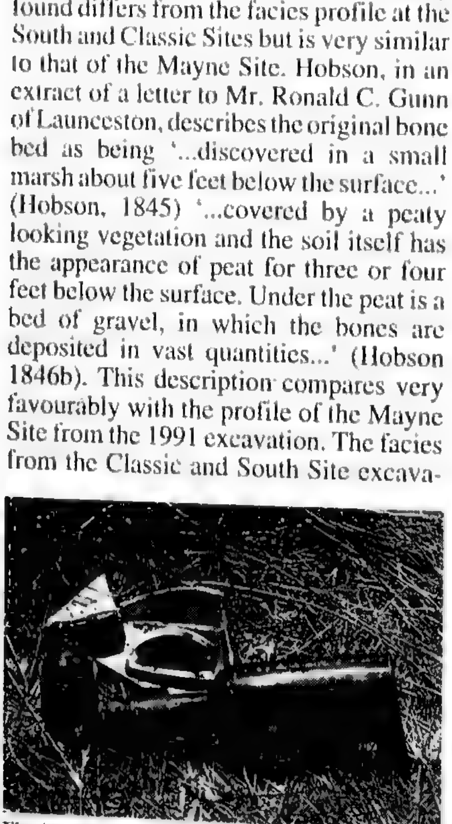

Fig. 1. Bottles and pottery. Mayne Site, Lancefield.

The nature of the faunal assemblage included in the historical records is more closely in accord with the type of elements found at the Mayne Site than that at the Classic Site. According to the description of 14 bone specimens, by British palaeontologist Richard Owen, (in Orchiston, 1977) at least 2 individuals of *Diprotodon australis* were located from the original excavation. In the Vertebrate Zoology Registers, located at the Museum of Victoria, another specimen of *Diprotodon australis* is described (Number P15072, donated by Hon. A. Greeves in 1862). It appears that, historically, only *Diprotodon* species have been described from the original site. However, from excavations this century, *Diprotodon* species was not commonly found in the assemblage at the Classic Site with evidence for only one individual. At the Mayne Site, evidence of at least 2 more individuals of *Diprotodon* have been found from the excavations in 1991, supporting the historical records.

Partly rotted axe point picket posts, that have been broken off and worn down level with the ground surface, were found marking two of the corners of what appeared to be an old excavation at the Mayne Site. These posts were exactly 3 feet (0.91 metres) apart. After investigation several poorly preserved hand cut planks of wood were also found lining one wall of the excavation. A row of similar picket posts are located about 5 metres to the north of this well, which may once have been part of a fence. These posts are made of the same wood, in the same fashion, and occur at the same depth in the ground as the other post (Fig. 2).

The excavation undertaken in 1991 at the Mayne Site was a 7 feet by 7 feet (2.13 metres) square, oriented north/south by east/west. The area delineated by the picket posts, where the European artefacts were found, was discovered at the **western** end of the excavation. At the level of the bone bed at this Site was a red gravelly matrix (similar to that described

Fig. 2. Axe point fence post, Mayne Site.

Fig. 3. The bones at Lancefield are found in concentrated pockets.

by Hobson 1846b). The few bones found at this level, at the western end, were small and broken and had the appearance of being previously 'picked over' (that is, that specimens of interest had been collected, leaving the less 'exciting' fragments in the pit). The eastern side of the pit was directly adjacent to the western side but outside the area defined by the picket posts. There was a large collection of bones in the eastern side displaying the characteristic jumble of the bones found in other areas at Lancefield (Fig. 3). This collection appeared rich and diverse and included larger specimens of incisors, molars and limb bones. The eastern side appeared undisturbed. Between the two ends of the pit there was nothing to suggest that the deposition of the bone bed wasn't synchronous or that the difference had been influenced by processes such as water flow or reworking.

I believe the evidence outlined above confirms the relocation of the original Site, discovered last century, which is now referred to the as the 'Mayne Site'.

In all 24 species of animals have been found in the Lancefield deposits, 16 exclusively from the Classic Site and 18 from the South Site. Table 1 details this more clearly.

Fauna Notes

Sub family Macropodinae

Today, members of this group are the dominant terrestrial herbivorous mammals in Australia. One extinct species of this group from the Lancefield collection is *Macropus titan*. Related to the modern *Macropus giganteus* (Eastern Grey Kangaroo) elements of this species make up approximately 90% of the total number of individuals found at the Lancefield Site.

Subfamily Diprotodontinae

Diprotodons are the giants of the marsupial world and the species at Lancefield, *Diprotodon australis* was the largest know marsupial ever, (Rich, from Vickers-Rich *et al.* 1991) about the size of a living rhinoceros and weighing about 1150 kg. They were common and wide spread, inhabiting drier interior regions as well as coastal margins. Most finds have been from old lake basins such as Lake Callabona in S.A..

Family Dromornithidae

Genyornis species

These were a large ground dwelling bird with hoof-like phalanges and a heavy jaw. Their wings were reduced suggesting they were not to be able to fly. *Genyornis* may have weighed up to 200 kg.

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References

Bowler, J.M. (1982). Aridity in the Late Tertiary and Quaternary of Australia. Barker W.R., and Greenslade. P.J.M., In 'Evolution of the Flora and Fauna of Arid Australia'. (Peacock Publications: Australia).

Frakes, L.A., B McGowran and J. Bowler, (1987). 'Fauna of Australia', Vol 1, (Australian Grovernment Printing Services: Canberra).

Gillespie, R. et al (1978). Lancefield Swamp and the Extiction of the Australian Megafauna. Science (reprint series) 200: 1044-1048.

Table 1: Faunal List for the Lancefield Palaeofaunal sites - Classic and South

GENUS and SPECIES NAME	COMMON NAME	HABITAT	FEEDING PREFERENCE	MODERN STATUS	MIN. # CLASSIC SITE	MIN.# SOUTH SITE
Macropus titan	none	forest edge, grass lands	grazer	Common modern form	91	(139)
Protemnodon anak	Giant Wallaby	grassy forests	grazer browser	extinct	9	(6)
Protemnodon brehus	Giant Wallaby	grassy forests	grazer browser	extinct	shares number with above	(5)
Sthenurus occidentalis	none	grassy forests	browser	extinct	4	(6)
Diprotodon australis	none	light scrub and bush land	browser	extinct	1	(10)
Vombatus species	Wombat species	open forest	browser	common modern forms	1	(1)
Thylacinus cf. cynocephalus	Tasmanian Tiger, Thylacine	open forest, grassy plains	carnivore	extinct	1	(1)
Sarcophilus species	Tasmanian Devil	scrub sclerophyll forest	carnivore	extinct mainland Australia	1	-
Aepyprymnus rufescens	Rufous Rat-kangaroo, Rufous Bettong	open forest wood land	omnivore	common	1	-
Propleopus species	none	open forest, forest edge	Carnivrous/ omniverous	extinct	1	(2)
cf Thylogale	Pademelon	forest edges	grazer and browser	common	1	-
Macropus cf. furogriseus	Red-necked Wallaby	open forest	grazer	common	1	-
Macropus dorsalis	Black-striped Wallaby	forest, dense scrub	grazer	common	1	-
Mastacomys fuscus	Broad-toothed Rat	woodland, wet sclerophyll	grass and seeds	modern uncommon	1	(1)
Genyomis species	none	forests	omnivorous	extinct	5	-
Dromaius species	none	forests	omnivorous	extinct	1	(6)
Scincidae	Skink	various	insectivorous	common	-	(1)
Thylacoleo carnifex	Marsupial Lion	forest edge, open forest	carnivorous	extinct	-	(1)
cf. Petrogale	Rock-wallaby	open forest	grazer and browser	common	-	(1)
Zygomaturus trilobus	none	grassy woodland	browser	extinct	-	(3)
cf. Onchegalea	Nailtail Wallaby	scrub, open wood-land	browser	common to rare	-	(1)
Potorous species	Potoroo	heath, sclerophyll forest	browser, omnivorous	common	-	(1)
Gallinula mortierii	Tasmanian Native-hen	Near permanant water	grazer	Extinct on mainland	-	(1)
Procoptodon rapha	none	Various	grazer	extinct	-	(1)

Brackets denote minimum species numbers prior to 1991 excavation at the South Site Habitat and feeding information from Murray (1984) from Rich, Monaghan, Baird and Rich, (1991), Robert Baird (pers. comm. Monash University) Chris Nedin (pers. comm. University of Adelaide)

Hobson, E.C. (1845). In Orchiston, D.W. et al. (1977). A History of Nineteenth Century Investigations at the Lancefield Megafaunal Site. The Artefact 2(3): 105-22.

Hobson, E.C. (1846b). In Orchiston D.W. et al. (1977). A History of Nineteenth Century Investigations at the Lancefield Megafaunal Site. The Artefact 2(3): 105-22.

Hope, J. (1984). The Australian Quaternary. In 'Vertebrate Zoogeography and Evolution in Australia'. Eds. M. Archer and G. Clayton. (Hesperian Press: Australia).

Horton, D.R. (1984). Red Kangaroos: The Last of the Australian Mega fauna. In 'Quaternary Extinctions'. Eds. P.S. Martin and R.G. Klein. (Universtity of Arizona Press: USA).

Horton, D.R. and Samuel, J, (1978). Palaeopathology of a Fossil Macropod Populations. Australian Journal of Zoology 26: 279-292.

Ladd, P.G. (1976a). Past and Present Vegetation of the Lancefield Area, Victoria. The Artefact 1(3): 113-27.

Ladd, P.G. (1976b). Pollen Studies in Central and Eastern Victoria. PhD thesis. (University of Melbourne: Australia).

Murray, P. (1984). Extinctions Down Under: A Bestiary of Extinct Australian Late Pleistocene Monotremes and Marsupials. In 'Quaternary Extinctions'. Eds. P.S. Martin and R.G. Klein. (University of Arizona: USA).

Orchiston, D.W. et al. (1977). A History of Nineteenth Century Investigations at the Lancefield Megafaunal Site. The Artefact 2(3): 105-22.

Rich, T.H. (1984). Australias Largest Marsupial, Diprotodon: Its Ancestry, Palaeobiology and Extinction. In 'Vertebrate Zoogeography and Evolution in Australia'. Eds. M. Archer and G. Clayton. (Hesperian Press: Australia).

Vickers-Rich, P. Monaghan, J.M., Baird, R.F. and Rich, T.H. (1991). 'Vertebrate Palacontology of Australasia'. (Pioneer Design Studios.)

Plant associations of Some Australian Jewel Beetles (Coleoptera: Buprestidae: Agrilinae)

G.A. Webb*

Recent observations on the Adult and larval host plants for some species of the jewel beetle genera *Agrilus* Curtis, *Cisseis* Gory and Laporte, and *Ethon* Gory and Laporte are presented in Table 1. The following discussion reviews earlier literature on host plants for these species.

Previous Observations and Discussions

Introduction

Jewel beetles fill two important ecological roles. As larvae (and as adults in some cases) they contribute to nutrient recycling through breakdown of timber and other vegetative matter, and as adults they are important pollen vectors. Despite their obvious ecological importance, very little is known of the adult and larval food plants of many Australian jewel beetles, particularly the smaller, less colourful species of the subfamily Agrilinae.

The tribe Agrilinae in Australia currently comprises 14 genera (Bellamy 1986). The largest genus, *Cisseis*, is known to use a wide variety of plant families but individual species may be associated with only single plant families and in some cases single plant species. The genera *Ethon* Gory and Laporte and *Agrilus* Curtis mostly use the three large Australian plant families Mimosaceae, Myrtaceae and Fabaceae. Few data are available for the remaining genera of Agrilinae.

Agrilus

Agrilus australasiae Laport and Gory

This species has been recorded feeding on the foliage of a number of *Acacia* spp. (Mimosaceae) (Froggatt 1902; Gurney 1910; Hawkeswood 1981; 1992; van den Berg 1982; Williams and Williams 1983). Both Froggatt (1927) and Tepper (1887) recorded *Acacia pycnantha* Benth. as a larval host of *A. australasiae* while Volkovitsch and Hawkeswood (1990) reared adults from *Acacia sophorae* (Labill.) R.Br. Brooks (1965) recorded an adult *A. australasiae* on the foliage of *Allocasuarina littoralis* (Salisb.) L.A.S. Johnson (as *Casuarina suberosa* Otto and Dietr.) (Casuarinaceae) but did not state whether it was feeding on this plant.

Although *Acacia* spp. appear to be the primary hosts of *A. australasiae* and other *Agrilus* spp. (Hawkeswood and Peterson 1982; Williams 1985), Williams (1985) has reared *Agrilus deauratus* Macleay from species of Euphorbiaceae and Myrtaceae.

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Cisseis

Cisseis acuducta Kirby

This species has been previously recorded on the flowers of *Leptospermum* spp. (Myrtaceae) (Webb 1986) and on the foliage of *Acacia longifolia* (Andr.) Willd., but mostly on the flowers and foliage of species of Fabaceae including *Dillwynia floribunda* Sm. and *Dillwynia retorta* (Wendl.) Druce (Hawkeswood 1978; Hawkeswood and Peterson 1982; Williams and Williams 1983). Froggatt (1892) reared *C. acuducta* (as *Ethon marmoreum* Laporte and Gory) from root galls on *Dillwynia retorta* (as *D. ericifolia* Smith).

Cisseis viridiceps Kerremans

A host plant had not previously been recorded for this species. Hawkeswood (1980) reported similar damage to the petals of *Patersonia occidentalis* R. Br. (Iridaceae) caused by *Ethon breve* Carter.

Cisseis scabrosula Kerremans

C. scabrosula has been recorded feeding on the foliage of a number of *Acacia* spp. (Hawkeswood 1981; Webb 1988; Williams and Williams 1983) and has been reared from the timber of *Acacia longifolia* (Froggatt 1895; van den Berg 1982; Webb 1988) and now from *Acacia floribunda* (Vent.) Willd. Williams and

Table 1. Adult and larval host plants of some jewel beetles (Agrilinae). Insect specimens are lodged in the collection of the Forestry Commission of N.S.W., Sydney.

Species	Location	Collector	Date	Adult Host Plant	Larval Host Plant	Comments
Agrilus australasiae	NSW, Bombala, Coolangubra SF	G.A. Webb	22 January 1984	*Acacia dealbata* Link (Mimosaceae)		Collected on intact foliage. Damage to adjacent foliage was evident
Cisseis acuducta	NSW, Cowan	G.A. Webb	27 October 1982	*Dillwynia floribunda* Sm. (Fabaceae)		Collected on flowers.
	NSW, Cheero Point via Brooklyn	G.A. Webb	5 November 1982	*Dillwynia retorta* (Wendl.) Druce (Fabaceae)		Collected on flowers.
	NSW, Sydney, Caringbah	J.E. Kelly	22 November 1962	*Leptospermum* sp. (Myrtaceae)		Collected on flowers.
Cisseis scabrosula	NSW, Sydney, Cumberland SF	G.A. Webb	21 September 1983		*Acacia floribunda* (Vent.) Willd (Mimosaceae)	Emerged from dead branch, 21 Octobber 1983
Cisseis viridiceps	NSW, Sydney, Darling Mills S.F.	G.A. Webb	23 November 1988	*Dillwynia retorta* (Wendl.) Druce (Fabaceae)		Feeding on flower petals producing small (ca. 1 mm diameter) round holes in the petals.
Cisseis vicina	NSW, Bombala, Cann Valley Hwy near Rockton	G.A. Webb	29 January 1985	*Leptospermum myrtifolium* Sieb. ex DC (Myrtaceae)		Collected on stem at dusk. Sheltering overnight with range of other insects.
Ethon affine	NSW, Cheero Point via Brooklyn	G.A. Webb	3-5 November 1982	*Pultenaea ferruginea* Rudge (Fabaceae)		Collected on flowers.
				Pultenaea flexilis Sm (Fabaceae)		Collected on flowers.
				Dillwynia retorta (Wendl.) Druce (Fabaceae)		Collected on flowers.
	NSW, Sydney, Cowan	G.A. Webb	26-27 October 1982	*Pultenaea ferruginea* Rudge (Fabaceae)		Collected on flowers.
				Dillwynia floribunda Sm. (Fabaceae)		Collected on flowers.
	NSW, Sydney, Darling Mills SF	G.A. Webb	30 September 1988	*Phyllota grandiflora* Benth. (Fabaceae)		Collected on flowers.
	NSW, Sydney, Bobbin Head	A.B. Rose	No data specified	? *Cassinia longifolia* R. Br. (Asteraceae)		Collected "in cop." on "C. longifolia"
Ethon fissiceps	NSW, Sydney, Cowan	G.A. Webb	26-27 October 1982	*Dillwynia floribunda* Sm. (Fabaceae)		Collected on flowers.
Ethon maculatum	NSW, Grafton	F.S. Paul	10 October 1946	*Jacksonia* sp. (Fabaceae)		Collected on flowers.

Williams (1983) also recorded adult *C. scabrosula* on *Leptospermum flavescens* Sm. (Myrtaceae) and an unidentified *Casuarina* sp. (Casuarinaceae).

Cisseis vicina Kerremans

This species has been recorded from the flowers and foliage of a number of *Leptospermum* spp. (Myrtaceae) (Hawkeswood 1978, 1987, Williams and Williams 1983), but not previously from *Leptospermum myrtifolium* Sieb. ex DC. Williams and Williams (1983) also recorded *Leptomeria acida* R. Br. (Santalaceae) as an adult host plant.

Cisseis spp. do not appear to be host specific and have been recorded on hosts from a wide range of plant families including Apiaceae, Casuarinaceae, Fabaceae, Mimosaceae, Myrtaceae, Proteaceae, Santalaceae and Xanthorrhoeaceae (Brooks 1948; 1965; Froggatt 1895; 1896; 1914; Gallard 1916; Gurney 1910; Hawkeswood 1978; 1981; 1987; Hawkeswood and Peterson 1982; Tepper 1887; van den Berg 1982; Webb 1986; 1988; Williams and Williams 1983). Most species have been found on *Acacia* spp. (Mimosaceae) and on various species of Myrtaceae and Fabaceae. As a number of species have been reared from *Acacia* spp. timber and adults are most often observed on the foliage of acacias it is probable that, as Hawkeswood and Peterson (1982) suggested, *Acacia* spp. are the primary hosts. A number of species have been recorded on the flowers and foliage of species of Fabaceae but only *C. acuducta,* has been recorded using Fabaceae as a larval host (Froggatt 1892).

Ethon

Ethon affine Laporte & Gory

Apart from the uncertain record of *E. affine* from *Cassinia longifolia* R. Br. (Asteraceae) above, this species is known only from species of Fabaceae and *Leptospermum* (Carter 1923; Froggatt 1892; Hawkeswood 1988; Hawkeswood and Peterson 1982; Williams and Williams 1983; this study), being collected from flowers, foliage and timber. *E. affine* has not previously been recorded from *Dillwynia retorta* and *Pultenaea flexilis* Sm. (Fabaceae).

Ethon fissiceps Kirby

The only known host for *E. fissiceps* is *Dillwynia floribunda* (Williams and Williams 1983; this study).

Ethon maculatum Blackburn

This species had not previously been recorded from *Jacksonia* spp. (Fabaceae). Froggatt (1892) reared *E. maculatum* from root galls on *Dillwynia retorta* (as *D. ericifolia*).

Ethon spp. are mostly associated with species of Fabaceae (Froggatt 1892; Tepper 1887; Williams and Williams 1983). However, Hawkeswood (1980) observed *E. breve* feeding on the petals of *Patersonia occidentalis* (Iridaceae), and *Ethon bicolor* Laport and Gory (Williams and Williams 1983), and unspecified *Ethon* spp. (Carter 1923) have been recorded on *Leptospermum* spp. Hawkeswood and Peterson (1982) suggested that this close association with Fabaceae represents a recent divergence from *Acacia* feeding *Cisseis.* While *Ethon* spp. are known to breed only in Fabaceae, the presence of adults on other plant families indicates that adults may be less discriminating in their choice of food.

References

Bellamy, C.L. (1986). The higher classification of Australian Buprestidae, with the description of a new genus and species (Coleoptera). *Australian Journal of Zoology* **34:** 583-600

Brooks J.G. (1948). Some north Queensland Coleoptera and their food plants. *North Queensland Naturalist* **15:** 26-29.

Brooks J.G. (1965). North Queensland Coleoptera - their food and host plants. *North Queensland Naturalist* **32:** 29-30.

Carter H.J. (1923). Revision of the genera *Ethon, Cisseus* and their allies (Buprestidae). *Proceedings of the Linnean Society of N.S.W.* **48:** 159-176.

Froggatt W.W. (1892). Gall-making buprestids. *Proceedings of the Linnean Society of N.S.W.* **7:** 323-326.

Froggatt, W.W. (1895). On the life-histories of Australian Coleoptera. Part 3. *Proceedings of the Linnean Society of N.S.W.* **10:** 325-336.

Froggatt W.W. (1896). The entomology of the grass-trees (Xanthorroea). *Proceedings of the Linnean Society of N.S.W.* **21:** 74-87.

Froggatt W.W. (1902). Insects of wattle trees. *Agricultural Gazette of N.S.W.* **13:** 701-720.

Froggatt W.W. (1914). Insects associated with *Angophora cordifolia. Australian Naturalist* **3:** 18-20.

Froggatt W.W. (1927). 'Forest Insects and Timber Borers'. (Government Printer: Sydney.)

Gallard L. (1916). List of insects associated with *Acacia decurrens. Australian Naturalist* **3:** 112-114.

Gurney W.B. (1910). A study of wattle trees *(Acacia)* and a list of insects of wattle trees. *Australian Naturalists* **2:** 56-59.

Hawkeswood T.J. (1978). Observations on some Buprestidae (Coleoptera) from the Blue Mountains, N.S.W. *Australian Zoology* **19:** 257-275

Hawkeswood T.J. (1980). An adult food plant of *Ethon breve* (Coleoptera: Buprestidae). *West Australian Naturalist* **14:** 198.

Hawkeswood T.J. (1981). Observations on two sympatric species of Buprestidae (Coleoptera) from sand dunes on the north coast of New South Wales. *The Victorian Naturalist* **98:** 146-151.

Hawkeswood T.J. (1987). Pollination of *Leptospermum flavescens* Sm. (Myrtaceae) by beetles (Coleoptera) in the Blue Mountains, New South Wales, Australia. *Giornale Italiana Entonologia* **3:** 261-269.

Hawkeswood T.J. (1988). A review of larval host records for twelve Australian Buprestidae (Coleoptera). *Giornale Italiana Entonologia* **4:** 81-88.

Hawkeswood T.J. (1992). Review of the biology and host plants of the Australian jewel beetle *Agrilus australasiae* Laporte and Gory (Coleoptera: Buprestidae). *Spixiana* **15:** 81-87.

Hawkeswood T.J. and M. Petersen (1982). A review of larval host records for Australian jewel beetles (Coleoptera: Buprestidae). *The Victorian Naturalist* **99:** 240-251.

Tepper J.G.O. (1887). 'Common Native Insects of South Australia. A Popular Guide to South Australian Entomology. Part 1. Coleoptera or Beetles'. (E.S.Wigg and Son: Adelaide.)

van den Berg M.A. (1982). Coleoptera attacking *Acacia dealbata* Link., *Acacia decurrens* Willd., *Acacia longifolia* (Andr.) Willd., *Acacia mearnsii* De Wild. and *Acacia melanoxylon* R. Br. in Australia. *Phytophylactica* **14:** 51-55.

Volkovitsch and Hawkeswood T.J. (1990). The larvae of *Agrilus australasiae* Laporte and Gory and *Ethon affine* Laporte and Gory (Insecta: Coleoptera: Buprestidae). *Spixiana* **13:** 43-59.

Webb G.A. (1986). Flower-visiting beetles of some New South Wales Leptospermoidea. *The Victorian Naturalist* **103:** 170-174.

Webb G.A. (1988). Some foliage insects of *Racosperma longifolia* (Andr.) L. Pedley (Mimosaceae) in New South Wales. *The Victorian Naturalist* **105:** 88-91.

Williams G.A. (1985). New larval host plants for some Australian Buprestidae and Cerambycidae (Coleoptera). *Australian Entomologiea Magazine* **12:** 41-46.

Williams, G.A. and T.W. Williams (1983). A list of the Buprestidae (Coleoptera) of the Sydney basin, New South Wales, with adult food plant records and biological notes on food plant associations. *Australian Entomologiea Magazine* **9:** 81-93.

Grevillea williamsonii F.V.M. Rediscovered

Neil R. Marriott*

In 1893 H. B. Williamson discovered a solitary Grevillea at the foot of a small hill between Mt Abrupt and Mt Sturgeon, at the southern extremity of the Grampians/Gariwerd Ranges in western Victoria. This was described by Von Mueller in December of that year as *Grevillea williamsonii,* the description of which was published in The Victorian Naturalist Vol 10: 129. It is therefore most appropriate that this article about its rediscovery a hundred years later should also be published in *The Victorian Naturalist.*

The southern section of the Grampians was burnt out in 1897, and the sole *Grevillea williamsonii* was destroyed. Subsequent searches (often quite thorough and extensive) by botanists and naturalists had failed to relocate the species, and it was eventually presumed extinct. In 'A Handbook to Plants in Victoria Vol.II (1972) Jim Willis states that 'affinities are with *G. aquifolium* and it is possible that *G. williamsonii* was a mutant of this species or part of a hybrid population'.

Fig 1. *G. williamsonii,* type specimen housed at Melbourne Herbarium. Photo: Neil Marriott.

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Several years ago, further doubt was thrown on the validity of *G. williamsonii* as a species, when steam-softened specimens housed at the Melbourne Herbarium were found to be sterile. McGillivray, in 'Grevillea'(1993) states that 'Its treatment as an extinct species is not appropriate'.

Last year I was told by a friend, of the discovery in the southern Grampians of a population of unusual Grevilleas with toothbrush flowers and entire leaves. Entire leaved forms of *G. aquifolium* are not uncommon in the Grampians, and although I briefly considered *G. williamsonii,* I dismissed the idea, preferring to see a specimen of the plant first.

In November 1992 I was duly brought some flowering specimens and I couldn't believe my eyes: having seen the original specimens of *G. williamsonii* in the Melbourne Herbarium, a quick examination of the fresh material pointed to it being almost certainly that species. And this was a small population, not just one solitary plant! As I was going to the Herbarium the next day to complete some work on new species for the 'Grevillea Book', I took the opportunity to carry out microscopic comparisons between H. B. Williamsons collection and the fresh specimens. There was no doubt, *G. williamsonii* had been rediscovered.

Dave and Lyn Munro of Dunkeld sensed that they had discovered something different when they stumbled on the small colony of unusual Grevilleas whilst looking for orchids. They were absolutely thrilled to find out the plants were the presumed extinct *G. williamsonii.* The site was in the bush off Cassidy's Gap Road, north of Picaninny Hill where Williamson discovered his Grevillea 100 years ago.

Arrangements were made to visit the site, and we marvelled at the luck of the Munro's discovery. The Grevilleas are not visible from the track and thorough searching of the area failed to reveal any more plants. On the other hand, there are many miles of trackless bush between both collection sites, so it is highly probable that further populations exist. The Cassidy Gap colony consists of 5 mature plants and 7 smaller plants. Mature plants were dense shrubs 1 m x 1 m with a distinct horizontal layering habit, ashy grey-green entire leaves and masses of small yellow, orange-yellow, pink and red flowers. One shrub was greener with occasionally toothed leaves, while the young shrubs had similarly toothed juvenile leaves. Examination confirmed that all plants were of seed origin, and not root-suckers as is usually the case with sterile species, eg *Grevillia infecunda* from near Anglesea, and *G. renwickiana* from near Braidwood, NSW.

It was also most interesting to note that several of the larger bushes had immature follicles (seed pods) developing (c 30 follicles), despite the fact that the flowers we had dissected had no anthers, hence no pollen, and therefore theoretically sterile, tying in with the findings for Williamsons plant. A number of young follicles were bagged, resulting in the subsequent collection of 5 well-developed seeds several weeks later. Possible explanations of this surprising outcome could be that the species has different phases of fertility in its flowers over the flowering season, for example, early season flowers may be fertile with end-of-season flowers being sterile. A further explanation could be that the flowers are self pollinated while in bud, with anthers being shed at anthesis. Or it may be that *G. williamsonii* is parthenogenetic: that is, it has the ability to develop seed from the female gamete without fusion with the male. If this were the case it would make it unique within the genus. However, further research will eventually reveal the truth to this fascinating puzzle.

What is clear is the fact that *G. williamsonii* is a species in its own right; it has numerous characteristics that separate it from all other species, such as a scarcely enlarged style end, angularly revolute leaf margins, semi-appressed indumentum on lower leaf surface and flowers that markedly change colour after anthesis. As well as these features it also breeds true, as is evidenced by the 7 young plants. From its morphological features it appears to be actually closer to *G. ilicifolia* than *G.aquifolium*, and in fact, may be a precursor to both, possibly being displaced, due to its highly specialised breeding mechanism. The wonderful thing is that Von Meuller's *Grevillea williamsonii* now does exist as a living species, albeit in a rather precarious state.

Fig 2. *G. williamsonii*, Cassidy Gap tk, October 1992. Photo: Neil Marriott.

Fig 3. *G. williamsonii*, Cassidy Gap tk, October 1992. Photo: Neil Marriott.

Fauna Survey Group Contribution No. 15

Mammal Survey of Sunday Island, South Gippsland, Victoria

P. Myroniuk*, J. Grusovin**, R. Thompson**

Summary

A limited survey was conducted of the mammalian fauna of Sunday Island. The list of mammals presented is a compilation of previous surveys and the one reported on here. Where possible, other vertebrate taxa were identified and recorded. It is recommended that further surveys of a longer duration take place, not only on Sunday Island, but other private and public islands of the Corner Inlet group. Follow-up monitoring surveys at regular intervals should also take place, so as to ascertain the viability and fitness of these relatively small island populations, and to detect possible local extinction processes which may be occurring.

Introduction

Sunday Island (38°42'S, 146°37'E) is a continental island separated from the mainland by the shallow Midge Channel. It is approximately 220 km south-west of Melbourne and 6 km from the closest mainland town of Port Albert.

The Mammal (now Fauna) Survey Group of The Field Naturalists Club of Victoria was requested by the committee of management of Sunday Island, to conduct a survey of the island. To this we have added earlier surveys of Davidson *et al.* (1987) and Norris *et al.* (1979). Although Norris *et al.* (1979) was concerned with the whole South Gippsland region, they do make specific mention of the mammals recorded on Sunday Island.

Methods and Survey Area

To investigate the mammal fauna of Sunday Island, several methods were chosen: Collapsible aluminium treadle traps, manufactured by Elliott Scientific, Upwey, Victoria (commonly referred to as Elliott traps); wire cage traps with spring loaded trapdoor; pitlines consisting of six plastic buckets approximately 24 cm in diameter and 60 cm deep, spaced 5 m apart with flywire drift fences approximately 30 cm high, running across the buckets; harp traps as described by Tideman and Woodside (1978); mist nets; spotlighting and general observations of tracks, scats, diggings, etc. The Elliott and cage traps were baited with a mixture of peanut butter, oats and honey, except for a few cage traps, which were baited with small fish. Seven trapping sites were chosen to sample the mammalian fauna (Fig. 1.).

Site 1 - The Jetty

The preliminary reconnaissance of the island found Water-rat tracks in sand on the east side of the jetty. Ten cage traps were placed on the east side of the jetty and baited with small fish in order to try to trap any Water-rats in the area. On the third night of trapping, the cage traps were moved to the west of the jetty.

Site 2 - Lipscombe Point

An area of secondary sand dune bushland located east of the jetty and north of Gumboot Flat. A Harp trap was set for two nights, to catch bats.

Site 3

An area of secondary sand dune bushland with *Banksia serrata* Saw Banksia and *Eucalyptus viminalis* Manna Gum on the crest of dunes, and *Melaleuca ericifolia* Swamp Paperbark in the dune swales.

The trapping site was approximately 1.5 km south-west from the jetty. One pitline was set, for small terrestrial species.

Site 4

Located directly opposite Site 3, Site 4 was located in a *M. ericifolia* thicket,

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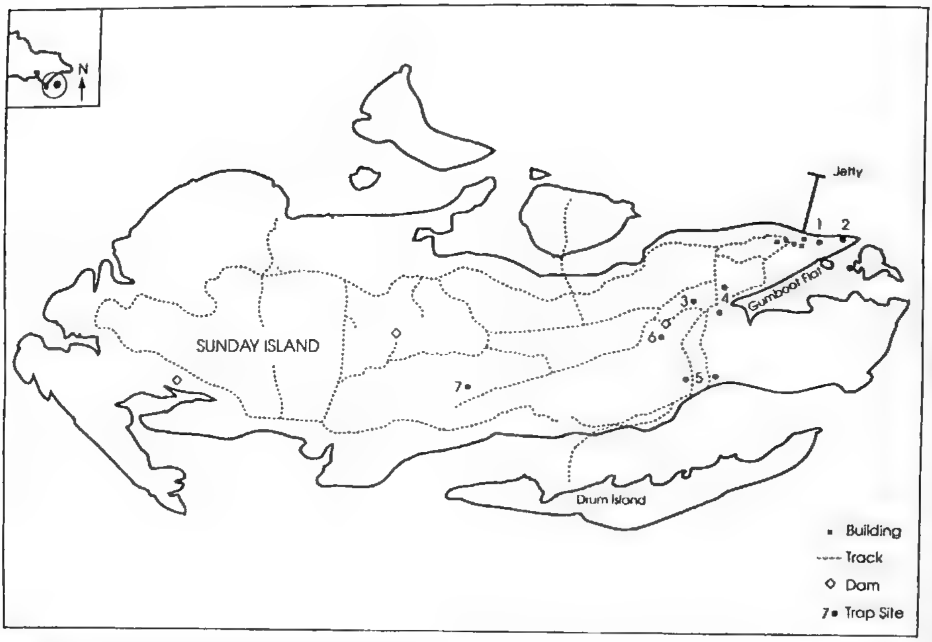

Fig. 1. Sunday Island, showing location of trap sites.

merging into sedgeland comprising of *Juncus* sp., *Poa* sp. and *Sarcocornia* sp. Fifteen cage traps were set.

Site 5

This site was located at the southern end of a large fire break, south-west of Gumboot Flat. The habitat is described as an interdunal Banksia woodland (Will and Chris Ashburner, personal communication), comprising of *E. viminalis, B. serrata, M. ericifolia, Acacia mearnsii* Black Wattle, *Cassinia aculeata* Common Cassinia, *Leptospermum lanigerum* Woolly Tea-tree, *Lepidosperma laterale* Sword Sedge and *Lomandra longifolia* Spiny-headed Mat-rush. One pitline and 30 Elliott traps were set at this site.

Site 6

A mist net and harp trap were set at Site 6, a small water hole at the northern end of the fire break mentioned for Site 5.

Site 7

This site is some 4 km south-west of the jetty, approximately 500 m west of a 7 hectare holding pen for deer. The area is a tall open Banksia/Eucalypt woodland, bordered by *Gahnia* sp. sedgeland and an understorey predominantly of *Gahnia trifida* Coast Saw-sedge and bracken.

One pitline, 30 Elliott traps and 12 cage traps were set at this site.

Results

Three nights of trapping took place on Sunday Island from November 1st to November 3rd 1987. Table 1 lists the vertebrate fauna trapped and observed on Sunday Island.

One *Antechinus minimus* Swamp Antechinus and *Cercartetus nanus* Eastern Pygmy-possum were trapped at Site 3 and three *C. nanus* were trapped at Site 5. One *Tiliqua nigrolutea* Blotched Blue-tongued Lizard was the only animal trapped in the cage traps at Site 7. There was no success at Site 1 and only one *A. minimus* was trapped at Site 5.

The mist net was attended on the second night at Site 6 without success. However, *Nyctophilus geoffroyi* Lesser Long-eared Bat was trapped on two consecutive nights in the harp trap at Site 6. The harp trap at Site 2 was unsuccessful.

A number of *Cervus porcinus* Hog Deer were sighted as well as *Wallabia bicolor* Swamp Wallaby, together with traces of *Macropus giganteus* Eastern Grey Kangaroo and *Cervus dama* Fallow Deer.

A few dead specimens were found on the coast, which included the complete carcase of *Hydrurga leptonyx* Leopard Seal, the head of which was removed and the skull extracted, a complete skeleton of *Hydromys chrysogaster* Water-rat and skulls of *Diomedea melanophrys* Black-browed Albatross and *Macronectes halli* Northern Giant Petrel. All material was lodged with the Museum of Victoria.

Many birds were sighted (Table 1), including several nests of *Haematopus longirostris* Pied Oystercatcher along parts of the coast, and a report of at least 12 *Haliaeetus leucogaster* White-breasted Sea Eagle seen circling together on a thermal.

Some reptiles were seen during the day, including small unidentified skinks, *T. nigrolutea*, several *Austrelaps superbus* Copperhead, and *Notechis scutatus* Eastern Tiger Snake.

The one night of spotlighting was unsuccessful in detecting any nocturnal vertebrates, particularly large possums.

From data presented here, and past surveys, a list to date of mammals for Sunday Island can be presented (Table 2).

Table 1. Vertebrate fauna trapped and sighted on Sunday Island during the FNCV Mammal Survey field trip, November 1987.

Class Amphibia
Unidentified Frog

Class Reptilia
Unidentified Skinks
Tiliqua nigrolutea Blotched Blue-tongue Lizard
Austrelaps superbus Copperhead
Notechis scutatus Eastern Tiger Snake

Class Aves
** *Diomedea melanophrys* Black-browed Albatross
** *Macronectes halli* Northern Giant Petrel
Egretta garzetta Little Egret
Threskiornis molucca White Ibis
Cygnus atratus Black Swan
Tadorna tadornoides Australian Shelduck
Anas castanea Chestnut Teal
Haliaeetus leucogaster White-bellied Sea Eagle
Aquila audax Wedge-tailed Eagle
Falco berigora Brown Falcon
**Phasianus colchicus* Ring-necked Pheasant
Turnix varia Painted Button-quail
Haematopus longirostris Pied Oystercatcher
Vanellus miles Masked Lapwing
Pluvialis squatarola Grey Plover
Charadrius ruficapillus Red-capped Dotteral
Numenius madagascariensis Eastern Curlew
Tringa nebularia Greenshank
Limosa lapponica Bar-tailed Godwit
Calidris ruficollis Red-necked Stint
Calidris alba Sanderling
Larus novaehollandiae Silver Gull
Larus pacificus Pacific Gull
Hydroprogne caspia Caspian Tern
Sterna bergii Crested Tern
Phaps chalcoptera Common Bronzewing
Platycercus elegans Crimson Rosella
Dacelo novaeguineae Laughing Kookaburra
Hirundo neoxena Welcome Swallow
**Turdus merula* Blackbird
Colluricincla harmonica Grey Shrike-thrush
Rhipidura fuliginosa Grey Fantail
Rhipidura leucophrys Willie Wagtail
Cisticola exilis Golden-headed Cisticola
Acanthiza sp. Thornbill
Anthochaera carunculata Red Wattlebird
Anthochaera chrysoptera Little Wattlebird
Lichenostomus chrysops Yellow-faced Honeyeater
Lichenostomus penicillatus White-plumed Honeyeater
Phylidonyris novaehollandiae New Holland Honeyeater
Acanthorhynchus tenuirostris Eastern Spinbill
Ephthianura albifrons White-fronted Chat
Pardalotus punctatus Spotted Pardalotte
Emblema temporalis Red-browed Firetail
Sturnus vulgaris Common Starling
Gymnorhina tibicen Australian Magpie
Corvus sp. Raven

Class Mammalia
Antechinus minimus Swamp Antechinus
Cercartetus nanus Eastern Pygmy-possum
Macropus giganteus Eastern Grey Kangaroo
Wallabia bicolor Swamp Wallaby
Nyctophilus geoffroyi Lesser Long-eared Bat
** *Hydrurga leptonyx* Leopard Seal
**Cervus dama* Fallow Deer
**Cervus porcinus* Hog Deer
** *Hydromys chrysogaster* Water-rat

Key: * Introduced
** Skeletal remains found

Table 2. Record of mammals for Sunday Island

Tachyglossus aculeatus Short-beaked Echidna	* *Cervus dama* Fallow Deer
Antechinus minimus Swamp Antichinus	* *Cervus porcinus* Hog Deer
Phascolarctos cinereus Koala	** *Cervus unicolor* Sambar Deer
Cercartetus nanus Eastern Pygmy-possum	* *Bos taurus* Domestic Cattle
Macropus giganteus Eastern Grey Kangaroo	** *Capra hircus* Goat
Wallabia bicolor Swamp Wallaby	* *Oryctolagus cuniculus* European Rabbit
Tadarida australia White-striped Mastiff-bat	*Hydromys chrysogaster* Water-rat
Nyctophilus geoffroyi Lesser long-eared Bat	* *Mus musculus* House Mouse
Chalinolobus morio Chocolate Wattled Bat	
Vespadelus regulus King River Eptesicus	Key: * Introduced
* *Vulpes vulpes* Red Fox	** No longer present
* *Felis catus* Feral Cat	Sources: Norris *et al* .(1979); Davidson *et al.*
Hydrurga leptonyx Leopard Seal	(1987); this paper.

Discussion

As this survey was of a relatively short duration, the vertebrates recorded by no means form an exhaustive list. Lengthier surveys over 12 months or more are required to record all possible vertebrate taxa for Sunday Island. However, we can look at past surveys, together with Museum records, to determine the extent of the vertebrates of Sunday Island.

There have been two surveys prior to this, which examined the vertebrates of Sunday Island. Norris *et al* (1979) surveyed South Gippsland, including the islands, using a number of techniques such as direct trapping, observations and literature and museum searches. Their reptilian and avian lists are concerned with the distribution of species in particular habitats, not specific localities, although they do give species distributions mapped on five minute grids of their study area. Their amphibian data is mapped on ten minute grids. The reader is referred to Norris *et al* (1979) for a fuller account of amphibian, reptilian and avian distribution for South Gippsland, including Sunday Island. Their mammalian lists however do mention Sunday Island.

A second survey conducted in March 1987 was undertaken by Monash University (Davidson *et al* 1987). Their survey recorded mammals and no other vertebrate taxa.

Comparing the surveys for mammals, the Norris *et al.* (1979) survey was the most extensive for the South Gippsland region, but they admit that further work on the island is required. Norris *et al.* (1979) failed to record any chiropteran fauna for any of the islands in the Corner Inlet group. However, Davidson *et al.* (1987) recorded four species of chiropterans for Sunday Island, and our survey recorded one.

Norris *et al.* (1979) trapped for chiropterans using trip lines over dams. The shortage of dams on the islands of South Gippsland may be a reason why Norris *et al.* (1979) failed to record chiropterans for the islands, and the fact that they limited their techniques for detecting chiropterans to trip lines. Triplining for bats is only one of three common techniques available. The two other techniques, mist nets and harp traps, are commonly used together, with much success. Both of these were available for this survey, and Davidson *et al.* (1987) had the use of two harp traps. With further field surveys using a combination of these techniques, plus others, further chiropteran records for the island may come to light.

The few small native mammals recorded for Sunday Island (Table 2) are characteristic of mammals of coastal dunes throughout the State. However, notable exceptions are *Sminthopsis leucopus* White-footed Dunnart and *Isoodon obesulus* Southern Brown Bandicoot.

Norris *et al.* (1979) found in their survey of the islands that the mammalian fauna was quite depauperate, consisting of two large macropods, several exotic species and a group of four native mammals, *A. minimus, C. nanus, Rattus lutreolus* Swamp Rat and *Pseudomys noveahollandiae* New Holland Mouse. They suggest that this pattern of native mammalian distribution can be explained by the way the islands were formed, through the build-up and dissection of coastal dunes by the tidal channels of the Albert and Tana rivers at the south-west end of Ninety Mile Beach (Turner *et al.* 1962 cited in Norris *et al.* 1979). Norris *et al.* (1979) suggests that the original dune habitat was suitable for the native mammals presently occurring on some of the islands. As the dune was dissected to form the islands, populations of these species were isolated and survived on some of the islands. However, the habitat was not suitable for such species as *A. stuartii* Brown Antechinus, *Trichosurus vulpecula* Common Brushtail Possum, *Pseudocheirus peregrinus* Common Ringtail Possum, *Petaurus breviceps* Sugar Glider and *Rattus fuscipes* Bush Rat. This may explain the poor spotlighting results for large possums.

The introduction of deer to the island was deliberate. The committee of management of Sunday Island manage populations of Hog and Fallow deer for sport shooting. The other exotic mammals recorded for the island were either accidentally introduced or swam to the island. According to Norris *et al.* (1979), koalas were introduced to Sunday Island, as well as other islands.

Further surveys are required, not only of Sunday Island, but for other private and public islands in the area. As human-induced pressures do not seem to be abating on our natural habitats both on private and public land, surveys of this kind become extremely important in monitoring the ecology of the habitat.

Extinction of species starts from local extinction of small populations, such that the overall population of the species becomes fragmented. As further habitat is altered or destroyed, these fragments become smaller and smaller, until only a small isolated population exists. This small population is then susceptible to many forces of extinction, including natural catastrophes such as fires, drought and disease, through to genetic bottlenecks from which the species may never recover, to socioeconomic and political factors. The islands of Corner Inlet, of which Sunday Island is one, can be viewed as habitat fragments similar to natural undisturbed habitats in a sea of agricultural lands. They thus can become easily susceptible to local extinction processes if habitat is destroyed. It is, therefore, important to manage these island fragments for native wildlife, and this requires the retention of natural vegetation.

Acknowledgments

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Keith Marshall, for his enthusiasm, guidance and concern for the native wildlife of Sunday Island. The committee of management of Sunday Island for allowing us to undertake the field work and for permitting the team to camp on Sunday Island. Members of the Mammal (now Fauna) Survey Group who conducted the field work and identified specimens. Graeme George, Graham Mitchell and Ed Grey for giving helpful suggestions on the manuscript. All trapping was undertaken under Conservation, Forests and Lands permit number 87-50.

References

Davidson, R., Greenwood, G., Johnson, L.A., Marks, C., Martin, A., Pinceratto, J., and Pitt, G. (1987). Mammal Survey Data. Sunday Island, mimeographed report. Monash University Graduate School of Environmental Science. Environmental Report - Vegetation, Soil and Mammal Survey.

Norris, K.C., Gilmore, A.M., and Menkhorst, P.W. (1979). Vertebrate fauna of South Gippsland, Victoria. *Memoirs of the National Museum of Victoria* **40:** 105-199.

Tidemann, C.R., and Woodside, D.P. (1978). A collapsible bat-trap and a comparison of results obtained with the trap and with mist-nets. *Australian Wildlife Research* **5:** 355-62.

Beach Sand, Periwinkles and Green Algae Height Variations at Point Lonsdale

N. W. Schleiger*

Introduction

In this study a series of observations were made along a stretch of sea wall in the southern section of Lonsdale Bight: beach sand heights, monitored since mid 1985; upper limit of the high swash mark as indicated by the Blue-banded Periwinkle, *Nodilittorina unifasciata*, monitored since early 1989, the upper limit of the green algal zone by the green filamental alga, *Enteromorpha intestinalis*, monitored 1989 - 1993. Over these periods, measurements on the sea-wall show that the height of the beach sand has steadily decreased while the levels reached by the Blue-banded Periwinkle in the period December 1988 to December 1991 has showed a gradual upward trend, and the heights at which the green filamentous alga grows also shows a slight rise in the levels reached each successive spring from the period 1989 to 1993. The measurements based on the upward movement of *N. unifasciata* and *E. intestinalis* suggest that the mean maximum wave height rose by 0.92 cm per year over the period to 1991 but then fell by 1.37 cm per year to date.

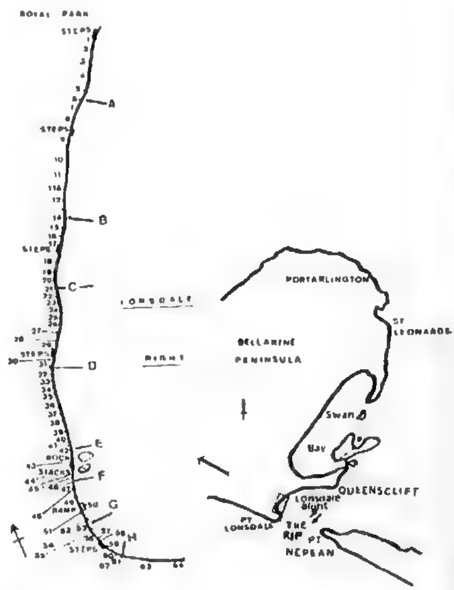

Fig 1. LOCALITY PLAN showing the sandy area in relation to Lonsdale Bight and the Bellarine Peninsula.

Beach Sand Height Variation

Since 1983 the author has been recording the sand heights at 64 stations along the sea wall, Point Lonsdale, at the southern end of Lonsdale Bight (Schleiger 1989, 1990) (Fig. 1). In all cases the sand has shown a depletionary trend in the last eight years. In searching for the reason for the loss of sand, the question of a rise of sea level was considered. However, increased beach erosion does not necessarily mean a rise in sea level since so many other factors have to be taken into consideration. Bird (1988) suggested that the tube worm *Galeolaria caespitosa* could be used as an indicator of sea level rise. However *G. caespitosa* is not accessible for regular measurement in Lonsdale Bight, although small local colonies do occur. The author found that *N. unifasciata*, the Blue-banded Periwinkle and the green filamentous alga *E. intestinalis* was more readily accessible on the sea wall at Point Lonsdale and therefore decided to monitor the heights of these as indicators of wave swash levels.

Figure 2, typical of most of the 64 localities, shows the monthly variation of beach sand heights against the sea wall at the Royal Park steps (Loc. 1). All measurements were taken from the top of the wall so that the lower numbers indicate the greater height the sand reached. A measurement of 114 cm from the top of the wall recorded the maximum height reached by the sand in June 1984. In July 1985, the maximum height was similar,

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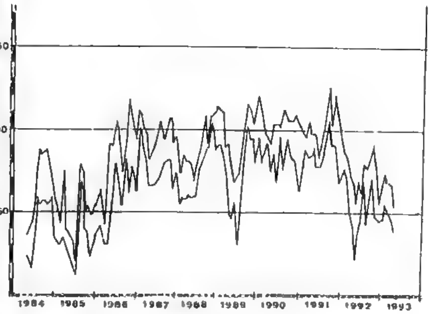


Fig. 2. Variation in sand height, measurements are cm below top of wall at Locality 1 (Royal Park Steps) from mid-1984 to April 1993.

113 cm. Since then the maxima, usually in the summer or autumn of each year, have been successively lower e.g. December 1990 (165cm from the top of the wall) and November 1991 (175cm). Minimum sand levels likewise were getting lower until 1989 but since then they have been getting higher especially in 1991 and 1992.

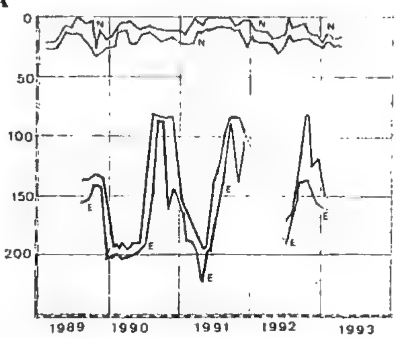
Thus Fig. 2 shows that sand levels could be cyclic. However, whether this is an eight year cycle will not be known until data on the sand heights has been continuously collected for a much longer period of time. Generally the minima are most common in spring when south-westerly winds are strongest, whilst maxima in sand heights are more usual in autumn and late summer when easterlies and calm weather are most prominent. However, there are exceptions which are related to the prevailing winds and the tides, which are influenced by the various phases of the moon.

Behaviour of *Nodilittorina unifasciata* (Blue-banded Periwinkle) on the Sea Wall

Of the 64 stations traversed from Royal Park steps to the end of the concrete wall at Point Lonsdale Front Beach, only 51 stations have regular populations of *N. unifasciata* on the wall. Some of the remaining 13 stations have occasional populations but most of them have none. At many of the 51 stations waves actually splash over the wall at some high tide periods during the year so that *N. unifasciata* individuals live on the landward side of the wall as well as the top and seaward side of the wall. The best stations for measuring variations in position of *N. unifasciata* are those where individuals reach a maximum height well below the top of the wall. It is clear from observation that individuals have to be splashed by sea water to maintain their position. If not splashed, they move down the wall until they are. Thus the maximum height reached at each observation period is the height of swash at high tide. Those stations which demonstrate that the swash goes over the top of the wall are still useful in indicating the lower levels of *N. unifasciata* at times when the sea is calmer and splashes at lower levels (Figs 3 & 4).

Locality 63 at the junction of the basalt pitcher and concrete walls is particularly

A



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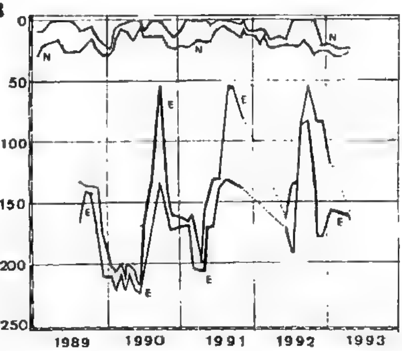

Fig. 3. Plots of Nodilittorina (N) and Enteromorpha E) for two localities No.17 (3A) and No.18 (3B) typical for northern localities. Measurements are cm below top of wall.

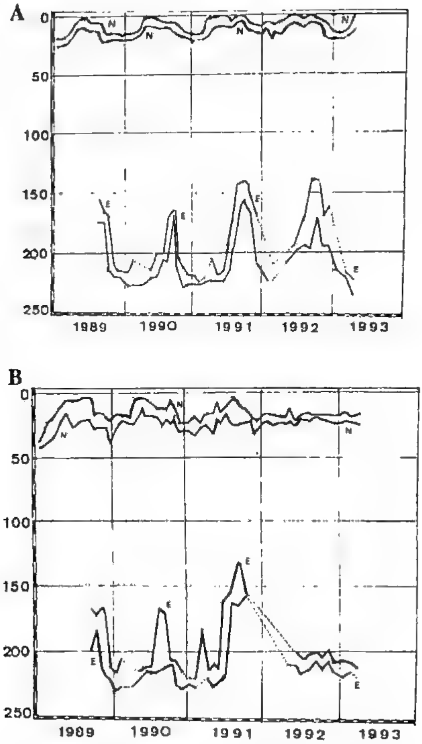

Fig. 4. Plot of Nodilittorina (N) and Enteromorpha (E) for two localities No.38 (4A) and No.42 (4B) typical of southern localities. Measurements are cm below top of wall.

useful. Although the swash reaches well above the height of both walls, the calcarenite cliffs whose bases are protected by this wall allow the swash to be recorded by *N. unifasciata* individuals up to three quarters of a metre above the top of the wall (Fig. 5). It is likely that *N. unifasciata* individuals have different heights or levels of operation; some like living closer to the water than others.

At the most southern locality (Loc. 64) when sand levels and seaweed *(E. intestinalis)* observations have been measured, *N. unifasciata* individuals have been counted on the top of the wall in a 25 cm x 25 cm square. As shown in Fig. 6, during times of high seas and storms especially in late winter and spring, there is the greatest number of individuals, whilst in the late summer when the sea is calm, individuals are restricted to less than ten.

It is therefore strategic to measure the most elevated *N. unifasciata* on the sea wall as the most likely indication of upward swash limit movement. Those most elevated individuals are those most likely to thrive in the extreme limit of swash, and hence an indicator of the high swash mark.

There has been a trend in successive summers for greater maximum numbers of *N. unifasciata* individuals on top of the wall, and this suggests an improvement in the swash environment, e.g. 120 in June

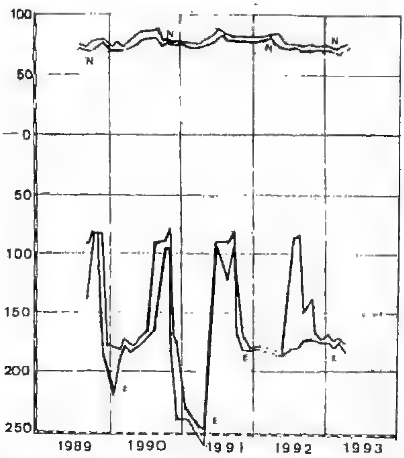

Fig. 5. Loc. 63 is unique in having a cliff of Aeolianite (calcarenite) rising behind and above the sea wall. Measurements in cm where 0 = top of the wall.

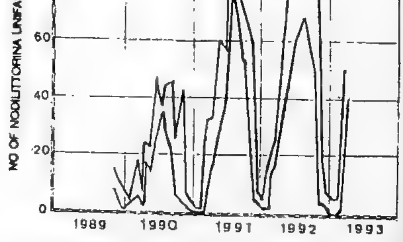

Fig. 6. Plot of the number of *N. unifasciata* individuals in a 25 cm x 25 cm square at Loc. 64 on the top of the wall.

1991 compared with about 50 (in June 1990) at Locality 64 (Fig. 6).

Behaviour of the Green Filamentous Alga *Enteromorpha intestinalis* on the Sea Wall

Figure 7 shows the number of localities with *E. intestinalis* month by month from 1989 to 1993. The maximum was 45 localities in Spring 1991 and for 3 months in Autumn 1992. *E. intestinalis* intermittently dried up at all localities. There was a trend of increasing maximum number of localities until Spring 1991. Since then they have decreased. The same trends are seen in *Nodilittorina unifasciata* numbers on top of the wall at Loc 64.

All *E. intestinalis* profiles show a large variation in monthly maxima and minima heights below the top of the wall, in some cases up to 1.5 metres from maximum to neighbouring minimum. The lowest levels occur from midsummer to early winter, whilst the highest occur during spring to early summer. In many cases there is a rising trend from the 1990 maximum to the 1991 maximum, as seen at Locs. 17, 38, 42 and 63. This may be due to a higher wave swash level caused, during that period, by stronger prevailing

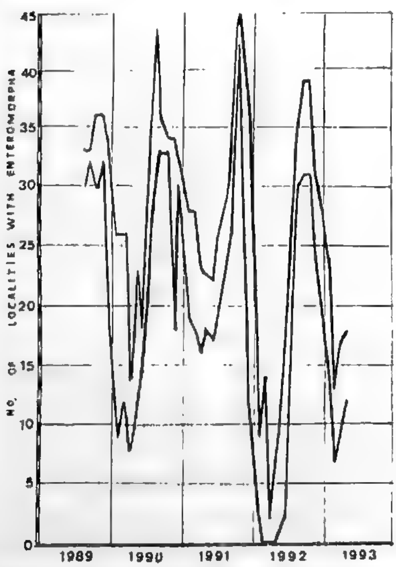

Fig. 7. Number of localities with *E. intestinalis* from 1989-1993.

winds at high tide and which also corresponds to the continued depletion of sand

Estimates of the Order of Upper Swash Mark

The graphs of both *N. unifasciata* and *E. intestinalis* show the heights of monthly maxima and minima for Locs. 17, 18, 38, 42 and 63 and indicate trends of rising swash heights which could have resulted from the greater sand depletion and hence larger rising waves. However, *N. unifasciata* changes are more likely accentuated by strong prevailing winds. These are summarised in Table 1 below.

Conclusions

1. The graphs of *Enteromorpha* and *Nodilittorina* show trends of increasing and decreasing wave swash levels with a maximum around Aug. 1990 and Aug. 1991 respectively.
2. The sand heights of Loc. 1 (Fig. 2) show an all-time low (severest scouring) for the spring of 1991. Since then sand heights have returned to maxima similar to the period 1984-1985.
3. The graphs indicate that the waves are splashing higher at high tide probably because of stronger prevailing winds during half to full tide coinciding with sand depletion. Both *Nodilittorina unifasciata* and *Enteromorpha intestinalis* can live at higher levels on the sea wall if the waves splash higher.
4. The study indicates that *Nodilittorina unifasciata* is a sensitive indicator of upper swash limit change. Likewise *Enteromorpha* is a useful indicator of the change in the upper limit of the green algal zone, especially if heights during each Spring are compared year by year.
5. Further data collection and analysis of these two indicators is needed to monitor zonal changes on the sea wall over a longer-period to determine whether prevailing wind strength and sand depletion are the only significant factors in producing the trends described above.

Table 1. Estimation of high swash mark rise from graphs of *Enteromorpha intestinalis* and *Nodilittorina unifasciata*. Monthly maxima and minima.

Source	Figure	Criterion	Abscissa	Ordinate	Change cm/yr
Locality 17	3A	N minima	27	18/9/89	+4.50
			21	25/1/90	
			28	2/12/91	-4.00
			30	30/6/92	
		E maxima	83	5/10/90	+0.90
			82	18/10/91	
Locality 18	3B	N minima	23	22/10/89	+2.80
			20	17/11/90	
			20	17/11/90	-4.00
			28	21/11/92	
		E maxima	54	15/9/90	+0.48
			53	10/10/92	
Locality 38	4A	N minima	23	12/88	+1.33
			19	12/91	
		E maxima	55	18/10/91	-1.00
			54	10/10/92	
		E minima	232	10/11/90	+2.40
			225	14/2/92	
Locality 42	4B	N maxima	3	23/7/89	-0.92
			5	16/9/91	
		N minima	228	1/90	+2.00
			226	1/91	
Locality 63	5	N maxima	86	29/6/90	-0.86
			85	23/8/91	
		N minima	71	2/7/89	+1.15
			73	22/3/91	
			72	5/6/92	-1.20
			71	10/4/93	
		E maxima	77	26/8/89	+1.77
			75	14/10/90	
			82	22/9/91	-1.09
			83	18/8/92	

Acknowledgments

The author is most grateful to Dorothy Mahler for her help in the field and for typing the manuscript; to Ed and Pat Grey for advice re the figures and to Dr E. C. F. Bird for constructive criticism of the manuscript.

References

Bird, E.C.F. (1988). The Tubeworm *Galeolaria caespitosa* as an indicator of sea level rise. *The Victorian Naturalist* **105:** 98-104.

Schleiger, N.W. (1989). Five years of recorded sand heights at Point Lonsdale. *In* 'Everyone Counts'. Ed. B.A.Doig. (Mathematical Association of Victoria.)

Schleiger. N.W. (1990). Indicators of Sea Level Change at Point Lonsdale. *In* 'Whither Mathematics?' Ed Ken Clements. (Mathematical Association of Victoria.)

The Orchid Man. The Life, Work and Memoirs of the Rev. H.M.R. Rupp 1872 - 1956

by L. A. Gilbert
Published by: *Kangaroo Press, Kenthurst 1992*
Hardbound, 248 pp. rrp $50.00.

In any field of human endeavour, some enthusiasts inevitably seem to rise to the top of the tree, providing a focus and inspiration for others. In the field of taxonomic botany, and specialising in orchids, Herman Montague Rucker Rupp was such a figure.

Rupp was the last of a 'distinguished quartet' of Australian orchidologists (Willis 1956), including the pioneer R. D. Fitzgerald (1830-92), as well as R. S. Rogers (1862-1942) and W. H. Nicholls (1885-1951).

Though self effacing, and rather hesitant in his early efforts at scientific writing, Rupp went on to become an authority on Australian orchids. His interest in wildflowers began early in life, and building on his botanical training at university he thereafter pursued his hobby with considerable zeal. Rupp published over two hundred scientific papers including the description of four new orchid genera and over seventy new species. He also wrote two authoritative books on the orchids of NSW.

Rupp was rather conservative in his approach to taxonomy. Referring to the greenhoods, he once wrote that 'the rank of Species, like titles, was given away rather too freely.' (Rupp; 1926). One wonders what he would make of current trends in orchid taxonomy with numerous new species being recognised by various authors. He was not one to avoid voicing an opinion.

This biography and memoirs of Rupp is therefore welcomed as a record of an outstanding orchidologist (and, I suspect, a very capable cleric) and will help to ensure that Rupp's contribution in both his profession and his hobby can be fully appreciated and acknowledged.

The author, historian Dr Lionel Gilbert, was one of the first graduate external students of the University of New England, undertaking PhD studies in Australian botanical history. He has written numerous articles and several books on various historical subjects, including a biography of another botanical cleric, the Reverend William Woolls. The present work has been painstakingly researched over many years; the author has visited most of the sites relevant to Rupp's life story, as well as bringing together as far as possible his considerable correspondence.

The book is divided into three main parts (the first by Gilbert, the second and third by Rupp himself), accompanied by a number of informative supplements, notes and appendices. The first part, occupying some 90 pages, is Gilbert's biography of Rupp. Beginning well before his birth in a chapter entitled 'Despair and Deliverance' the historical setting is established in an evocative manner. Rupp was clearly descended from resourceful stock for his father, then a boy of ten, and his father's younger sister, were the two survivors of a family of five that emigrated from Germany in 1849. The rest of the family died during the journey. To arrive an orphan in a strange land could hardly be considered an auspicious start.

A further six chapters then systematically trace, with clarity and detail, the twists and turns of H. M. R. Rupp's life. The reader is led through childhood, schooling at Geelong Grammar, university days at Melbourne, and then his clerical work in NSW, Victoria and Tasmania. In the last two chapters of this section, entitled 'Man of Letters, Man of Science', and 'Retirement and Recognition', Gilbert describes and evaluates Rupp's scientific contribution and his writing. Of Rupp as correspondent, Gilbert says, 'As a man of letters, Montague Rupp had few equals in his field – he was the consummate correspondent. His letters, like his memoirs, were characterized by a delightful literary style – direct, lucid, and enquiring; comfortably conversational, free of unnecessary embellishment and imbued with a delicious sense of humour.' Rupp was certainly prolific - some 1700 of his letters have been located to date - and he did not mince words, freely expressing his opinions on all manner of subjects, some of which seem eerily topical:

> We Australians seem to have a genius for misgovernment. It is appalling that a young country like ours should be in the condition it is in today and though general extravagance is partly the cause, to my mind misgovernment is mainly responsible - and we seem determined to go from bad to worse.

This was written some 60 years ago. Or again:

> 'Dark days' literally and metaphorically, seem to lie ahead of this State. I have been a 'barracker' for labour for years, but I'm fed up. No capitalist ever showed more indifference for the public welfare than the gang running this country at present. By which remark you may perceive that I'm not given to concealing my views.

The second and third parts of the book, totalling some 83 pages, were written by Rupp himself; the 'gentle and judicious editing' by Gilbert was not apparent. The first of these sections, entitled 'Recollections of an amateur Botanist' was written in December 1932 to January 1933, and the other, 'Retrospect' written in November 1948 to January 1949. Lionel Gilbert comments in the Preface that 'they were obviously written at different times from different points of view and for readers with different interests'. Although the accounts overlapped in some respects, Gilbert felt there was insufficient reason to combine them into one. Certainly there was overlap but I didn't find it tiresome. The 'Recollections' has an obvious botanical bias and 'Retrospect' is more general, although still including many botanical passages. Perhaps a researcher, looking for information on a particular subject or facet of Rupp's life necessitating a search in each of the three sections, might succumb to frustration. To help overcome this, the index seems detailed and thorough.

The book is liberally illustrated with black and white photographs, and many of Rupp's own line drawings of orchids. A selection of these with brief explanatory annotations, collected under the heading 'The botanist as artist: a supplement of sketches' follows the three (auto) biographical parts of the book. Eight pages show Rupp's illustrations reproduced in colour. In the review copy the colour register is not always good leaving a number of the subjects with blurred edges. Although Rupp himself says, 'it is well understood by now (or ought to be) that I am no artist ...', he could have been better served by the publishers in attending to these technical details. Also on the matter of presentation, the cover is very sombre and hardly does justice to the beauty and variety of the subjects of Rupp's study. It also seems out of step with his 'friendly, jovial personality'. Apart from these two quibbles, the book attains a very high standard of production and presentation with refreshingly few typographical errors.

Unobtrusive superscript figures throughout the text refer the reader to the appendix for detailed notes and sources. The book concludes with a very comprehensive bibliography of Rupp's works (including both published and manuscript), extensive notes to the earlier biographical sections, a botanical index and a general index. A very welcome feature of the botanical index is the updating of names (which are left virtually undisturbed - as Rupp knew them - in the text) to coincide with current nomenclature.

Taken overall, the result is a tribute to Gilbert's capacity for detailed research and his tenacity in surviving the rigours of dealing with publishers. He is to be commended for making Rupp's work and observations so readily available in such an accessible volume.

Rupp had the passionate interest, the capacity, and particularly the opportunity, to observe the native vegetation of substantial parts of SE Australia that will never be the same. The recording of the vegetation and landscape of his various parishes may yet prove to be one of his most valuable contributions - given the increasing awareness of what we are losing in terms of natural heritage, and the increasing efforts being made to conserve and restore. While the descriptions are sometimes not detailed, and lists of species are not reproduced here, enough is provided to give an indication whether further research into Rupp's manuscripts would be fruitful. For me, his eloquent descriptions of his parishes, with the inevitable botanical slant, are a highlight of this volume. Rupp's writing style, no doubt honed by years of preparing weekly sermons, is very readable; at times quite poetic. In setting down his contact with so many interested amateurs, recognising their value to the pursuit of his hobby, Rupp has also provided an important record of the natural history fraternity of the time. His substantial personal correspondence with a diverse range of people surely stimulated others to contribute and follow his example.

Although this reviewer's bias is obviously botanical, I found that Rupp's reminiscences of his life and work in the Anglican Ministry made interesting reading; no doubt it would mean far more to someone acquainted with the many clerical figures on whom his narrative touches.

This biography and memoirs thus provides not only a detailed account of a major figure in Australian orchid research but also the first hand story of a prolific writer and meticulous observer passionate about botany. Lionel Gilbert has set out to record for posterity the life and work of this tireless enthusiast, who achieved and contributed much in his chosen hobby as well as his profession. Both Gilbert and Rupp must be said to have succeeded admirably.

References

Rupp, H.M.R., (1926). Notes on various plants ... (unpubl. ms held in the Herbarium of The University of Melbourne Botany School. Without pagination.)

Willis, J.H., (1956). The passing of a great orchidologist (Rev. H. M. R. Rupp, 1872-1956). *The Victorian Naturalist* **73:** 105-110.

Ian Clarke
National Herbarium, Vic.

The Ants of Southern Australia. A Guide to the Bassian Fauna

by Alan N. Andersen
Published by: *CSIRO, East Melbourne (1991).*
70 pages, 17 figures, 17x25 cm soft cover r.r.p. $20.00

The purpose of the book is to 'enable non-specialists to identify the genera and more common species of ants occurring in cool and wet southern Australia'. Anyone with a good hand lens and a general familiarity with insects will be able to use it to do this, with varying success.

The taxa described are listed. There are two brief chapters on simple general biology and community ecology totalling five pages and including introductory discussion of space, time and food resource partitioning (niche segregation). The main body of text includes keys to sub-families, genera and, for some genera, species; outlines the general biology of the sub-families, and provides a paragraph or more on each genus detailing aspects of appearance, distribution, diet, etc. A glossary of 33 terms occupies one and one half pages, but if you wonder what such terms as frontal carina and integument (used in the keys) means you won't find them in the glossary. A list of 42 references, including 12 with Andersen as author or co-author, is included, of which 80% have been published since 1978. Better layout would have enabled the inclusion of several more at no extra cost. A decided disadvantage is the lack of an index. A chosen taxon can be found by looking through a two page systematic list which gives page numbers for the figures, but if you only have a common name you'll have to waste time.

There is a regrettable tendency in some schools of biology to overstate the importance of a work by exaggerating its geographical coverage. This book would have been more appropriately titled 'The Ants of Victoria' the state outlined in the book's only map. Andersen notes that the work 'concentrates on mesic Victoria' an area roughly to the south of the line joining Wodonga, Seymour and Hamilton, and that the'keys to species within genera deal specifically with this region'. So 'The Ants of Victoria' is actually an overstatement. The species coverage is not comprehensive for mesic Victoria since two or three genera (each represented by a single, rare species) (does this mean two, or three, species?) 'are not included'. The book's failure to provide a means of identifying these rare species is a negative for ant conservation.

There are problems with the keys provided. The Myrmecia key failed at the first couplet for D. Britton (Hochuli, pers. comm.) who collected mandibularis' near Sale which exceeded the 10 mm length limit of the key by 50%. Many insect species show great length variation and keys often fail if better characters are not also considered but the novice may not know this. Closer reading of the book enables *'M. mandibularis'* to be identified by these characters.

The work could have been much improved by the inclusion of photographs and illustrations of whole insects. Many species have distinctive nest entrances and some photos of these would have been interesting. All the figures are line drawings and, apart from the map and a simplified drawing of the whole worker of *Prolasius niger*, are all of the head viewed face-on, and the trunk and waist. There is enough space on the existing pages for illustrations of whole ants at natural or two to three times natural size to have been included and this would have improved the book immensely. The existing drawings could be better labelled.

Alternatively the book could have been reduced in size by at least ten pages by the removal of superfluous spacing, better layout and smaller type for the main text. Bad design and excessive use of paper seems to be a generalised failing in the recent batch of small entomology books from the CSIRO editorial and print production teams.

A similar and superior book is that of Greenslade (1979). He covers species of the arid country as well as mesic areas, providing a work of more general reference. Only two of the 41 genera included in Andersen are not included in Greenslade who covers an additional 15 nominal genera and an additional subfamily. Greenslade's illustrations are more realistic and show the head attached to the trunk as well as the frontal view, plus the coxae. Greenslade's Guide is a little dated but cost only $5.00. Andersen's book could be photocopied for less than $10. Its main advantage it that it allows identification to species or species group level. Bickel (1992) gave a favourable review.

Acknowledgements

I thank Dieter Hochuli and Dave Britton for information on the *Myrmecia* key.

References

Bickel, D. (1992). *In Australian Natural History* **23**: 956.

Greenslade, P.J.M. (1979). A Guide to the Ants of South Australia'. (South Australian Museum: Adelaide)

Ian Faithfull
7/20 Adam Street,
Burnley, Victoria, 3121

Obituary

Mr Alf Fairhall

During April this year, another past stalwart of the FNCV passed away. Alf Fairhall, a teacher in the Horsham area before moving to Melbourne, had a very keen interest in native plants and their propagation and became a foundation member of The Society for Growing Australian Plants.

Alf joined The Field Naturalists Club of Victoria in 1952 and was a very active member of the Botany Group, leading many of their excursions. He and his wife Rene were always present at General Meetings and at most of the Club Christmas Tours. He served as an FNCV Council Member.

Alf helped another old member of the Club, Mr Percy Wyatt, in the formation of The Native Flower Reserve in Cheltenham Park.

In 1972 Alf Fairhall was keen to start a Day Group in the Club similar to a group he had seen in operation in Western Australia. The idea was for members to go on excursions during a midweek day. Alf formed the first committee and was Chairman for most of the life of the Group. Day Group members went on visits to 110 different places of interest around Melbourne, all the result of the initiative of Alf Fairhall. A Good Club Member.

D.E. McInnes

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The Victorian Naturalist

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since 1884

FNCV Calendar of Activities

November	
Sat 6	General FNCV Excursion. **Mosses, Lichens and the Ada Tree.** Leader Arthur Thiess. Contact Dorothy Mahler for bus fare details. 435 8408.
Mon 8	**Australian Natural History Medallion Presentation.** Reception for all members in grounds of Astronomer's Residence 5.30 pm. Cost $5.00 per head. RSVP Ed Grey 435 9019. Presentation in Herbarium Hall 8 pm. (free).
Thurs 11	Botany Group Meeting. **Grasslands** - John Morgan. Herbarium Hall 8 pm.
Wed 17	Microscopical Group Meeting. **The Use of Microscopes in the Study of Plants** - David Beardsell. Astronomer's Residence. 8 pm.
Sat 20	Fauna Survey Group Field Survey. **Leadbeaters Possum Survey.** Contact Ray Gibson 874 4408.
Wed 24	Geology Group Meeting. **Volcanoes and Volcanic Action** - Prof. Ray Cass. Herbarium Hall 8 pm.
Sat 27	Botany Group Excursion. **Indigenous Grasslands Excursion.** Leader John Morgan. Contact Joan Harry 850 1347.
December	
Sat 4	Fauna Survey Group Field Survey. **Leadbeaters Possum Survey.** Contact Ray Gibson 874 4408.
Tues 7	Fauna Survey Group Meeting. **The Romance of Rat Kangaroos and Potoroos - Prehistoric and Present.** John Seebeck. Herbarium Hall 8 pm.
Thurs 9	Botany Group Meeting. **Members Night - Slides and Exhibits.** Herbarium Hall 8 pm.
Sat 11	General FNCV Excursion. **Marine Life on a Reef Flat at Point Danger, Torquay.** Leader Robert Burn. Late date due to tides. Contact Dorothy Mahler for bus fare cost 435 8408. Leave Batman Ave 9 am.
Mon 13	General FNCV Meeting. **Members Night - Slides and Exhibits.** Herbarium Hall 8 pm. All members please bring a plate.
Sun 26 Mon 3 Jan	Fauna Survey Group Field Survey. **Jilpanger Scrub Survey.** Contact Ray Gibson 874 4408.

Note for Authors

Please send all material for publication in The Victorian Naturalist to:

The Editors, The Victorian Naturalist
FNCV c/- National Herbarium,
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General enquiries to (03) 650 8661, (AH) (03) 435 9019

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The Victorian Naturalist

F.N.C.V.

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Assistant Editors: Ed and Pat Grey

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Cover Photo: Trout Cod *Maccullochella macquariensis*.
Photo courtesy DCNR, Arthur Rylah Institute for Environmental Research.

Swamp Wallaby Distribution

Dear Editor

Two recent articles in *The Victorian Naturalist* (Vol 109(3) 89-91 and Vol 109(5) 152) on the distribution of the Swamp Wallaby *Wallabia bicolor* attracted my attention. I first became interested in this species when I found a dead animal on the side of the Henty Highway just south of Hopetoun in 1984. When I examined the carcass it appeared to be a Swamp Wallaby, but at this location I had my doubts. I sent the skull and one foot to Joan Dixon at the National Museum of Victoria where it was positively identified as *Wallabia bicolor.* Subsequent investigations with local people revealed that there was a small colony of Swamp Wallabies living along the Yarriambiak Creek. Apparently they had been around for as long as they could remember.

From that time I have been gathering records for this species around the Wimmera and sending them to the Atlas of Victorian Wildlife for inclusion in their data base. It appears that Swamp Wallabies are fairly common throughout the Grampians and have spread along watercourses in the Wimmera River catchment. Some of the sightings have been at relatively dry locations and in fairly open situations indicating that they are fairly mobile and move from one habitat to another.

During hot dry conditions there have been a number of incidences where Swamp Wallabies have ventured into residential situations, presumably in search of green feed. On at least five occasions we have caught and relocated Swamp Wallabies from within Horsham and there have been two reports of them in gardens at Warracknabeal. I can assure you that these animals are perfectly healthy, very mobile and difficult to catch. A number of staff (particularly Roger Macaulay) have scars to show following these encounters. Unfortunately there have been quite a number of Swamp Wallabies killed on roads around Horsham.

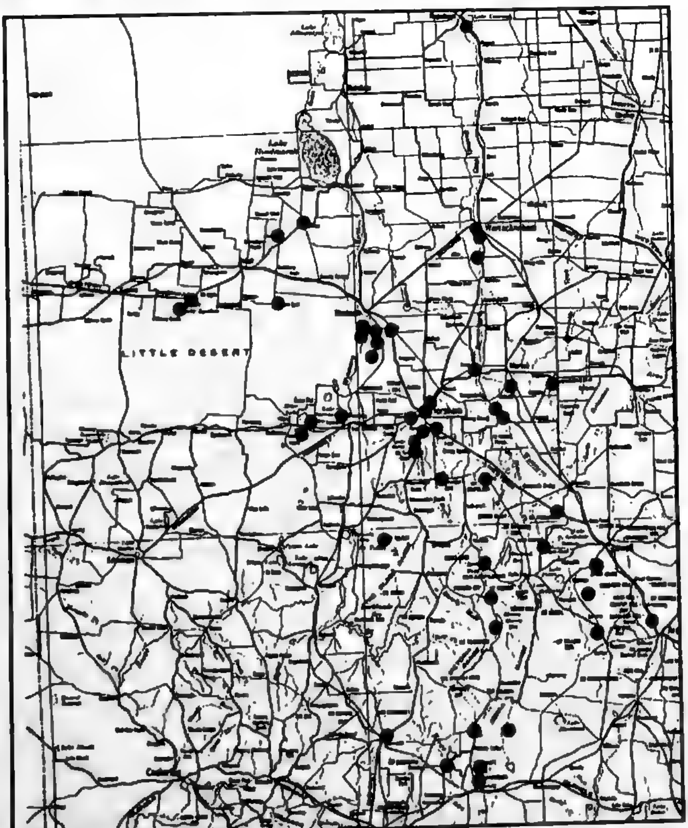
I have attached a computer printout of the recent records around Horsham as well as a map showing distribution.

David R Venn
Flora and Fauna Guarantee Officer
Department of Conservation & Natural Resources, Horsham Region

Table 1. Recent records of Swamp Wallaby, *Wallabia bicolor*, in the Horsham area.

Obs	Date	Map	AMG	Alt	Your Ref	Coverage B	M	H	Species	Count	X	T	R	Nearest Place Name	Locality
RA	21 02 1990	7125	410 692	150	DVH 0164	1			1242	1			S	Lawloit	Swampy edge of Lake Lawloit - Very low water
RA	27 04 1990	7324	954 588	140	DVH 0165	1			1242	1			S	Wail	Wail Forest
RA	27 12 1989	7323	956 012	230	DVH 0166	1			1242	1			S	Mt Talbot	E. Baxteri at base of mount
RA	08 03 1989	7324	920 590	120	DVH 0167	1			1242	1			S	Wail	Wail Forest near Wimmera River
RA	15 11 1989	7125	440 713	170	DVH 0168	1			1242	1	K		S	Lawloit	Edge of Highway at Lawloit Range
RA	09 10 1987	7423	566 904	400	DVH 0169	1			1242	1			S	Stawell	Basin Creek near Burrong Speedway
RA	00 09 1984	7326	247 430	90	DVH 0170	1			1242	1	K		M	Hopetoun	Beside Henty Highway as it crosses Yarriambiak Creek
RA	04 01 1988	7325	256 860	110	DVH 0171	1			1242	1			S	Warracknabeal	House garden near Yarrambiak Creek
RA	00 11 1985	7324	301 360	140	DVH 0172	1			1242	2			S	Murtoa	Barrabool Forest
RA	02 02 1986	7324	235 485	120	DVH 0173	1			1242	1			S	Jung	Yarriambiak Creek
RA	27 01 1987	7424	427 430	140	DVH 0174	1			1242	1			P	Rupanyup	Feeding in crop SW of Rupanyup
RA	02 09 1986	7432	542 884	310	DVH 0175	1			1242	1			S	Stawell	Creek adjacent to Bunjii Cave
RA	06 03 1987	7322	945 490	210	DVH 0176	1			1242	1	K		S	Cavendish	Road killed 2km north of Cavendish
RA	21 12 1986	7322	068 462	220	DVH 0177	1			1242	1	K		S	Cavendish	Road killed N of Wannon Bridge, Victoria Point Road
RA	19 01 1987	7324	030 345	120	DVH 0178	1			1242	1	K		S	Horsham	Road killed 4km west of Horsham
RA	08 01 1988	7324	974 476	140	DVH 0179	1			1242	1			S	Pimpinio	4km east of West Wail Forest
RA	20 01 1988	7224	742 337	160	DVH 0180	1			1242	1			S	Mitre	Pasture near Mitre Rock
RA	29 12 1987	7224	822 350	120	DVH 0181	1			1242	1			S	Natimuk	Roadside 2km NW of Natimuk
RA	28 12 1987	7225	700 850	120	DVH 0182	1			1242	1			S	Woorak	Injured on roadside - Fled
RA	05 01 1988	7325	256 860	110	DVH 0183	1			1242	1			S	Warracknabeal	Vegetablegarden near Yarriambiak Creek
RA	14 09 1990	7324	045 296		DVH 0921	1			1242	1	K		S	Haven	Dead on roadside adjacent to McKenzie Creek
RA	30 12 1990	7324	985 589		DVH 0376	1			1242	1	K		O	Wail	Dead on highway at overpass
RA	15 04 1991	7224	736 332		DVH 0413	1			1242	1			S	Arapiles	Mt Arapiles State Park
RA	12 04 1991	7324	270 365		DVH 0414	1			1242	1			O	Marma	Barrabool Flora and Fauna Reserve
RA	21 07 1991	7423	69- 76		DVH 0538	1			1242	1	K		X	Ararat	McDonald Park, Western Highway
RA	19 12 1991	7324	081 356	140	DVH 0654	1			1242	1			T	Horsham	Within City. Captured in backyard and released at river
RA	29 11 1991	7423	405 990	180	DVH 0658	1			1242	1			O	Lake Lonsdale	On road 16km north east of Halls Gap
RA	25 11 1991	7324	135 295	120	DVH 0663	1			1242	1	K		O	Horsham	2.5km east of Burnt Creek on Western Highway
RA	01 11 1991	7324	275 175	150	DVH 0668	1			1242	1	K		S	Dadswell's Bridge	On Western Highway 10 km west of Dadswell's Bridge

Obs	Date	Map	AMG	Alt	Your Ref	Coverage B	M	H	Species	Count	X	T	R	Nearest Place Name	Locality
RA	08 10 1991	7324	232 168	220	DVH 0676		1		1242	1			O	Mt Zero	1km east of Mt Zero on Halls Gap Road
RA	22 10 1992	7324	095 177	160	DVH 0705		1		1242	1	K			Wonwondah East	Dead on road
RA	18 01 1992	7324	915 590	120	DVH 0706		1		1242	1			O	Wail	Little Desert National Park near Wimmera River
RA	19 02 1992	7225	676 680	180	DVH 0727		1		1242	1			O	Wuniam East	LDNP Sanctuary picnic area
RA	27 02 1992	7324	953 594	110	DVH 0729		1		1242	1			S	Wail	State Forest
RA	09 03 1992	7324	055 352	130	DVH 0735		1		1242	1			S	Horsham	In house yard, unable to catch
RA	12 03 1992	7324	060 373	120	DVH 0737		1		1242	1			T	Horsham	In house yard, captured this time
RA	29 03 1992	7324	903 554	115	DVH 0767		1		1242	1			O	Wail	River Track Little Desert National Park
RA	02 06 1992	7324	056 310	140	DVH 0801	1			1242	5	K		S	Haven	Bugalally Creek dead on roadside
RA	04 05 1992	7324	270 370	140	DVH 0803	1			1242	2			X	Marma	Marma State Forest
RA	28 08 1990	7323	327 876	400	DVH 1080		1		1242	1			S	Grampians NP	
RA	19 05 1990	7332	212 375	260	DVH 1081		1		1242	1			S	Grampians NP	Off Wannon River Road
RA	30 08 1990	7423	340 886	300	DVH 1082		1		1242	1			S	Grampians NP	Off Venus Baths Track
RA	08 09 1990	7423	359 869	200	DVH 1083		1		1242	1			S	Grampians NP	Crossing Grampians Tourist Road
RA	20 10 1990	7322	218 382	250	DVH 1084		1		1242	1			S	Grampians NP	Wannon River Road
RA	22 10 1990	7323	108 772	250	DVH 1085		1		1242	1			S	Grampians NP	Harrop Track
RA	03 11 1990	7323	098 688	230	DVH 1086		1		1242	1			S	Grampians NP	Harrop Track
RA	18 01 1990	7423	353 916	241	DVH 1087		1		1242	1	K		S	Grampians NP	Dead on road
RA	18 11 1990	7322	167 343		DVH 1088		1		1242	1			S	Grampians NP	Mt Sturgeon
RA	20 11 1990	7423	615 705	260	DVH 1089		1		1242	1	K		S	Grampians NP	Moyston Road - dead
RA	23 12 1990	7322	250 484	270	DVH 1090		1		1242	1			S	Grampians NP	Mt Abrupt
RA	31 01 1991	7322	165 380	220	DVH 1091		1		1242	1			S	Grampians NP	Vicotia Valley Road
RA	02 02 1991	7323	255 852	250	DVH 1092		1		1242	1			S	Grampians NP	Phillip Island Track
RA	10 02 1991	7323	304 655	300	DVH 1093		1		1242	1			S	Grampians NP	On road
RA	01 06 1991	7322	172 356	260	DVH 1094		1		1242	1			S	Grampians NP	Quarry Track beside Mt Sturgeon
RA	12 07 1992	7324	033 306	140	DVH 2304		1		1242	1			S	McKenzie Creek	4km southwest of Horsham
RA	24 08 1992	7325	251 781	120	DVH 2314		1		1242	1			O	Ailsa	Yarriambiak Creek
RA	15 11 1992	7324	276 119	220	DVH 2375		1		1242	1			S	Grampians NP	1km from Golton Gorge
RA	01 12 1992	7523	845 663	360	DVH 2381		1		1242	1	K		S	Dobie	Road kill near Mt Langi Ghiran
RM	07 01 1993	7324	066 365	130	DVH 2383		1		1242	1			T	Horsham City	Chased into backyard swimming pool
RM	03 01 1993	7323	956 013	220	DVH 2384		1		1242	2			S	Mount Talbot	Flushed from scrub by terrier
RM	22 05 1993	7225	754 900	140	DVH 2460		1		1242	1	K			Glenlee	Road Kill
RM	21 06 1993	7323	205 925	200	DVH 2480		1		1242	1	K			Zumstein	Grampians National Park - road kill
DH	19 12 1992	7323	070 024	320	DVH 2494		1		1242	1			S	Glenelg River Road	Grampians National Park
DH	19 12 1992	7323	085 617	390	DVH 2495		1		1242	1			S	Glenelg River Road	Grampians National Park
DH	06 09 1992	7323	309 550	330	DVH 2496		1		1242	1			S	Yarram gap Road	Grampians National Park



Distribution of Swamp Wallaby, *Wallabia bicolor*, in the Horsham area.

A Significant Record of the Endangered Trout Cod, *Maccullochella macquariensis* (Pisces: Percichthyidae) made during Fish Surveys of the Barmah Forest, Victoria

Lachlan J. McKinnon*

Introduction

The Trout Code, *Maccullochella maquariensis* (Cuvier 1829) is an Australian native freshwater fish indigenous to the Murray-Darling Basin and is currently listed as endanged in Victoria (Koehn and Morison 1990) and nationally (Jackson *et al.* 1993). The action statement for Trout Cod, listed under the Victorian Flora and Fauna Guarantee Act (1988), has recently been released. The former known range of Trout Cod included the Macquarie River in northern New South Wales, Murrumbidgee River in southern New South Wales and throughout the Murray River from Mannum, South Australia (Berra and Weatherley 1972) to upstream of Yarrawonga (Lake 1971). The Trout Cod was also once widespread throughout many Victorian tributaries of the Murray River but its abundance and distribution have declined severely (Cadwallader and Gooley 1984).

The current known distribution of Trout Cod is reduced to two viable populations and a number of stocked populations in Victoria, NSW and the ACT. One of the viable populations exists in the Murray River downstream of Yarrawonga where its range was considered to be the stretch of river between Yarrawonga Weir and Tocumwal (Ingram *et al.* 1990), a distance of approximately 90 km. This is the only known natural viable population of the species. Trout Cod were recorded by J.T.O. Langtry from Barmah Lake in 1949-50 (Cadwallader 1977), and there have been some unconfirmed and old reports of Trout Cod from Cutting Creek and Broken Creek in the Barmah Forest area (Fig. 1). A confirmed capture of Trout Cod was made in the Murray River, 56 km downstream of Tocumwal in 1990 (J. Douglas Department of Conservation and Natural Resources, Victoria, *pers comm*).

The other known viable population of Trout Cod occurs in a short section of Seven Creeks, near Euroa, Victoria (Morison and Anderson 1987). This population is the result of fish stocked by local anglers in 1921-22 (Cadwallader 1979). A number of rivers and streams in Victoria, NSW and the ACT have been stocked with hatchery-bred fry and juvenile Trout Cod, but it is not yet known whether any of these stockings have established self-maintaining populations.

This paper reports the recent capture of a Trout Cod in Barmah Forest, extending the current known downstream limit of the species of the Murray River area to approximately 110 km downstream of Tocumwal and, apart from fish from stocked populations, is the first confirmed record of a Trout Cod from Victorian waters since 1973 (Tunbridge 1978).

The study site

Barmah Forest is situated on the Victorian side of the Murray River between Tocumwal and Echuca. It is a large (29000 ha), predominantly eucalypt forest which, prior to river regulation, was subject to large scale seasonal inundation (Dexter 1978; Leitch 1989). As a consequence of the construction of reservoirs such as Lakes Hume and Dartmouth, flow is highly regulated and flooding in the forest is generally less frequent, less extensive and of shorter duration than under natural conditions (Dexter 1978). The alteration of flooding regimes due to regulated flows is considered to be a major contributing factor to the decline of most native fish species in the Murray-Darling Basin (Cadwallader 1986).

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Barmah Forest consists of a series of anabranch creeks which leave the Murray River at several points and pass through the forest as well defined channels, braided streams, small lakes and depressions and ephemeral wetlands before draining back into the Murray River, via Barmah Lake as a single deep creek (Fig. 1). Since 1989, Barmah Forest has been the primary study site for a major project funded by the Murray-Darling Basin Commission which is examining the responses of native fish to various flooding regimes in order to determine flooding strategies that will benefit native fish populations.

Methods

A survey of fish in the Barmah Forest was conducted at 12 sites from September 21 to December 18, 1992 (Fig. 1). A variety of techniques was used consistently and included drum nets, single wing fyke nets and gill nets. Detailed descriptions of the gear types used are given in Brumley *et al* (1987). Many different wetland areas and habitat types were sampled and included the major effluent creeks, lake and swamp areas, billabongs, and the inundated floodplain.

Gill nets, with float line and lead line, (mesh size range 38-178 mm, 25 m in length, 2 m in depth, were set in areas of little water movement such as floodplain, lake and backwater areas. Drum nets comprised two hoops (1 m diameter), 1 m apart enclosed in either 83 or 133 mm nylon mesh containing one internal funnel and cod-end. Each of the two 3 m wings attached to the front hoop were of the same mesh size as the body of the net and were attached to poles in the water. Single-fyke nets comprised 7 hoops of 700 mm maximum diameter, containing three internal funnels, were a total of 4 m

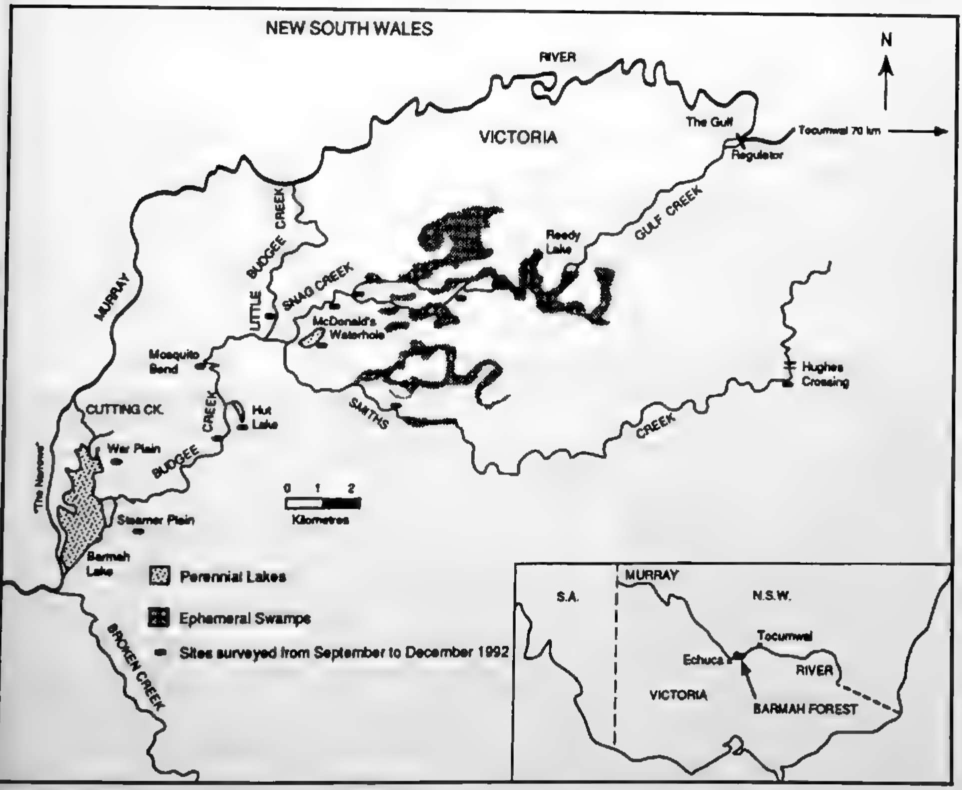

Fig 1. Barmah Forest indicating sites surveyed.

in length with a single 5 m wing attached to the front hoop. The mesh size of both net and wing was 25 mm. Drum nets and fyke nets were generally set along the banks of the main channels and in gullies on the inundated floodplain.

Various water quality parameters were regularly measured as part of the overall study to determine water quality changes occurring during flood events and these changes were related to the responses by fish. These data were included here as little information is available on the habitat requirements, including water quality, of Trout Cod (Lintermans *et al.* 1988).

Dissolved oxygen aand temperature were measured *in situ* using a YSI model 57 Oxygen meter and pH was measured *in situ* using an Orion model 250A pH meter. Water samples were preserved in the field and analysed for electrical conductivity, turbidity, colour, nutrients, tannins and lignins and phenolic compounds by the Rural Water Corporation, Melbourne.

Results and Discussion

Five native and three introduced fish species were recorded in the Barmah Forest during the sampling period using the gear types listed above (Table 1). One Trout Cod, (390 mm TL and 770 g), was captured in October 1992 in a single winged fyke net at Mosquito Bend in Budgee Creek (Fig. 1) during a rising water level. The sex of the Trout Cod was unknown, however it is conceivable that this individual had reached sexual maturity (G. Gooley, Department of Conservation and Natural Resources, *pers comm*). Anaesthetised with MS222 (Sandoz Chemicals) (80mg/l) and having length and weight recorded, the fish was tagged with two numerically sequential dart tags (Hallmark Tags), 95 mm each in length and left to recover in a methylene blue (100 mg/l) and salt (20 g/l) bath as a prophylactic and therapeutic treatment against infection, for 10 minutes prior to being released at the capture location. Other species and their relative numbers caught at Mosquito Bend during the sampling period are listed in Table 2. Increased sampling effort in the area did not produce further Trout Cod.

As was the case at all sites, Common Carp *Cyprinus carpio* made up the bulk of the catch at Mosquito Bend. The large numbers of Carp present at all sites are attributed to successful recruitment of the species following spawning in Barmah Forest in September, 1992. The bulk of the catch of the Carp was made during November and December and comprised mainly juveniles (<70 mm LCF). Catch per unit effort of Carp was otherwise relatively low during much of the sampling period. The species

Table 1. Summary of fish species and numbers caught during the sampling period at all sites using fyke, gill and drum nets.

Native Species	No. caught
Golden Perch *Macquaria ambigua*	261
Silver Perch *Bidyanus bidyanus*	22
Murray Cod *Maccullochella peelii*	37
Trout Cod *M. macquariensis*	1
Bony Bream *Nematalosa erebi*	2
Introduced Species	**No. caught**
Common Carp *Cyprinus carpio*	8447
Goldfish *Carassius auratus*	77
Redfin *Perca fluviatilis*	127

Table 2. Fish species and numbers caught at Mosquito Bend during the sampling period using fyke, gill and drum nets.

Native Species	No. caught
Golden Perch *Macquaria ambigua*	10
Murray Cod *Maccullochella peelii*	2
Trout Cod *M. maquariensis*	1
Introduced Species	**No. caught**
Common Carp *Cyprinus carpio*	354
Goldfish *Carassius auratus*	7
Redfin *Perca fluviatilis*	14

composition was generally the same at all sites and relative proportions of species were also generally the same between sites. With the exception of Trout Cod and Bony Bream *Nematalosa erebi*, all native and introduced species were sampled in a variety of habitats including creek, lake and floodplain habitat areas. Carp, however, were more prevalent on the inundated floodplain during September and early October when they were engaged in spawning.

The record of Trout Cod in Barmah Forest indicates that the only natural viable population of this species remaining may be extending its range downstream; that the species is still present, albeit in low numbers, in the Barmah Forest area or that individuals from this population occasionally move downstream. Very little is currently known of the movement and migration patterns of Trout Cod, however, tag-recapture data for Murray Cod *Maccullochella peeli* have shown that this species, a close relative of Trout Cod, have moved distances of up to 50 km downstream within one year (McKinnon unpublished data) and Koehn (unpublished data) found Murray Cod are capable of even greater migrations. It may be possible that Trout Cod are also capable of relatively long migrations.

There is little available information on the habitat requirements of Trout Cod (Lintermans *et al.* 1988; Wager and

Table 3. Habitat parameters at Mosquito Bend.

Substrate			**Instream cover**	
Est. %	diam. (mm)	%	**Est. % of wetted area**	%
Coarse Sand	1-2	20	Logs	10
Sand	0.5-1.0	10	Log Jams	10
Fine Sand	0.25-0.5	30	Branches	10
Silt/Clay	<0.25	40	Vegetation Overhang	20

Aquatic vegetation		**Riparian vegetation**	
Est. % of wetted area	%	**% Riparian zone**	%
Floating (*Azolla spp.*)	10	Native trees (>30m) *(Eucalyptus camaldulensis)*	30
Emergent (*Carex spp.*)	5	Native trees (<30m) *(E. camaldulensis)*	30
		Exotic Shrubs (Blackberry, Thistles)	10
		Sedges/Rushes *(Carex spp., Juncus spp.)*	20
		Grasses	10

Physio-chemical data (Maximum depth 6.8 m)	**Units**	**Surface**	**Bottom**
Temperature	(°C)	16.0	16.0
Dissolved Oxygen	% Saturation	60.34	62.35
pH		7.1	
Electrical Conductivity	(μScm^{-1})	57	
Turbidity	(NTU)	31	
Colour	(Pt/Co Units)	80	
Nitrates and Nitrites	(mg/1)	<0.003	
Reactive Phosphorus	(mg/1)	0.005	
Total Phosphorus	(mg/1)	0.056	
Tannins and Lignins	(mg/1)	1.5	
Secchi Depth*	(cm)	30	
Phenolic compounds as phenols	(mg/1)	<0.001	

*Estimate of Turbidity

Jackson 1993). Budgee Creek affords habitat which is typical of a lowland floodplain river system (Table 3) and is very similar to the habitat of the Murray River near Yarrawonga, often turbid with clay/silt or sand substrates. By contrast, Seven Creeks is a small stream in which Trout Cod are found in areas with flowing water over sand-gravel and rock substrates (Cadwallader 1979). The Trout Cod was captured in one of the deeper areas (6.8 m max. depth) of Budgee Creek and at this time, the flood in the forest was close to its peak. Results of habitat surveys conducted at Mosquito Bend at low flow levels in the forest in May 1991 indicate that the habitat changes from that observed during the sampling period to minimal flow and pools are reduced to 3.4 m (max. depth) and become virtually isolated. The structural characteristics of the habitat at Mosquito Bend (Table 2) remained relatively unchanged between May 1991 and October 1992.

It should be noted that, although this individual probably originated from the Murray River population, it was captured in Victorian waters, thus raising the possibility of the establishment of a natural population of Trout Cod in Victorian waters. At present the only confirmed populations of Trout Cod in Victoria are those derived from translocations and stockings of hatchery-bred fish.

Acknowledgements

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References

Berra T.M, and Weatherley, A.H. (1972). A systematic study of the Australian freshwater serranid fish genus *Maccullochella. Copeia* m1:53-64.

Brumley, A.R, Morison, A.K. and Anderson, J.R.(1987). Revision of the conservation status of several species of warmwater native fish after surveys of selected sites in northern Victoria (1982-1984). Arthur Rylah Institute for Environmental Research Technical report Series No. 33. (Conservation, Forests and Lands, Fisheries Division, Victoria).

Cadwallader, P.L. (1977). J.O. Langtry's 1949-50 Murray River Investigations. Fisheries and Wildlife Paper, Victoria No. 13 (Fisheries and Wildlife Division, Victoria).

Cadwallader, P.L. (1979). Distribution of native and introduced fish in the Seven Creeks River system, Victoria. *Australian Journal of Ecology* 4: 361-385.

Cadwallader, P.L. (1986). Flow regulation in the Murray River system and its effect on the native fish fauna. *In* 'Stream Protection. The Management of Rivers for Instream Uses.' Ed. I.C. Campbell, Water Studies Centre, Chisholm Institute of Technology. 115-133.

Cadwallader, P.L. and Gooley, G.J. (1984). Past and present distributions and translocations of Murray Cod *Maccullochella peelii* and Trout Cod *M. macquariensis* (Pisces: Percichthyidae) in Victoria. *Proceedings of the Royal Society of Victoria* **96**(1):33-43.

Dexter B.D. (1978). Silviculture of the river red gum forests of the central Murray floodplain. Proceedings of the Royal Society of Victoria, Symposium on the Murray Darling River System.

Ingram, B.A. Barlow, C.G., Burchmore, J.J., Rowland, S.J. and Sanger, A.C. (1990). Threatened native freshwater fishes in Australia - some case histories. *Journal of Fish Biology* **37** (Supplement A): 175-182.

Jackson, P.D., Koehn, J.D. and Wager, R. (1993). *In* 'Sustainable Fisheries through Sustaining Fish Habitat'. Ed. Hancock D.A (Australian Society for Fish Biology Workshop. Victor Harbour, S.A. 12-13 August 1993, Bureau of Resource Sciences Proceedings, AGPS, Canberra).

Koehn, J.D. and Morison, A.K. (1990). A review of the conservation status of native freshwater fish in Victoria. *The Victorian Naturalist* **107** (1):13-25

Lake, J.S. (1971). 'Freshwater Fishes and Rivers of Australia' (Nelson: Melbourne).

Leitch, C. (1989). Towards a strategy for Managing the Flooding of Barmah Forest. Benalla Region, Department of Conservation, Forests and Lands, Victoria.

Lintermans, M. Kukolic and Rutzou, T. (1988). The status of the Trout Cod *Maccullochella macquariensis*, in the Australian Capital Territory. *The Victorian Naturalist* **105** (1): 205-207.

Morison, A.K. and Anderson, J.R. (1987). Status of Trout Cod *Maccullochella macquariensis*, Macquarie Perch *Macquaria australasica*, and other fish populations in the upper reaches of Seven Creeks, based on surveys between 1981 and 1987. Arthur Rylah Institute for Environmental Research Technical Report Series No. 59.

Tunbridge, B.R. (1978). A survey of the fish populations in the Mitta Mitta River and tributaries before the construction of the Dartmouth Dam. *In* 'Dartmouth Dam Project: Report on Environmental Studies.' (State Rivers and Water Supply Commission, Victoria).

Wager, R and Jackson, P. (1993). The Action Plan for Australian Freshwater Fishes. Australian Nature Conservation Agency Endangered Species Program. Project Number 147, pp 65-67.

A Remnant of Coastal Vegetation on Phillip Island, Victoria

Rod Fensham*

Introduction

The wildlife of Phillip Island provides one of the major tourist drawcards in Australia. Flocks of sightseers make a regimented pilgrimage to view the Little Penguins, Koalas and Fur-seals. In addition to these popular attractions, the island provides important nesting habitat for Short-tailed Shearwaters and other sea-birds. Given the abundance of native wildlife it is ironic that native habitat is an extremely rare commodity on Phillip Island. It is probable that Phillip Island of all Australia's medium to large sized islands has suffered the most dramatic transformation from its pre-European condition.

There are only cursory descriptions of the original bush on the island. Seddon (1975) provides a speculative map of the broad structural vegetation types that may have originally clothed Phillip Island and there is some small scale mapping of the island's vegetation included in Land Conservation Council (1973). With the exception of these references there are only sketchy descriptions in the Excursion notes from this journal to contribute to an understanding of the islands original condition (Gabriel and Tisdall 1899; Gabriel 1913; Miller and Hodgson 1928).

The purpose of this paper is to document the current condition of one of the last remnants of native vegetation on Phillip Island. The ecological forces that have shaped this small area of bush are discussed and some suggestions as to how management might maintain and hopefully improve its native condition are provided.

Study site

The mean annual precipitation at Cowes on Phillip Island is 764 mm. A dominant feature of the climate on the south coast is the preponderance of south to westerly air streams. Data from 25 years of records at Cape Schank, about 34 km to the west shows that winds measured daily at 1500 hours were a direction between southeast or northwest and occur with an intensity greater than 20 km/hour at a frequency of 34%. Winds from the same direction were greater than 30 km/hr at a frequency of 19% and greater than 40 km/hour at a frequency of 8%.

With the exception of coastal sand and the granite rocks of Cape Woolamai the entire island is mantled by basalt soils. Along the southern coast the gently undulating basalt surface is almost entirely developed as cattle pasture or housing estate. The cliffs and headlands where this substrate plunges steeply to the coast are mostly covered by impenetrable thickets of the introduced shrub Gorse (*Ulex europaeus*). There is only one site where native vegetation extends from rocky shore platforms to the relatively level ground at the top of the steep landforms that comprise the southern coast of Phillip Island. This site is around Sunderland Bluff (Fig. 1) and provides the focus for this study.

The study area is on private land with the exception of a strip 60 m landward from the high tide mark. The area has been spared of clearing and maintained its original condition by virtue of a fence located approximately parallel to the coast (Fig. 1).

The vegetation

As a means of detecting plant species and in order to understand the vegetation patterns 32, 5 x 5 m quadrats were spaced around the study area in October 1991. The position, slope, aspect, soil type and a list of all species of vascular plant and mosses occurring in the quadrat was noted. The sites were revisited in late December 1992 to record species such as grasses that are difficult to identify during

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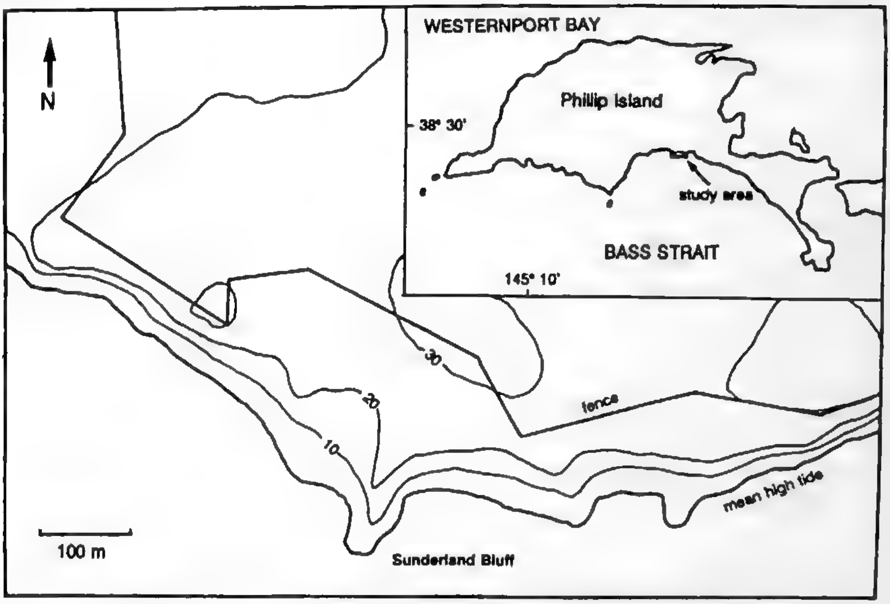

Fig. 1. Locality map. The study site is the strip of land between the fence and the coast.

spring. The site species lists, including exotic species were classified by a computer program called TWINSPAN. This program orders the plant lists on the basis of similarity in their species composition. It then splits the ordered sequence of sites and then reorders and resplits the halves. TWINSPAN continues this process until a hierarchy of site groups is formed. While the variations between these groups is usually continuous, the classification produces groupings of plant species that are common associates and presents indicator species that most faithfully distinguish groups. Thus computer derived classification schemes provide ecologists with a useful means of describing and summarising complex vegetation patterns. The ecological meaning of these groups becomes apparent after searching for environmental consistencies between the sites comprising single groups.

One hundred and one native higher plant species, 13 native liverworts and mosses, 55 naturalised exotic species and 4 planted species were located within the study area. Fig. 2 presents the arrangement of the classficatory groups in the TWINSPAN hierarchy and a full list of species (nomenclature follows Ross (1993) and Cropper *et al.* (1989) unless otherwise given) and their community associations is provided in Table 1. A description of the dominant native species for each group follows.

Group 1 These sites are dominated by *Leptospermum laevigatum* which forms a dense scrub of 2-5 m height (Fig. 3). Understorey is sparse under the closed canopy and typically includes rank

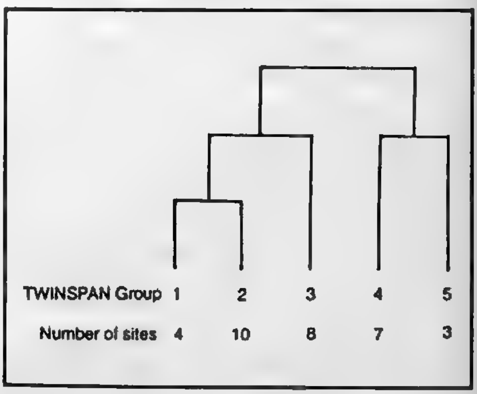

Fig. 2. Dendrogram showing the TWINSPAN hierarchy of the classificatory groups and the number of sites included in each group.

Fig. 3. View looking southeast from the paddock to the north of the study area. Closed *Leptospermum laevigatum* scrub is in the left mid-ground and *Phalaris aquatica* has invaded the study area in the right mid-ground.

tussocks of *Poa poiformis*, the herb *Dichondra repens* and the moss *Sematophyllum homomallum*.

Group 2 This group is comprised of grassy openings (Fig. 4) within scrub and as such comprises a diversity of species from both scrub (group 1) and grassland (group 3). The grass canopy is usually relatively open and these sites have a relatively high species richness. The group also includes species that were frequently encountered in the grassy openings but were not recorded in either group 1 or 3. These include the grasses *Danthonia laevis, Deyeuxia quadriseta, Dichelacne inaequiglumis, Pentapogon quadrifidus,* the herbs *Brachyscome parvula, Drosera peltata, Gnaphalium* sp. and the orchid *Thelymitra pauciflora,* sens. lat.

Group 3 Most of these grassland sites are dominated by a dense canopy of *Poa poiformis* (Fig. 5). Other common species in these grasslands include the grasses *Agrostis avenacea, Elymus scabrus* and the herbs *Acaena novaezelandiae, Geranium retrorsum* and *Oxalis perenrans. Calocephalus lacteus* is an abundant herb and *Dichelacne crinita* a prominent grass on sites within this group on exposed slopes. One site within this group was dominated by a closed canopy of bracken (*Pteridium esculentum*).

Group 4 These sites are usually dominated by *Poa poiformis* at varying densities. The climbing succulent *Tetragonia implexicoma* is common and often shrouds grass tussocks and shrubs that may include *Ozothamnus turbinatus, Leucopogon parviflorus* and *Olearia axillaris.*

Group 5 These three sites are herbfields dominated by the succulent species *Disphyma crassifolium, Sueada australis* and *Senecio spathulatus* (Fig. 6). The proportion of bare ground can be considerable and there may be patches of the rosette herb *Plantago varia* and tussocks of *Poa poiformis.*

Environmental relations

Salt laden winds constantly prune the growing tips of woody plants (Barbour and de Jong 1977). This produces the characteristic landward lean that shrubs develop on the front line of exposed coasts. Herbaceous and prostrate life-forms are favoured in these positions and tall shrublands cannot develop. The closed canopy scrub comprising group 1

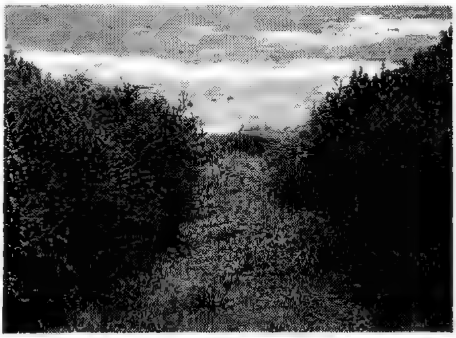

Fig. 4. Wind maintained opening in scrub on edge of a steep coastal bank.

Fig. 5. *Poa poiformis* grassland on steep coastal banks.

Fig. 6. Sunderland Bluff dominated by succulent herbfield (rearground). Grassland/shrubland complex on sand occupies the fore-ground of the photo and is heavily invaded by the grass *Lagurus ovatus*.

all occur on basalt soil on the inland sections of the study site (Fig. 3) and consequently are not as exposed to the salt spray carried by the strong south to westerly winds as more seaward sites.

The grassy openings within shrubland that comprise group 2 occur on the edge of steep banks falling to the coast (Fig. 4). In these situations conditions may be marginal for woody growth. Salt bearing winds are funnelled through openings in the shrub canopy. Thus the microclimate of these gaps tends to self perpetuate their open character. However, when other disturbances such as fire serve to reduce aerial biomass to ground level the position of openings in these coastal shrublands may change. Surfers walking a foot track have until recently provided another agent of disturbance on the edge of the coastal bank. It appears that the regular movement of people has been sufficient to provide habitat for herbaceous vegetation within the shrubland. It is even possible such an agent of disturbance predates Europeans. The presence of middens on rock platforms above the high tide mark within the study area attests to the use of marine foods by aborigines. Movement around the base of the steep coastal banks is restricted at high tides and the easiest means of travel may have been on regularly trammelled tracks on the level ground above the steep coastal banks.

Extensive grasslands (comprising group 3) occur on basalt substrate where there is moderate to severe exposure to salt-bearing winds (Fig. 5). These sites tend to occur on gentle to steep slopes facing between the west and the southeast. In the steepest situations land-slips were evident in December 1992 after an extremely wet spring. These occurred despite an almost closed canopy of *Poa poiformis* tussocks and seem to be a natural phenomenon resulting from the movement of water through the soil mantle on the steep landforms.

Group 4 sites are almost totally faithful to situations where coastal sand has accumulated. In one area there is an alcove in the basalt massif such that small dunes have formed on subdued topography not far above the high tide mark (Fig. 6). Group 4 communities also occurred in situations where wind-blown sand lies over basalt soils at elevations up to 20 m above the high water mark. The deposition of sand at these elevations attests to the strength of southwesterly winds along the southern coast of Phillip Island. Group 5 sites all occur around the basalt headland which forms Sunderland Bluff (Fig. 6). These situations are extremely exposed and are within the splash zone during high seas.

The maintenance and rehabilitation of the areas native condition

There is currently an active Landcare group on Phillip Island. The maintenance and rehabilitation of the Sunderland Bluff remnant could provide a focus for some of this groups activity. In order to ensure the perpetuation of this remnant the major effort should be directed towards the removal of the most aggresive exotic species. In order of priority, the following species require attention:

***The Bridal Creeper** (Myrsiphyllum asparagoides)* is a particularly invasive climbing herb and is difficult to eradicate due to its stout rhizome and abundant tubers. Only one plant of this species was observed during this study. The area should be further inspected to locate all individuals of this species, which should be carefully spot sprayed and/or excavated to ensure that all parts of the plant including its tubers are removed and effectively destroyed.

Limited areas have patchy infestations of Gorse. The real extent of these infestations do not appear to have dramatically increased over the last 15 years. However, local observation suggests that this species has expanded over coastal areas on Phillip Island following fire. The Sunderland Bluff site has not been burnt for at least 17 years. The area is afforded fire protection because of the pastures to the north and limited access to people. However, if a wildfire occurs it will almost certainly lead to the expansion of Gorse. Thus it is imperative that the existing clumps are eradicated. The seed of Gorse is long-lived and to ensure that the species is excluded from the area it will be necessary to monitor its re-establishment. If a fire occurs a concentrated effort may be required to remove seedlings.

On less fertile substrates in Victoria, native plant species richness declines as the cover of Coast Tea-tree *(Leptospermum laevigatum)* expands after long fire-free periods (Burrell 1981; Molnar *et al.* 1989). Most of the scrub at Sunderland Bluff is almost completely dominated by Coast Tea-tree. Thus occasional fire may be ecologically desirable at Sunderland Bluff. However, fire should not be used as a management tool in the area before efforts are directed towards the removal of Gorse.

Some parts of the study area are introduced grassland dominated by either Phalaris (Phalaris aquatica) or Kikuyu (Pennisetum clandestinum) (Fig. 3). Over the last fifteen years these aggresive pasture grasses do not appear to have spread. However, the rehabilitation of these areas would be extremely desirable, although considerably more challenging than the previous recommendations.

The grasslands of the study area include a broad array of exotic species. There is also a small area of plantation adjacent to the fence on the northern end of the study area. Most of these species may not pose a serious threat to the viability of the native vegetation at Sunderland Bluff in the medium to long term. However, the relative abundance of native and exotic cover at Sunderland Bluff should be monitored and expanding exotics removed.

Given the importance to the tourist industry of the native wildlife resource on Phillip Island, efforts should be extended to preserve the last natural habitats on the island. With careful active management the integrity of the precious remnant of native vegetation at Sunderland Bluff can be maintained.

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References

Barbour,M.G. and de Jong, T.M. (1977). Response of west coast beach taxa to salt spray, seawater inundation, and soil salinity. *Bulletin of the Torrey Botanical Club* **104**:29-34.

Burrell, J.P. (1981). Invasion of coastal heaths of Victoria by *Leptospermum laevigatum* (J. Gaertn.) F. Muell. *Australian Journal of Botany* **29**:747-64.

Cropper, S. C., Tomkinson, D. A. and Scott, G. A. N. (1991) 'A census of Victorian Bryophytes'. National Parks and Public Land Division. Department of Conservation and Environment, Victoria.

Gabriel, J. (1913). Excursion to Phillip Island. *The Victorian Naturalist* **30**:29-34.

Gabriel, J. and Tisdall, H.T. (1899). Two naturalists at Phillip Island. *The Victorian Naturalist* **16**:45-49.

Land Conservation Council (1973). Report on the Melbourne Study Area. Unpublished report to Land Conservation Council, Victoria.

Miller, V.H. and Hodgson, L.L. (1928). Excursion to Phillip Island. *The Victorian Naturalist* **44**:320.

Molnar, C.D., Fletcher, D. and Parsons, R.F. (1989). Relationships between heath and *Leptospermum laevigatum* scrub at Sandringham, Victoria. *Proceedings of the Royal Society of Victoria* **101**:77-87.

Ross, J.H. (1993). *'A census of the vascular plants of Victoria'*. Royal Botanic Gardens, Melbourne.

Seddon, G. (1975). Phillip Island: Capability, conflict and compromise, a report to the Western Port Regional Planning Authority. Publication No. 4.

Table 1. Species list

Sunderland Bluff, Phillip Island. Taxonomic nomenclature follows Cropper *et al.* (1991) amd Ross (1993) unless otherwise given. *-naturalised exotic; p-planted exotic.

BRYOPHYTA
HEPATICAE
Codoniaceae
Fossombronia pusilla
Geocalycaceae
Lophocolea semiteres
MUSCI
Bryaceae
Bryum billardieri
Dicranaceae
Campylopus introflexus
Fissidentaceae
Fissidens vittatus
Hypnaceae
Hypnum cupressiforme
Pottiaceae
Tortella calycina
Weissia controversa
Rhacopilaceae
Rhacopilum convolutaceum
Sematophyllaceae
Sematophyllum homomallum
Thuidiaceae
Thuidium furfurosum
PTERIDOPHYTA
Dennstaedtiaceae
Pteridium esculentum Bracken
MONOCOTYLEDONEAE
Centrolepidaceae
Aphelia pumilio
Centrolepis aristata
C. strigosa
Cyperaceae
Carex breviculmis
* *Cyperus tenellus*
Gahnia radula Thatch Saw-sedge
Isolepis nodosa Knobby Club-rush
Schoenus apogon Common Bog-rush
S. nitens Shiny Bog-rush
Juncaceae
Juncus pallidus Rush
Luzula meridionalis Wood-rush
Liliaceae
Dianella revoluta var. *revoluta* Flax Lily
* *Myrsiphyllum asparagoides* Bridal Creeper
Orchidaceae
Caladenia carnea Pink Fingers
Microtis parviflora Onion Orchid
M. unifolia Onion Orchid
Thelymitra flexuosa Twisted Sun Orchid
T. pauciflora sens. lat. Slender Sun Orchid
Poaceae
Agrostis avenacea Blown Grass
* *Aira caryophyllea* Silvery Hair Grass
* *Briza minor* Shivery Grass
* *Bromus hordeaceus* Soft Brome
* *B. sterilis* Sterile Brome
* *Catapodium rigidum* Rigid Fescue
p *Cortaderia selloana* Pampas Grass
* *Critesion marinum* Barley Grass
* *Dactylis glomerata* Cocksfoot
Danthonia caespitosa Wallaby Grass
D. geniculata Wallaby Grass
D. laevis Wallaby Grass
D. racemosa Wallaby Grass
D. semiannularis Wallaby Grass
D. setacea Wallaby Grass
Deyeuxia quadriseta Bent Grass
Dichelachne crinita Longhair Plume Grass
D. inaequiglumis Shorthair Plume Grass
Elymus scabrus Common Wheatgrass
Hemarthria uncinata Mat Grass
* *Holcus lanatus* Fog Grass
* *Lagurus ovatus* Hare's Tail
* *Lolium perenne* Perennial Ryegrass
Microlaena stipoides Weeping Grass
* *Parapholis incurva*
* *Paspalum dilatatum* Caterpillar Grass
* *Pennisetum clandestinum* Kikuyu
Pentapogon quadrifidus Five-awn Spear Grass
* *Phalaris aquatica* Canary Grass
* *Poa annua* Annual Meadow Grass
P. labillardieri Tussock Grass
Poa poiformis Coast Tussock Grass
Spinifex sericeus Coast Spinifex
Stipa flavescens SpearGrass
S. pubinodis SpearGrass
S. stipoides Coast Spear Grass
* *Vulpia bromoides* Rat's Tail Fescue
DICOTYLEDONEAE
Aizoaceae
Disphyma crassifolium Rounded Noon-flower
Tetragonia implexicoma Bower Spinach
Apiaceae
Apium prostratum Sea Celery
Hydrocotyle foveolata Yellow Pennywort
H. sibthorpioides Shining Pennywort
Apocynaceae
Alyxia buxifolia Sea-box
Asteraceae
* *Arctotheca calendula* Capeweed
Brachyscome parvula Coast Daisy
Calocephalus brownii Cushion Bush
C. lacteus Lemon Beauty Heads
* *Cirsium vulgare* Spear Thistle
Cymbonotus preissianus Bear's Ear
Euchiton involucratus
Gnaphalium. purpureum Cudweed
* *Hypochoeris glabra* Smooth Cat's Ear
* *H. radicata* Flatweed, Cat's Ear
* *Leontodon taraxacoides* Hawkbit
Olearia axillaris Coast Daisy Bush
O. ramulosa Twiggy Daisy-bush
Ozothamnus turbinatus Coast Daisy Bush
p *Senecio bicolor* (Willd.) Tod.
* *S. elegans*

S. glomeratus Groundsel
S. spathulatus Succulent Groundsel
Solenogyne dominii Small Bottle-daisy
* *Sonchus asper* Prickly Sow-thistle
* *S. oleraceus* Sow-thistle
Boraginaceae
Cynoglossum australe Sweet Hound's Tongue
Brassicaceae
* *Cakile maritima* Sea-rocket
Campanulaceae
Lobelia pratioides Poison Lobelia
Wahlenbergia multicaulis Bluebell
Caryophyllaceae
* *Arenaria leptoclados* Thyme-leaved Sandwort
* *Cerastium glomeratum* Sticky Mouse-ear Chickweed
Sagina maritima Sea Pearlwort
* *Spergularia rubra* Sand Spurrey
* *Stellaria media* Chickweed
Chenopodiaceae
Rhagodia candollana Coastal Saltbush
Sarcocornia quinqueflora Beaded Glasswort
Suaeda australis Austral Seablite
Clusicaceae
Hypericum gramineum St. John's Wort
H. japonicum St. John's Wort
Convolvulaceae
Dichondra repens Kidney Weed
Droseraceae
Drosera peltata ssp. *auriculata* Sundew
D. pygmaea Dwarf Sundew
Epacridaceae
Astroloma humifusum Native Cranberry
Leucopogon parviflorus Coast Beard Heath
Fabaceae
Bossiaea prostrata Creeping Bossiaea
Kennedia prostrata Running Postman
Pultenaea daphnoides Large Leaf Bush-pea
* *Trifolium dubium* Yellow Suckling Clover
* *T. glomeratum* Cluster Clover
* *T. repens* White Clover
* *T. resupinatum* Shaftal Clover
* *T. subterraneum* Subterranean Clover
* *Ulex europaeus* Gorse
* *Vicia sativa* Common Vetch
Fumariaceae
Fumaria sp. Fumitory
Gentianaceae
* *Cicendia filiformis*
* *Centaurium erythraea* Centaury
Geraniaceae
Geranium retrorsum Native Geranium
G. solanderi Native Geranium
Pelargonium australe Austral Stork's Bill
Goodeniaceae
Goodenia ovata Parrot Food
Haloragaceae
Gonocarpus tetragynus Raspwort
Lamiaceae
* *Prunella laciniata* Self heal
p *Westringia fruticosa* (Willd.) Druce
Lauraceae
Cassytha pubescens Dodder Laurel
Linaceae
* *Linum trigynum* French Flax
Mimosaceae
Acacia verticillata Prickly Moses
Myoporaceae
Myoporum insulare Coast Boobialla
Myrtaceae
Leptospermum continentale Prickly Tea-tree
L. laevigatum Coast Tea-tree
p *Melaleuca diosmifolia* Andrews
M. ericifolia Swamp Paper-bark
M. lanceolata Moonah
Onagraceae
Epilobium billardierianum Willow Herb
Oxalidaceae
Oxalis perennans Yellow Wood Sorrel
Pittosporaceae
Bursaria spinosa Prickly Box
Plantaginaceae
* *Plantago coronopus* Ribwort Plantain
* *P. lanceolata* Buck's-horn Plantain
P. varia Native Plantain
Polygalaceae
Comesperma volubile Love Creeper
Polygonaceae
* *Acetosella vulgaris* Sheep's Sorrel
Muehlenbeckia adpressa Climbing Lignum
Rumex brownii Slender Dock
Primulaceae
* *Anagallis arvensis* Scarlet Pimpernel
Ranunculaceae
Clematis microphylla Small-leaved Clematis
Rhamnaceae
Pomaderris paniculosa
ssp. *paniculosa* Coast Pomaderris
Rosaceae
Acaena agnipila Sheep's Burr
A. novae-zelandiae Buzzy
* *Rubus fruticosus* Blackberry
Rubiaceae
Asperula conferta Woodruff
* *Coprosma repens* Mirror Bush
* *Galium aparine* Goosegrass
* *G. murale* Small Goosegrass
Opercularia varia Stinkweed
Rutaceae
Correa alba White Correa
Santalaceae
Exocarpos strictus Dwarf Cherry
Scrophulariaceae
Veronica gracilis Slender Speedwell
Solanaceae
* *Lycium ferocissimum* African Box-thorn
* *Solanum americanum* Glossy Nightshade
Stylidiaceae
Stylidium graminifolium Grass Trigger Plant
Urticaceae
Parietaria debilis Shade Pellitory
Violaceae
Viola hederacea Ivy-leaf Violet

Reptiles and Amphibians of the Coastal Dunes at Venus Bay, Victoria

M. Schulz*

Abstract

Thirteen species of reptiles and four species of amphibians were recorded from seventeen kilometres of primary sand dunes at Venus Bay, South Gippsland in seventy-two visits between 1979 and 1990. Three species of skink were detected on all visits to the area. These were the Eastern Three-lined Skink *Bassiana duperreyi,* Grass Skink *Pseudemoia entrecasteauxii* and Metallic Skink *Niveoscincus metallica.* The Bougainville's Skink *Lerista bougainvillii* is an uncommon, patchily distributed species in South Gippsland and was located on only one occasion. Two marine reptiles, the Green Turtle *Chelonia mydas* and Yellow-bellied Sea Snake *Pelamis platurus,* were recorded as single beachwashed individuals. Preliminary observations were made on the effects of spring tide and storm waves penetrating the seaward side of the primary dunes on the reptile fauna.

Introduction

Detailed reptile and amphibian surveys have been conducted in a variety of habitats in Victoria, such as the semi-arid mallee and heathlands in north-western Victoria (Mather 1979; Robertson *et al.* 1989) and the montane forests of the Great Dividing Range and East Gippsland (Hutchinson 1979; Macfarlane *et al.* 1987; Schulz *et al.* 1987; Braby 1989; Westaway *et al.* 1990). However, little has been published on the occurrence of reptiles and amphibians in coastal dune systems along the Victorian coastline. The aim of the present study was to establish which species of reptiles and amphibians occur in the coastal dunes of Venus Bay, South Gippsland. This study was based on observations while conducting a survey of beachwashed birds present on the beach and foredunes of Venus Bay.

Few detailed studies of reptiles and amphibians have been undertaken in the Venus Bay region. Norris *et al.* (1979) listed nine species of reptiles and nine species of amphibians occurring in the Venus Bay area. Both these studies were broad-scale in nature with little habitat and distributional information provided. Consequently, it is difficult to identify from these studies which species occurred in habitats such as the coastal dunes at Venus Bay.

Study area

As the observations were made whilst undertaking a survey of beachwashed birds the study area includes only the beach and adjacent primary sand dunes to a distance of no more than 500 metres inland.

The study area extended for approximately seventeen kilometres along the coastline from the Venus Bay Surf Lifesaving Club (38°40', 145°,49') south-east to Arch Rock (38°51', 145°54'), Venus Bay, South Gippsland (Fig. 1). This area is typified by a long sand beach backed by Recent to Pleistocene dunes. The section between Six Mile Creek and Arch Rock contains outcrops of consolidated Pleistocene dune limestone (Land Conservation Council 1990). Three small ephemeral creeks flow through the dune system on to the beach. These creeks only flow following heavy and/or prolonged rain episodes. No wetlands are present within the primary sand dune system.

The site contains three distinct vegetation types as identified by the LCC (1980):

Bare sand dunes and beach. Apart from Pioneer plant species such as Sea Rocket *Cakile maritima* and scattered Hairy Spinifex *Spinifex sericeus* little vegetation is present and areas are typified by extensive patches of bare sand (Fig. 2).

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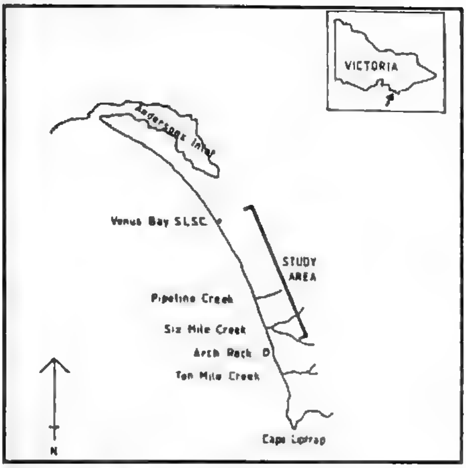

Fig. 1. Study area, Venus Bay, South Gippsland, Victoria.

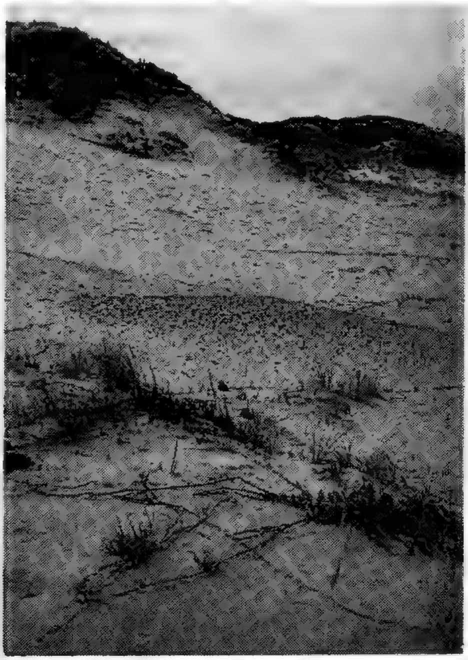

Fig.2. Bare sand dune vegetation community (from LCC 1980), Venus Bay, South Gippsland, Victoria.

Coastal Grassland. Dominated by a variable cover of Hairy Spinifex, Marram Grass *Ammophila arenaria* and Sea Wheat-grass *Thinopyrum junceum* (Fig. 3). Also present in lower abundance are the Knobby Club-rush *Isolepis nodosa,* Coast Sawsedge *Gahnia trifida,* Climbing Lignum *Muehlenbeckia adpressa,* Coast Wattle *Acacia sophorae,* Coast Everlasting *Ozothamnus turbinatus,* White Correa *Correa alba,* Seaberry Saltbush *Rhagodia candolleana* and Coast Swainson-pea *Swainsona lessertiifolia.* This vegetation type grades into the coastal scrub community and may contain stunted species of that community type.

Coastal Scrub. Dominated by stunted Coast Tea-tree *Leptospermum laevigatum.* Other well-represented species are the Coast Beard-heath *Leucopogon parviflorus,* Coast Wattle, Common Boobialla *Myoporum insulare* and Coast Ballart *Exocarpos syrticola* (Fig. 4).

Methods

The area was visited on seventy-two occasions between 1979 and 1990. Regular monthly visits were made in 1980, 1981 and 1982. The remainder of the survey period consisted of irregular visits with no more than six visits conducted in a single year. During each year of the study period at least one visit was made in both the spring and summer months. All visits included a coverage of at least eight kilometres along the primary

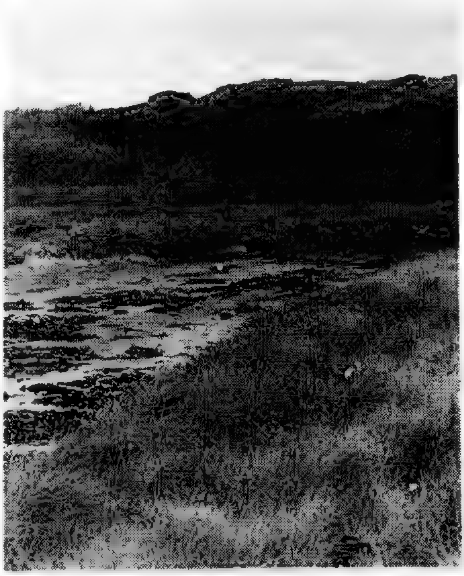

Fig. 3. Coastal grassland community (from LCC 1980), Venus Bay, South Gippsland, Victoria.

Fig. 4. Coastal scrub community (from LCC 1980), Venus Bay, South Gippsland, Victoria.

dune system, and on twenty-nine occasions the full seventeen kilometres of the study area was traversed.

Reptiles and amphibians were recorded by direct observational methods only. No pitfall trapping was conducted in the site. A visit to the site involved walking in the primary foredunes parallel to the beach, scanning for active individuals and searching under debris such as flotsam and jetsam cast ashore by spring tides and storm waves for resting individuals. At a number of locations drift wood cast up on the beach was relocated to the dunes to increase the potential for recording species.

Incidental observations of additional reptiles and amphibian species from adjacent coastal areas such as Point Smythe and Cape Liptrap and inland of the study site in adjacent coastal scrub and farmland were noted.

Nomenclature for reptiles and amphibians follows that of Cogger (1992). The common names used follows that of the Atlas of Victorian Wildlife (Dept of Conservation and Natural Resources).

Results

Thirteen species of reptiles from the five families (Cheloniidae, Agamidae, Scincidae, Elapidae and Hydrophiidae) and four species of amphibians from two families (Myobatrachiidae (also Leptodactylidae) and Hylidae) were recorded from the study area at Venus Bay (Table 1). Two species were only encountered as single beach-cast individuals. These were the Green Turtle *Chelonia mydas* and the Yellow-bellied Sea Snake *Pelamis platurus.*

The most common reptiles encountered were the Eastern Three-lined Skink *Bassiana duperreyi,* Grass Skink *Pseudemoia entrecasteauxxi* and the Metallic Skink *Niveoscincus Metallica.* All three species were recorded on every visit to the study area (Table 1). Other frequently encountered species were the Blotched Blue-tongued Lizard *Tiliqua nigrolutea* (58.3% of visits) and the Copperhead *Austrelaps superbus* (55.6% of visits). Two terrestrial species were recorded on only one occasion in the study area. These were the Tree Dragon *Amphibolurus muricatus* and the Bougainville's Skink *Lerista bougainvillii* (Table 1).

Amphibians were uncommon and primarily concentrated along the watercourses in the study area. The most frequently encountered species in this situation were the Common Froglet *Crinia* (also *Ranidella*) *signifera* (33.3% of visits) and the Striped Marsh Frog *Limnodynastes peroni* (27.8% of visits) (Table 1). The Southern Bullfrog *L. dumerilii* was not confined to the watercourses and a number of individuals were found sheltering under ground debris at least one kilometre from the nearest known watercourse in the spring and winter months. The Whistling Tree Frog *Litoria verreauxii* was recorded on only two occasions, both times on the edge of Six Mile Creek.

The majority of reptile species were observed along the entire length of the study area. The Southern Water Skink *Eulamprys tympanum* was only recorded from Pipeline Creek and Ten Mile Creek (Fig. 1). Here it was commonly encountered basking or searching for prey amongst accumulated piles of jetsam. The White's Skink *Egernia whitii* appeared patchily distributed and was recorded only between Pipeline and Six Mile Creek and on rocky outcrops in the Ten Mile Creek-Arch Rock area (Fig. 1). Here it was encountered sheltering under rocks, pieces of driftwood or basking in the open.

The Grass Skink varied in the colour of the dorsal and lateral surfaces from a dull olive-brown to a bright golden brown. The latter colour pattern appeared to be more commonly encountered, although this was not quantified. Frequently individuals of the two forms were found sheltering under the same piece of wood and on one occasion a dull coloured male was observed copulating with a brightly coloured female.

The only Bougainville's Skink encountered was found in May 1989 sheltering under a piece of driftwood in open Hairy Spinifex grassland. While the only Tree Dragon detected was observed in December 1987 on the edge of a dense stand of Coast Wattle and Coast Beard-heath. This species appeared to be rare in the area, judging by the paucity of characteristic dragon lizard tracks seen on open sandy areas.

The majority of reptiles and all amphibians were recorded in areas that rarely or never flooded during spring tide and/or storm wave conditions. However, in low-lying areas at the mouth of the three creeks and along sections of the primary dunes six species of reptiles were encountered in small numbers. These were the Southern Water Skink, Grass Skink, Metallic Skink, Copperhead, White-lipped Snake *Drysdalia coronoides* and the Tiger Snake (now Eastern Tiger Snake *Notechis scutatus*).

Reptiles were observed on the beach on three occasions, excluding beach cast marine species. Single Tiger Snakes were observed twice (December 1980 and March 1982) amongst beach wrack on the upper sections of the beach above the high water mark. On both occasions the conditions were fine and warm and the animals appeared to be searching for prey. On one occasion three Metallic Skinks and one Tiger Snake were encountered struggling in the tideline edge. These individuals appeared to have become dislodged from a pile of timber and other jetsam that provided ideal shelter during fine conditions. This observation was made in September 1983 during a south westerly gale with a 2.5 metre ground swell resulting in waves penetrating into the foredunes and up the creek channels.

Sections of the seaward side of the foredunes and creek mouths were checked during five other storm events, when waves were penetrating into these areas. However, no dislodged reptiles were located and a search under debris in areas affected by waves or within five metres of the water's edge failed to detect any reptiles.

One species of reptile, the Garden Skink *Lamphroholis guichenoti, and two* species of amphibians, the Spotted Grass Frog *Limnodynastes tasmaniensis* and the Southern Brown Tree Frog *Litoria ewingii,* were not recorded from the study area but were detected in adjacent localities. The Garden Skink was present on the rocky headland and pebble beaches of the Lower Devonian Liptrap formation between Morgans Beach and Cape Liptrap, approximately five kilometres south-east of Arch Rock. The two frogs were recorded from flooded pastureland, heathland and the edge of coastal scrub inland from Six Mile Creek.

Discussion

The diversity of the reptile and amphibian fauna in the coastal primary dune environment is suprisingly high, representing 41.5% of the total species recorded in South Gippsland (Norris *et al.* 1979). One species, the Bougainville's Skink, had not previously been recorded from the Venus Bay region. The nearest known localities for this lizard are Seal Island (Norris *et al.* 1979), Emerald (Museum of Victoria record, NMV D8543), the Cranbourne area (NMV D54611) and Sunnyside Beach on the Mornington Peninsula (Brereton and Schulz in prep.).

The two marine reptiles recorded in the area are both rare species in Victorian waters (Cogger 1992). Two records are listed for the Green Turtle in central Victoria in the 'Atlas of Victorian Wildlife' database (Dept Conservation and Natural Resources). Both of these records were from the Wilsons Promontory region: Corner Inlet on the 7 May 1951 and Tidal River on the 22 September 1975. The individual located in the present study was an immature, found washed up on the 27 September 1979 in a moderately advanced state of decomposition. It was a surprise finding a turtle that normally inhabits tropical and subtropical Australian waters with its nearest breeding ground in southern Queensland, (Cogger 1992) beachwashed at the same time as sub-antarctic and/or antarctic breeding seabirds, such as the Southern Fulmar *Fulmaris glacialoides*, Kerguelen Petrel *Pterodroma brevirostris* and the Blue Petrel *Halobaena caerulea*. These birds are rare winter/spring visitors to southern Australian waters (Lindsey 1986), and generally only occur in Victorian waters when forced into lower latitudes by intense low pressure systems and associated galeforce south-westerly winds (Brown *et al.* 1986).

The Yellow-bellied Sea Snake is a pelagic species, with its latitudinal distribution greater than for any other species of sea snake (Kropach 1971). It has been suggested that a minimum sea temperature of 20°C is needed to maintain permanent breeding populations (Graham *et al.* 1971; Dunson and Ehlert 1971). Cogger (1975) suggested that such a population is present off the central New South Wales coast judging by the number of individuals taken in mid-winter when the sea-surface temperature is at its annual minimum and at a time when gravid females are present. This is probably the closest permanent population to Victoria. In Victoria this species is an uncommon visitor with the majority of records occurring between December and April in East Gippsland ('Atlas of Victorian Wildlife' database: Dept of Conservation and Natural Resources). The occurrence of the sea snake at this time of the year appears to be associated with the East Australian current. The single record of this snake in the study area was a sickly individual freshly washed up on the strand line at Six Mile Creek in December 1988.

The Grass Skink was commonly found in the same location as the Eastern Three-lined or Metallic Skinks. However, the latter two species were rarely observed together. The Eastern Three-lined Skink appeared to favour elevated situations that never flooded and the Metallic Skink was primarily found around the three creek mouths, on the shoreward edge of the primary dunes south-east of Pipeline Creek and along the margin of limestone protrusions on the edge of the beach.

Six species of reptiles occurred in areas that occasionally flooded during spring and/or galeforce conditions with a large predominantly onshore south-westerly swell. Such conditions tend to occur during the winter and spring months. Limited observations suggest some individuals are caught out in such conditions and may get washed away. However, with one exception, during periods of high energy waves, which penetrate the shoreward edge of the primary dunes and up the creeks no reptiles were detected within five metres of the water's edge. In fine conditions throughout the year at the same localities, numbers of reptiles were recorded.

The question remains as to how such species leave these shoreward areas during the colder months when the ambient temperature is low and hence activity is low and when a south-westerly gale is imminent. It is suggested that individuals move to higher ground before each storm or spring tide event takes place. However, no observations were made to support this hypothesis.

Due to the duration of the survey and the number of site visits conducted it is considered unlikely that additional reptile and amphibian species frequent the area. The Garden Skink is common south-east of Morgan's Beach on the Rocky headlands and upper sections of the pebble beaches on Cape Liptrap. The rock in these areas consists of Lower Devonian sedimentary deposits (LCC 1980). This is in contrast to the Recent to Pleistocene sedimentary deposits in the study area. Consequently the vegetation is different, with two communities (Wet Heath and Sand Heath - Heath Tea Tree) that are not present in the study area. The differences in geology and vegetation community types may provide the explanation for the absence of the Garden Skink in the study area. The Southern Brown Tree Frog and Spotted Grass Frog are common in moist situations in pastureland and immediately adjacent coastal vegetation inland from Six Mile Creek and elsewhere (e.g. Tarwin Meadows). The paucity of wetlands in the primary dune system may explain the absence of these frogs from the area.

The Swamp Skink *Egernia coventryi* has been recorded in the Cape Liptrap area (Norris *et al.* 1979). This lizard inhabits densely vegetated cane grass or heathy swamps (Robertson 1980; Smales 1981; Schulz 1993) or saltmarsh (Schulz 1985). No suitable habitat for this species was present in the study area.

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References

Braby, M.F. (1989). Reptiles of the northern section of Kinglake National Park. *The Victorian Naturalist* **106**: 79-85

Brereton, R. and Schulz, M.(In prep.). 'Sites of zoological significance in the south-east region of Melbourne". Technical Reports, Department of Conservation and Natural Resources: Melbourne.

Brook, A.J. (1982). 'Atlas of frogs in Victoria'. Publication No. 6, Department of Zoology, University of Melbourne: Victoria.

Brown, R.S., Norman, F.I. and Eades, D.W. (1986). 'Notes on Blue and Kerguelen Petrels found beach-washed in Victoria, 1984. *Emu* **86**: 228-238.

Cogger, H.G. (1975). The sea snakes of Australia and New Guinea pp. 59-139. *In*: 'The biology of sea snakes'. Ed. Dunson, W., pp. 59-139. (Univ. Park Press: Baltimore).

Dunson, W.A. and Ehlert, G.W. (1971). Effects of temperature, salinity and surface water flow on distribution of the sea snake *Pelamis. Limnol.* and Oceanog. **16**: 845-853.

Graham, J.B., Rubinoff, I. and Hecht, M.K. (1971). Temperature physiology of the sea snake *Pelamis platurus:* an index of its colonisation potential in the Atlantic Ocean. *Proceedings of the National Academy of Science USA* **68**: 1360-1363.

Hutchinson, M.N. (1979). The reptiles of Kinglake National Park. *The Victorian Nat.* **96**: 124-134.

Kropach, C. (1971). Sea snake *(Pelamis platurus)* aggregations on slicks in Panama. *Herpetologica* **27**: 131-135.

Land Conservation Council (1980). 'Report on the South Gippsland Study Area, District 2'. (Land Conservation Council: Victoria).

Lindsey, S.R. (Ed.) (1986). 'The Seabirds of Australia'. (Angus & Robertson: Sydney).

Macfarlane, M.A., Schulz, M., Parkes, D.M., Traill, B.J. and Triggs, B.E. (1987). 'Flora and fauna of the Buckland Forest Block, East Gippsland, Victoria'. Ecological Survey Rep. No. 8, Public Lands and Forest Division, Department of Conservation, Forests and Lands, Melbourne.

Mather, P.B. (1979). An examination of the reptile fauna of Wyperfeld National Park using pitfall trapping. *The Victorian Nat.* **96**: 98-101.

Norris, K.C., Gilmore, A.M. and Menkhorst, P.W. (1979). Vertebrate fauna of South Gippsland, Victoria. *Memoirs of the National Museum of Victoria.* **40**:105-199.

Pengilly, R. (1972). 'Systematic relationships and ecology of some Lygosomine lizards from south-eastern Australia'. 2 vols. Unpubl. PhD Thesis, Australian National University, Canberra.

Rawlinson, P.A. (1969). The reptiles of East Gippsland. *Proceedings of the Royal Society of Victoria.* **82**: 113-128.

Robertson, P. (1980). 'Alcoa Portland Smelter Environmental Study Report No. 1. Mourning Skink investigations', (Kinhill Planners:Melbourne).

Robertson, P., Bennett, A.F., Lumsden, L.F., Silveira, C.E., Johnson, P.G., Yen, A.L., Milledge, G.A., Lillywhite, P.K. and Pribble, H.J. (1989). Fauna of the Mallee Study Area North-Western Victoria". Technical Report Series No. 87, Arthur Rylah Institute for Environmental Resources, Department of Conservation, Forests and Lands, Victoria.

Schulz, M. (1985). The occurrence of the Mourning Skink, *Egernia coventryi* Storr, in saltmarsh in Westernport Bay, Victoria. *The Victorian Nat.* **102**: 148-152.

Schulz, M., (1993). 'The Swamp Skink Egernia coventryi-a review'. Report prepared for Melbourne Water. (Ecological Horticulture: Clifton Hill).

Schulz, M., Macfarlane, M.A., Parkes, DM and Traill, B.J. (1987). 'Flora and fauna of the Mount Murray Forest Block, North-east Region, Victoria'. Ecological Survey Report No. 14, Public Lands and Forest Division, Department of Conservation, Forests and Lands, Melbourne.

Westaway, J., Henry, S.R., Gillespie, G.R., Lobert, B.O., Scotts D.J. and Mueck, S.G. (1990). 'Flora and fauna of the West Errinundra and Delegate Forest Blocks, East Gippsland, Victoria'. Ecological Survey Report No. 31, Lands and Forest Division, Department of Conservation and Environment, Victoria.

Table 1. Reptile and amphibian fauna of the coastal dunes at Venus Bay, South Gippsland, Victoria.

Species	No. of visits recorded	% of visits recorded
Reptilia		
Green Turtle *Chelonia mydas**	1	1.4
Tree Dragon *Amphibolurus muricatus*	1	1.4
White's Skink *Egernia whitii*	26	36.1
Southern Water Skink *Eulamprus tympanum*	32	44.4
Bougainville's Skink *Lerista Bougainvillii*	1	1.4
Eastern Three-lined Skink *Bassiana duperreyi*	72	100.0
Grass Skink *Pseudemoia entrecasteauxii*	72	100.0
Metallic Skink *Niveoscincus Metallica*	72	100.0
Blotched Blue-tongued Lizard *Tiliqua nigrolutea*	42	58.3
Copperhead *Australaps superbus*	40	55.6
White-lipped Snake *Drysdalia coronoides*	22	30.6
Eastern Tiger Snake *Notechis scutatus*	34	47.2
Yellow-bellied Sea Snake *Pelamis platurus**	1	1.4
Amphibia		
Common Froglet *Crinia signifera*	24	33.3
Southern Bullfrog *Limnodynastes dumerilii*	12	16.7
Striped Marsh Frog *L. peroni*	20	27.8
Whistling Tree Frog *Litoria verreauxii*	4	5.6

*recorded only as beachwashed individuals

Zonation of *Austrocochlea* sp. at Cape Otway

B. L. Parker BSc*

Introduction

The abundance and world wide distribution of the sea shore winkles (*Austrocochlea*) has made them a popular subject for study and their significance in shore ecology is clearly recognised in schemes of zonation marking the upper limit of the littoral fringe.

The concept of zonation implies that different organisms (be it of the same genus, or of the same order) inhabit different areas across the shore and an organism's presence in a rocky shore ecosystem is determined by such factors as the availability of resources, competition, predation, environmental disturbances and local colonisations and extinctions of other organisms.

It has been suggested for species where the proximate factors of zonation have been identified that physiological factors often fix upper zonal limits, especially of high-shore species, and that ecological and behavioural factors tend to fix lower zone boundaries (Barnes 1982).

Such zonations of marine rocky ecosystems are commonly accepted, since renown groups of organisms (e.g. barnacles, limpets, kelp) occupy typical areas. However, less recognised is the fact that different genus members also tend to occupy different zones. According to Dakin (1973) most species of periwinkles have their own special horizons or levels and tend to keep to them, and it is the point of this experiment to test this theory.

The study carried out at Cape Otway National Park involved four species of *Austrocochlea: A. constricta; A. concamerata; A. odontis* and *A. adelaidae.* According to Phillips (1984) these four species are thought to occupy the following areas across the littoral zone:

(i) *Austrocochlea constricta* is the most abundant of the four and most common in the mid-tidal level, on exposed rock surfaces;

(ii) *A. concamerata,* which is thought to be only locally abundant in the mid-tidal areas;

(iii) *A. odontis,* which is common at and below mid-tide level, and

(iv) *A. adelaidae,* which is common at and below low-tide, and inhabits well-sheltered areas.

This investigation was to determine whether these four species of *Austrocochlea* occupied different zones across the shore, and whether these zones overlapped.

Study site and method

The study took place near the Parker River inlet in the Cape Otway National Park at Cape Otway, 43 kilometres west of Apollo Bay, Victoria (Lat. 38°50'35", Long. 143°33'49": Fig. 1). The marine ecosystem here was typical of a rocky coast, and the beach showed a 6% (3.5°) decline, or slope.

A transect line was selected, using a measuring tape, so that it encountered a variety of micro-environments ranging from rock platforms to shallow pools. Zero metres on the tape corresponded with what I perceived as being the high water mark and forty metres on the tape

Fig. 1. Location of the study site within the Cape Otway National Park, 43 km west of Apollo Bay.

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marked low water. This covered the area of the littoral zone.

A quadrat, 80 cm by 80 cm, was placed next to the tape to measure the presence and abundance of the four species of *Austrocochlea (A. constricta, A. concamerata, A. odontis* and *A. adelaidae)* within it. Only those species visible without moving the rocks were counted, because:

(i) In moving the rocks other marine life that reside under them are at risk, and

(ii) Some rocks would have been too big to move, and thus making exceptions for these would introduce bias into the experiment. It is important to note that this method is also subject to bias, because it is known that two of the four *Austrocochlea species (A. odontis* and *A. adelaidae*) prefer rock crevices and protected micro-habitats, and these species are less likely to be seen.

Results

The distance at which each species was found (from the littoral fringe) is shown in Fig. 2. From these boxplots (Fig. 2) it is evident that each species has its own zone of abundance, some of which seem to overlap. To give a better visual interpretation, Fig. 3 plotted all the data concerned with species abundance against the distance from the high water mark.

It seems that *A. constricta* was the most abundant species, both for numbers, and in the size of the zone they occupy. It also seems to be the sole species of the genus *Austrocochlea* occupying the upper shore area. In the centre of *A. constricta's* abundance is the concentration of *A. concamerata,* which has a much smaller population size. *A. odontis* was abundant when *A. constricta* started to decline while *A. adelaidae* was found in large numbers in the absence of all others at the lower shore (low water mark).

To analyse whether these zones differed significantly the computer data was changed from an input of the numbers occuring in the quadrats (Fig. 3) to an input of the distances at which species were found. Then an analysis was performed on the medians (rather than the means or variances) of the zones they occupied using the Wilcoxin Rank Sum Test (Table 1, showing p-values).

According to Roberts (1989) any p-value that is above 0.05 indicates that such species show similar zoning, whilst below 0.05 indicate that the species' zones differ significantly. Thus from Table 1 it

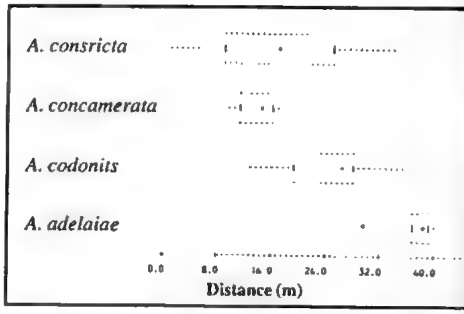

Fig. 2. The zones at which each species was concentrated.

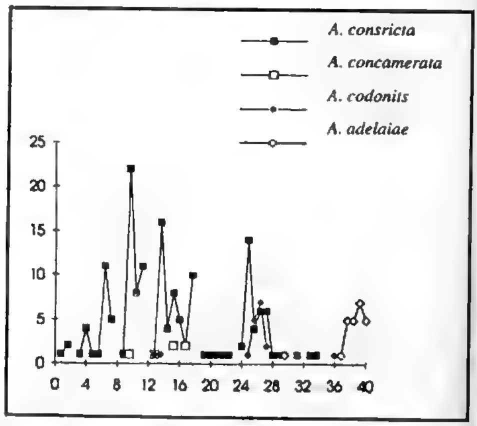

Fig. 3. Species richness vs distance from high water mark.

Table 1. The resultant p values from the Wilcoxin Rank Sum tests, which were performed to test for differences in the medians (i.e. zones) of each pair of *Austrocochlea* species.

	A. concamerata	*A. odontis*	*A. adelaidae*
A. odontis	0.0449		
A. adelaidae	0.0021	0.0085	
A. constricta	**0.6434**	0.0199	0.0000

is clear that both *A. constricta* and *A. concamerata* occupy similar areas across the littoral zone (p-value of 0.643) while *A. constricta* and *A. adelaidae* exhibit the greatest 'zonal' difference, illustrated by the fact that they have the lowest p-value (0.000).

This low p-value indicates that the species exhibit different physiological adaptations and micro habitat preferences. From observations it is clear that *A. constricta* and *A. concamerata* favoured rock surfaces whilst *A. odontis* and *A. adelaidae* preferred rock crevices and protected micro-habitats.

Discussion

The dominance of *Austrocochlea constricta* across most of the littoral zone, both in the distance, or size, of their zone and in the numbers of individuals, can be attributable to the fact that the species was more competitive than the others and more adapted to the area they dominate. They seemed to prefer the high-tide and mid-tidal areas, concentrating on rock surfaces rather than crevices, which is not uncommon (Phillips 1984).

Another possible reason for *A. constricta's* superiority could be that they are less susceptible to predators such as seabirds since they are somewhat camouflaged against the rock platforms that they inhabit. Such a suggestion is supported by Croxall (1987) who states that 'although seabirds take a wide variety of prey, relatively few prey species are dominant'.

Being present close to the high water mark also means that the species has to tolerate dessication longer than the others, the intensity of which is greater due to their direct exposure to the sun. Thus some morphological, behavioral or physiological adaptation may have enabled *Austrocochlea constricta* to resist dessication more than the other three species, and this has acted as a selective advantage.

The least common species was *Austrocochlea concamerata* and its appearance in the centre of *A. constricta's* dominance could be explained in several ways. Prolonged competition of two species (with *A. constricta* being more competitive) will cause the better competitors to expand and those members of the poorer competitors to dwindle, perhaps resulting in local extinction (Barnes 1982). Thus the poor numbers of *A. concamerata* may decrease even more if this situation exists. Also, such zonation could have been a result of some form of disturbance to *A. constricta's* favoured environment. According to Phillips (1984) such a local abundance of the species is not unusual.

Below the mid-tide level it would seem that both *Austrocochlea odontis* and *A. adelaidae* outcompete *A. constricta* and *A. concamerata*. This may be because the abundance of suitable microhabitats (i.e. rock crevices) increased so much that *A. odontis* and *A. adelaidae* had a competitive advantage over *A. constricta* and *A. concamerata*, and thus excluded them from the region.

The main concentration of *A. odontis* occurs where *A. constricta* ends, at about 28 metres from the high water mark. In contrast *A. adelaidae* predominates below the 39 metre mark (i.e. effectively the low water mark) where the sea bed stays permanently submerged. Here there are no other *Austrocochlea* species present. *A. adelaidae* may be superior here because it prefers the deeper regions since it appears unable to withstand much dessication. This zone may also be where its favored food predominates.

The gap between *A. odontis* and *A. adelaidae*, of about 11m, may have been caused by a limiting food resource, perhaps where the favoured algae species had been grazed out, resulting in a form of ecological desert. Another reason for this could be the abundance of some other marine organism which outcompetes both *A. odontis* and *A. adelaidae*.

In conclusion, one can see that each of the four species concerned did have their own unique centre of abundance across the littoral zone, the positions of which coincided with the findings of other researchers in the past. The zones of all species tested proved to be significantly different to each other, the exception being *A. constricta* and *A. concamerata* who occupied zones that completely overlapped.

Such results demonstrate that even closely related species show different micro-habitat preferences. Thus even though such species show common ancestry, they have diverged enough to monopolise different, mostly unique, areas as a result of varying physiological adaptations and food habits.

Further research is needed to investigate the feeding patterns of the species, the abundance and location of their food source, and the extent to which predation affects their populations.

References

Barnes, R.S.K. and Hughes, R.H. (1988). *An Introduction to Marine Ecology.* (Blackwell.)

Baker, J.M. and Wolff, W.J. (1987). *Biological Surveys of Eustuaries and Coasts.* (Cambridge University Press: Melbourne.)

Brehaugh, R.N. (1982). *Ecology of Rocky Coasts* (Edward Arnold.)

Croxall, J.P. (1987). *Seabirds, Feeding Ecology and Role in Marine Ecosystems.* (Cambridge University Press.)

Dakin, W.J. (1976). *Australian Seashores.* (Angus and Robertson.)

Jefferies, R.L. and Davy, A. J. (1979). *Ecological Processes in Coastal Environments.* (Blackwell.)

Phillips, D.A. B. *et.al.* (1984). *Coastal Invertebrates of Victoria.*

Moore, R.G. and Seed, R. (1985). *The Ecology of Rocky Coasts.* (Hodder and Stoughton.)

Roberts, L. (1988). *Statistics.* (Ballarat University College Printers.)

Tait, R.V. (1980). *Elements of Marine Ecology.* (Butterworths: London.).

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Ferdinand Mueller in the Jungles and 'Australian Switzerland' of East Gippsland

Linden Gillbank*

The vegetation of East Gippsland has a long reputation for attracting botanical interest. Impressive even to non-botanically-trained eyes are sheltered patches of cool and warm temperate rainforest, and striking plants such as the Gippsland Waratah, *Telopea oreades* F. Muell., and the blotchy mintbush, *Prostanthera walteri* F. Muell. Before the conversion of many rich river flat rainforests into pasture, and long before the investigations of Norman Wakefield, David Ashton and David Cameron, another botanist was also fascinated by the diversity and richness of the vegetation of East Gippsland.

Almost 140 years ago Victoria's first government botanist, Dr Ferdinand (later Baron von) Mueller, sought a particular patch of near-coastal warm temperate rainforest - vine-smothered 'jungle' which nurtured the colony's only indigenous palm. Later he ventured even further east - into areas which he called 'Australian Switzerland'. He was delighted with his botanical findings in both the 'jungles' and 'Australian Switzerland' of East Gippsland.

This paper describes Mueller's mid-nineteenth century botanical exploration of the largely trackless and little- known part of the colony east of the Snowy River. Decades later, as new tracks were being cut through the district of Croajingolong, Mueller proposed that FNCV members should visit the region, and argued for the formation of vegetation reserves in East Gippsland.

Ferdinand Mueller

Dr Ferdinand Mueller was appointed to the new position of Government Botanist for the young colony of Victoria in January 1853, and spent his first three summers on extensive field trips surveying the flora of the colony. Since explorers and botanists, including Mueller himself, had already collected and documented some of the plants of lowland southern and eastern Australia, Mueller was most anxious to investigate the unknown flora of Victoria's alps - a flora which could provide new plants for European horticulture. However, he included lowland parts of Gippsland in each of these three epic expeditions (Barnard 1904; Gillbank 1992a).

East Gippsland was of particular interest to a botanist in search of the eastern limits of Victorian plants and the southern limits of sub-tropical plants. In his second and third trips Mueller crossed the lower Snowy and Brodribb rivers to reach Cabbage-tree Creek, where he marvelled at the tropical appearance of jungle which included the Cabbage Tree Palm, *Livistona australis* (R. Br.) Martius, and many vines and other plants which botanists, such as Robert Brown and Allan Cunningham, had already found much further north along the eastern coast of Australia. A few years later Mueller managed to reach the eastern tip of the colony and documented the flora of the Genoa valley and its environs - parts of which he later described as 'Australian Switzerland'.

First field trip, 1853

Mueller's first field expedition began late in January 1853, within days of his appointment as Government Botanist. The five month trip covering over 2,000 kilometres targeted the alps but included parts of South Gippsland (Gillbank 1991). In May 1853 Mueller stayed at Alberton. At the southern end of the Tambo Valley track to Omeo and the Monaro Tableland, Alberton was the gate-way to Gippsland. From there he sailed across to Wilson's Promontory, whose flora he was keen to

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compare with that of Tasmania. Pleased with his botanical findings, he was aware that botanical riches awaited discovery in other parts of Gippsland. As he explained to the Chief Secretary,

> I feel perfectly convinced, that the more distant localities in the East and North of Gipps land must be considered as the richest and most deserving country for a full phytological exploration (Mueller to Lonsdale, 19 May 1853).

The fruits of Mueller's second and third expeditions vindicated his botanical expectations.

Second Field Trip, 1853/54

During his second expedition, Mueller managed to reach both North and East Gippsland. In the summer of 1853/54 bushfires prevented his reaching the heart of Victoria's alps. Disappointed, he climbed the Cobberas mountains and then continued in a north-easterly direction to where he thought the Snowy River crossed the unsurveyed NSW border. He followed the main Monaro-Omeo track from south of the Cobberas across the ranges to the junction of the Pinch and Snowy rivers and perhaps a further few miles up the Snowy Valley (Wakefield 1952). By the Snowy river Mueller (1854) noticed the Kurrajong, *Brachychiton populneus* R. Br.,

> a beautiful tree from the tropics, growing with its turgid stem out of the bare granite rocks, washed by the tremendous floods of the melting snow. With many of its usual companions, it reaches here its most southerly limits.

Mueller's collections from this part of the Snowy Valley were all from well within what is now known to be New South Wales and included several species which were not authentically recorded for Victoria for nearly a century (Wakefield 1952). Mueller was quite generous (some may say cavalier) in determining which plants could be considered Victorian. Plants found within about a day's walk outside the colony's border were accepted as Victorian and included in his 'Key to the System of Victorian Plants' (Williamson 1919). Since, in the 1850s, the exact position of the eastern end of the NSW-Victorian border was still unknown, it could be said that Mueller was being thorough, as well as generous, in including plants from the Snowy Mountains in the flora of Victoria.

Since Mueller's reports and letters were primarily vehicles for botanical information, it is unfortunate but not surprising that they include only rare mention of the people who provided information, company and shelter, and only sparse details of the routes he followed. Mueller did report that, during his quest for the Cabbage Tree Palms in the summer of 1853/54, he was unable to follow the Snowy River southwards from where he thought it crossed the NSW border. Instead he had to backtrack to Omeo to follow the main Monaro-Gippsland track down the Tambo valley and then trek eastwards across the lower Snowy River towards Cabbage-tree Creek (Mueller to Foster, 10 March 1854).

His published reports do not reveal his source of information about those palms. However, in a letter written decades later, Mueller acknowledged some pastoral help. He mentioned that the McLeods knew of the unusual patch of palms near the lower Brodribb River, which then formed the eastern boundary of John McLeod's Orbost run. The Newmerella or Lochend run on the other (western) side of the Snowy River was leased by John's older brother, Norman (Wakefield 1969a). Mueller explained that, while searching for pasture, Norman McLeod and two other squatters had stumbled across the patch of palms, which, since it was not pasture vegetation, held little interest for them (Mueller to Barnard, 19 February 1889).

In March 1854, several years after the pastoralists' discovery of the palms, Mueller reached McLeod's deserted Orbost run and the already-named Cabbage-tree Creek, where he found the Cabbage Tree Palms, whose genus he sometimes called *Corypha* and sometimes *Livistona.* He quickly informed the Chief Secretary that:

> Here occurs between the Broadribb [sic] and Snowy-river sparingly and on a rather circumscribed locality on the Cabbage-tree river the stately *Corypha australis*, the only Palmtree of the province (Mueller to Foster, 10 March 1854).

In this letter, and in his Annual Report Mueller wrote glowingly of this beautiful fan palm.

> The stately *Corypha* palm or *Livistonia* [sic] *australis*, one of the 'princes of the vegetable world,' attains here the height of more than sixty feet, and may be deemed one of the most useful productions of our Flora, furnishing in its young leafstalks and terminal bud the palm cabbage, a food equally wholesome and delicious, whilst the fan-shaped leaves are eagerly collected for the manufacture of hats (Mueller 1854).

Mueller was pleased and proud to be able to locate and identify Victoria's only palm and to make its presence known to the government and public.

Mueller was amazed that, at a latitude similar to that of Melbourne, the vegetation appeared so tropical.

> Many of the plants which the late Allan Cunningham collected in Illawarra and made that locality his favourite place, I was also fortunate enough to observe here towards the mouth of the Snowy river and along the Broadribb [sic] and Cabbage-tree river, where almost suddenly the vegetation assumes a tropical character with all its shady groves of dark and broadleaved trees of horizontal foliage, with all those impenetrable and intricate masses of climbers over running the highest trees, and with so many peculiar forms of the vegetable Kingdom never transgressing the tropical zone unless under the favourable influence of the humid mild atmosphere of the coast (Mueller to Foster, 10 March 1854).

Mueller was thrilled with the variety of 'tropical' plants growing in East Gippsland. Unfortunately however, it was late in the season and many plants were already in fruit. To observe their flowers, Mueller realized that he would have to revisit East Gippsland earlier in the season.

> Perhaps many other connections with the Flora of the Morton-bay district will be once pointed out, as I could in this cursory visit not exhaust the botanical richdom of the place; for the impossibility of recrossing the Snowy River without canoes in rainy weather and the want of protection against the hostilities of the aborigines since the Squatting- stations here are deserted, induced me to an earlier return, as I originally desired (Mueller to Foster, 10 March 1854).

He forwarded his botanical specimens to Governor La Trobe via the Police Magistrate at Alberton, who, on Mueller's previous expedition, had helped him reach Wilson's Promontory (Mueller to La Trobe, 14 March 1854). Excited but only partly satisfied with his botanical observations, Mueller returned to the Botanic Gardens in Melbourne to complete his over 3,000 kilometre trek.

Third field trip, 1854/55

On his third epic botanical expedition Mueller succeeded in reaching the alps of Victoria and New South Wales, from where he again sought to visit the fabulous palm jungles of East Gippsland. This time he travelled south along the track to the west of the Snowy River, through Wulgulmerang, Murrindal and Buchan pastoral runs; to the lower Snowy River (Wakefield 1969b). Late in January 1855 he sought the flowers of plants which he had observed already in fruit during his previous visit.

> I collected in the Cabbage-tree country *Cissus Australasica* beautifully in flower; but I was again too late for *Celastrus Australis, Cocculus Harveyanus*, and others, which are yet required in an early state of development (Mueller 1855b).

Mueller (1855d) travelled as far east along the East Gippsland coast as the boggy nature of the country permitted and realized that, for an investigation of the vegetation further to the east, he would have to approach it from the other direction - from the south-eastern corner of New South Wales. In the autumn of 1855 he returned to Melbourne via pastoral runs by Lakes King and Wellington.

Taxonomic tinkerings

The difficulty of correctly naming plants so far from other botanical authorities and from the herbarium specimens which had been used in their naming (now called type specimens) is illustrated by the eight plant names which Mueller (1854) listed in his Annual Report as examples of tropical climbing plants -

Cissus Australasica, Cocculus Harveyanus, Celastrus Australis, Morinda jasminoides, Tylophora barbata, Marsdenia rostrata, Smilax spinescens, Eustrephus latifolius

In his first trip to East Gippsland in March 1854, Mueller was seeing each of these plants for the first time. Five of the climbers had already been named. Accompanying Matthew Flinders on his circumnavigation of Australia at the beginning of the nineteenth century, Robert Brown had collected and later (1810) named *Tylophora barbata, Marsdenia rostrata, Smilax australis*, and *Eustrephus latifolius*; while *Morinda jasminoides* was Allan Cunningham's name which William Hooker published in 1834 (Ross 1993). Mueller was aware of and correctly used all but one of these names - *Smilax spinescens* instead of *S. australis.* Subsequently Mueller (1888) used Brown's name for native sarsaparilla.

The three other climbers' names were Mueller's. In a paper presented to Victoria's Philosophical Society late in 1854, Mueller (1855a) had officially described and named *Cissus Australasica* and *Celastrus Australis*. His name for the native grape which he found on the banks of the Brodribb River, *Cissus Australasica*, was too late. Across the Pacific the American botanist, Asa Gray, had just beaten him in the naming game with the name *Cissus hypoglauca* . In his 'Plants Indigenous to the Colony of Victoria' Mueller (1862) used Gray's name but later, in his 'Key to the System of Victorian Plants', Mueller (1888) tried to influence the naming of the native grape by calling it *Vitis hypoglauca.* However, Gray's name has endured.

Mueller was more successful with his two other names. The first recorded Australian species of *Celastrus* still bears Mueller's name. His specimens in Victoria's National Herbarium, three of which are now the type specimens for *Celastrus australis* Harvey & F. Muell., came from the Snowy and Buchan rivers and a rocky mountain near the Murrindal River, a tributary of the Snowy.

Mueller suffered some indecision about his third new name, *Cocculus Harveyanus.* On the labels of the herbarium specimens, which he collected from the mouth of the Snowy River, the Brodribb River, and Cabbage-tree Creek in March 1854 and January 1855, Mueller sometimes wrote *Cocculus Harveyanus* and sometimes *Sarcopetalum Harveyanum.* Mueller took a specimen to grow in the Botanic Gardens, Melbourne, which flowered in November 1859. Later Mueller (1862) officially described and named the vine *Sarcopetalum Harveyanum* in honour of his esteemed and learned friend, Professor William Harvey of Trinity College, Dublin, who visited Victoria in the spring and summer of 1854 and who, jointly with Mueller (1855a), named *Celastrus Australis.* Mueller (1862) considered these two plants noteworthy as examples of the most southerly 'commencement of the tropical jungle flora, which in eastern Australia bears so much resemblance to that of India'(p27).

Climbing plants are crucial elements in the ecology and physiognomy of the warm temperate rainforests of East Gippsland. Thick festoons of vines affect the humidity, wind speed, and sunlight entering these rainforests and give them their jungle appearance. A small patch of 'jungle' may include over a dozen species of climbing plants, most of which are rarely found in Victoria outside East Gippsland. These climbers emphasize the uniqueness in Victoria of this rainforest vegetation.

As Mueller noted, many plant families as well as genera reach their most southern latitude here and are not found elsewhere in Victoria. Each of the three vines, *Cissus hypoglauca* A. Gray (jungle grape), *Sarcopetalum harveyanum* F. Muell. (pearl vine), and *Celastrus australis* Harvey & F. Muell. (staff climber), is the only Victorian member, not just of its genus, but of its family - the Vitaceae, Menispermaceae, and Celastraceae respectively. Four other vines which Mueller collected from East Gippsland jungles and which Robert Brown had named early in the nineteenth century - *Smilax australis* R. Br. (Austral Sarsaparilla or Lawyer-vine), *Ripogonum album* R. Br. (White Supplejack), *Eustrephus latifolius* R. Br. (Wombat Berry or Orange Vine), and *Geitonoplesium cymosum* (R. Br.) Cunn. (Scrambling Lily or Shepherd's Joy) - were once considered Victoria's only climbing lilies. These four plants were recently taken out of the Liliaceae and now constitute the only Victorian members of the family Smilacaceae (Ross 1993).

Useful plants

Mueller was always on the lookout for new useful plants. East Gippsland was indeed a garden of Eden. As well as the Cabbage Tree Palm, he noted and gathered seeds of a kind of elder tree, a raspberry, and a species of *Smilax*, which he hoped would be medicinally allied to the true American Sarsaparilla (Mueller to Foster, 10 March 1854). Mueller (1855a) hoped that the new elder tree, which he found on shady moist banks of the Snowy, Brodribb, and Cabbage-tree rivers, would be as useful as the common elder, whose habit it aped. In his paper to Victoria's Philosophical Society, Mueller (1855a) described and named the new elder tree *Sambucus xanthocarpa*. It has since been renamed S. australasica (Lindley) Fritsch.

Mueller (1855b) also had high hopes for a new species of *Solanum*:

> Here, on the coast, and in various other parts of Gipps' Land, I observed a *Solanum*, called by the aborigines Gungang [Gunyang], which promises to become an additional fruit-shrub of our gardens. I have not yet obtained the perfect ripe fruit, which is said to be of excellent taste, and of which the natives are passionately fond. In the summer and autumn of 1855 Mueller (1855c) found the tasty-fruited Gunyang growing quite widely - on sandy ridges round Lake Wellington, along the coast towards the mouth of the Snowy River, on grassy hills of the Tambo and Nicholson rivers, near the Buchan River, and on the banks of the La Trobe River. Mueller (1855c) gave it its current name *Solanum vescum* F. Muell.

By Lake King in February 1855 Mueller (1855d) also observed,

> amongst other rare and unknown plants, some fine trees of Acronychia, a genus known from Eastern Australia and New Caledonia, remarkable for its splendid wood and the aromatic property by which the species are pervaded.

A member of the Rutaceae, *Acronychia oblongifolia* (Cunn. ex Hook.) Endl. ex Heynh., has the common name Yellow-wood. Its yellow, hard, straight-grained, dense timber is suitable for tool handles and mallets, veneers and cabinet work as well as carving.

From Eden, 1860

In 1860 Mueller realized his ambition of half a decade earlier and approached the far eastern tip of Victoria from New South Wales before the summer months. He sailed from Melbourne to Twofold Bay on the service newly established for the exodus of goldminers from Melbourne en route to the Snowy Mountains diggings (Mueller to Hooker, 17 September 1860). In one of his characteristically long sentences Mueller (1861a) in his Annual Report related that:

> During the month of September I was

engaged in elucidating the vegetation along the south-eastern frontiers of the colony, crossing the country from Twofold Bay to the Genoa, along which river I travelled to the coast, deviating to Cape Howe and to the adjoining freshwater lake, and ascended again the Genoa River to near its sources, examining the adjacent elevated country and the Nungatta mountains on my way, where I was rewarded with the discovery of a new Warratah [sic] (*Telopea oreades*), which luxuriates at an elevation of 4000 feet, and where also a very remarkable and beautiful tree, hitherto unknown (*Elaeocarpus holopetalus*), was added to our collection.

In a letter to Sir William Hooker at Kew and later in his Annual Report, Mueller was pleased to record his discovery of two species of *Dendrobium* orchids so far south. On frosty Genoa Peak and other rocky outcrops in the vicinity of the lower Genoa River he noted patches of *D. speciosum* and another species which he referred to as *D. Milligani* (Mueller to Hooker, 17 September 1860; Mueller 1861a).

In 1860 there were six pastoral runs along the valley of the Genoa River and its source streams - Bondi, Nungatta, Wongrabell/Wangarabell, Merrimingo /Maramingo, Genoa and Mallacoota (Wakefield 1969a). However, this was the first botanical exploration (for anything other than pasture) of this remote part of the colony.

Although Mueller collected in the vicinity of Cape Howe, Mallacoota, Genoa Peak, and the Genoa River, he discovered two of East Gippsland's botanical gems, the Gippsland Waratah and the Black Oliveberry, outside East Gippsland - in the Nungatta mountains on the NSW side of the yet-to-be-determined border. When he first saw the Waratah, Mueller thought that it was the Tasmanian species, *Telopea truncata* R. Br.: It was early in the season and he had not yet seen good flowers (Mueller to Hooker, 25 October 1860). Back in Melbourne, Mueller (1861b) recognised it as a new species and named it after Milton's nymphs of the mountains, the Oreads.

On the herbarium label of the specimen which he collected on that trip and which is now the type specimen of *Telopea oreades* F. Muell., Mueller recorded that it was found on Nungatta Creek. Mueller is not the only name on that label. The name of the lessee of Nungatta Station, Weatherhead, is also recorded. Perhaps they discovered it together. However it is more likely that, as was the case for the Victorian patch of Cabbage Tree Palms, botanical science was aided by pastoral knowledge. Weatherhead probably told or showed Mueller where the beautiful Waratah grew on his run. The Gippsland Waratah and Black Oliveberry still bear the names Mueller (1861b) gave them - *Telopea oreades* and *Elaeocarpus holopetalus* - and were subsequently found in Victoria. Other plants which Mueller collected across the border in 1860 and included in his 'Key to the System of Victorian Plants', have not subsequently been found in Victoria (Wakefield 1952).

By 1860 Victoria's first government botanist, Dr Ferdinand Mueller, had completed a substantial perlustration of the flora of East Gippsland. He had recorded for the first time in Victoria many plants already known from elsewhere and had named many plants new to science.

Towards conservation

Mueller's interest in the flora of East Gippsland continued long after his treks in the region. As a founding member of the young FNCV, Baron von Mueller suggested the permanent reservation of areas of the Cabbage Tree Palm and the Waratah (Mueller to Barnard, 10 August 1887, and 1 September 1887). He called the Waratah country of East Gippsland the 'Australian Switzerland', a term which one of his collectors, the landscape photographer Charles Walter, had used in the *Illustrated Australian News* in 1871, after visiting the Genoa Valley and the newly named Mount Ellery (Gillbank 1992b).

Mueller also proposed the extensive FNCV expedition in East Gippsland in January 1889, and helped to identify plants which Professor Baldwin Spencer and four other Club members brought back (Spencer and French 1889). Their botanical enthusiasm for Victoria's isolated patch of palms on the Cabbage-tree Creek matched the Baron's. With Mueller's support, the FNCV successfully sought

> to reserve from selection a strip of country along the banks of the Cabbage-tree Creek, County of Croajingolong. This proposed reservation which should extend for about two chains on each side of the creek from the 9 mile tree to the 16th would contain the best groups of the Cabbage Palms and is the only spot in Victoria where this beautiful palm is to be seen in its natural state (Barnard to Secretary for Lands, 12 February 1889).

In March 1889, a reservation of 8,500 acres was gazetted (Secretary for Lands to Barnard, 28 March 1889). The wooden sign now at the start of the walking track in the reserve commemorates Spencer but not the FNCV.

Mueller was pleased with the reservation of the area of Cabbage Tree Palms, but was concerned that Victoria's beautiful Waratah was not protected in any reserve. As a member of the FNCV Committee for the preservation of the indigenous vegetation, Mueller repeated his earlier plea for the permanent reservation of some Waratah country, and urged that the Club apply for 'withdrawing from selection the best of the *Waratah Vallies* in Eastern Gippsland', which Professor Spencer and his companions would be able to describe, 'so that the District Surveyors might become instructed to keep these glorious spots intact' (Mueller to Barnard, 3 May 1890).

A century after the FNCV members had seen Waratahs on Mt Ellery and near Goonmirk Rocks, their descendent plants were protected within the incredibly indented boundary of the Errinundra National Park. The Baron would be relieved that some Waratah country in areas he sometimes referred to as 'Australian Switzerland' has eventually been reserved in a National Park.

Mueller and the FNCV deserve our thanks for surveying the vegetation and for arguing for its preservation. Sometimes it takes a long time for a vision to be realized.

Acknowledgements

I thank Sara Maroske, from the Mueller Correspondence Project, for supplying transcripts of Mueller's unpublished letters, and Angela Taylor and Sheila Houghton for other correspondence in the FNCV Archives.

References

Unpublished letters

A53/4902, unit 408, VPRS 3991 inwards registered correspondence, VA 860 Chief Secretary's Office, Public Records Office, Laverton, Victoria, Australia: Mueller to Lonsdale, 19 May 1853.

E54/3047, unit 203, VPRS 1189 inwards registered correspondence, VA 856 Colonial Secretary's Office, Public Records Office, Laverton, Victoria, Australia: Mueller to Foster, 10 March 1854.

Item 531, box 72/5, La Trobe papers, La Trobe Collection, State Library of Victoria, Melbourne, Victoria, Australia: Mueller to La Trobe, 14 March 1854.

Royal Botanic Gardens, Kew. Directors' Letters, Vol. LXXV, Australian and Pacific Letters 1859-1865, Letter No. 127: Mueller to William Hooker, 17 September 1860, & 25 October 1860.

FNCV Archives 015-028: Mueller to Barnard, 10 August 1887.

FNCV Archives 015-031: Mueller to Barnard, 1 September 1887.

FNCV Archives 022-045: Mueller to Barnard, 19 February 1889.

FNCV Archives 022-047: Barnard to Secretary for Lands,12 February 1889.

FNCV Archives 022-049: Secretary for Lands to Barnard, 28 March 1889.

FNCV Archives 014-019: Mueller to Barnard, 3 May 1890.

Published sources

Barnard, F. G. A. (1904). Some Early Botanical Explorations in Victoria. *The Victorian Naturalist* 21: 17-28.

Gillbank, L. (1991). Ferdinand Mueller in Gippsland. *Gippsland Heritage Journal* 10: 3-10.

Gillbank, L. (1992a). Alpine Botanical Expeditions of Ferdinand Mueller. *Muelleria* 7: 473-489.

Gillbank, L. (1992b). Charles Walter - collector of images and plants in East Gippsland. *Gippsland Heritage Journal* 13: 3-10.

Mueller, F. (1853). First General Report of the Government Botanist on the Vegetation of the Colony, 5 September 1853. *Votes and Proceedings of the Legislative Council of Victoria, 1853-4* vol 1, Paper no A.26a.

Mueller, F (1854). Second General Report of the Government Botanist on the Vegetation of the Colony, 5 October 1854. *Votes and Proceedings on the Legislative Council of Victoria, 1854-5* vol 1, Paper no A.18.

Mueller, F. (1855a). Definitions of rare or hitherto undesribed Australian plants, chiefly collected within the boundaries of the colony of Victoria. *Transactions of the Philosophical Society* **1**: 5-24, 34-50.

Mueller, F. (1855b). Botany of Victoria (Southern Australia). *Hooker's Journal of Botany and Kew Garden Miscellany* **7**: 237-238.

Mueller, F. (1855c). Account of the Gunyang: A new indigenous fruit of Victoria. *Transactions and Proceedings of the Victorian Institute for the Advancement of Science* **1**: 67-70.

Mueller, F. (1855d). Annual Report from the Government Botanist for the year 1854. *Votes and Proceedings of the Legislative Council of Victoria, 1855-6* vol 1, Paper no A.10, p4.

Mueller, F. (1861a). Annual Report of the Government Botanist and Director of the Botanic and Zoologic Garden. *Votes and Proceedings of the Legislative Assembly 1860-1* vol 3, Paper no 19, p12.

Mueller, F. (1861b). *Fragmenta Phytographiae Australiae* **2**: 143, 170.

Mueller, F. (1862). 'The Plants indigenous to the Colony of Victoria', vol 1 (Government Printer: Melbourne).

Mueller, F. (1888). 'Key to the System of Victorian Plants'. vols I & II (Government Printer, Melbourne).

Ross, J. H. (1993). 'A Census of the Vascular Plants of Victoria'. (National Herbarium of Victoria: Melbourne.)

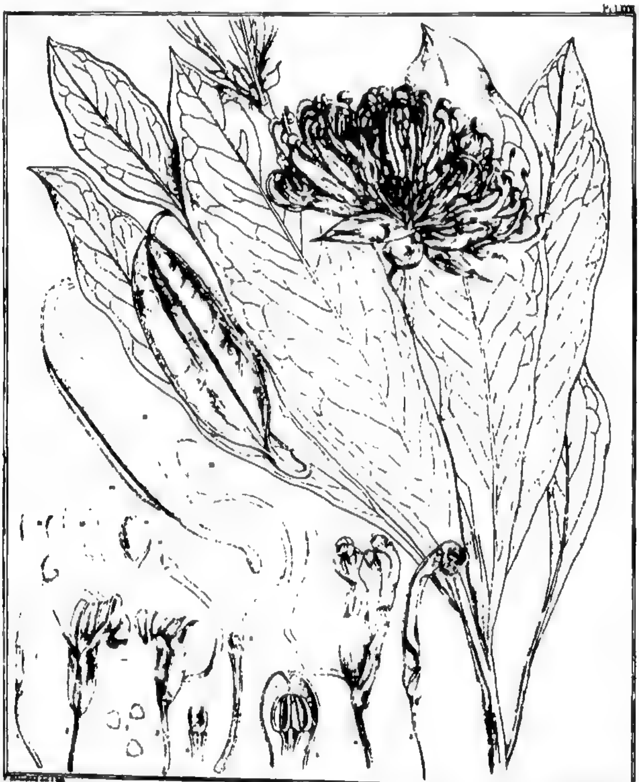
Spencer, W. B. and French, C. (1889). Trip to Croajingolong. *The Victorian Naturalist* **6**: 1-38.

Wakefield, N. A. (1952). Premature and erroneous records of plants for Victoria. *The Victorian Naturalist* **69**: 80-89.

Wakefield, N. A. (1969a). Aspects of Exploration and Settlement of East Gippsland. *Proceedings of the Royal Society of Victoria* **82**: 7-25.

Wakefield, N. A. (1969b). Botanical Exploration of East Gippsland. *Proceedings of the Royal Society of Victoria* **82**: 61-67.

Williamson, H. B. (1919). Notes on the Census of Victorian Plants. *The Victorian Naturalist* **36**: 11-19.



The Gippsland Waratah *Telopea oreades*. From A.J. Ewart (1910, Melbourne). 'Plants Indigenous to Victoria' Vol. II Plate LXXIII.

Observations of Nest Mound Decoration by the 'Bulldog' Ant *Myrmecia forficata* and other *Myrmecia* Species in South-west Victoria.

L.E. Conole*

Introduction

The bulldog ant *Myrmecia forficata* occurs in coastal Victoria and Tasmania (Walton 1985), normally where annual rainfall exceeds 1000 mm (Andersen 1991). Within this climatic zone, it occupies a range of habitats from tall open-forest (wet sclerophyll) through to heathland, and also forages in the littoral zone (Conole pers. obs.). *M. forficata* is a medium-large species, worker total length 15 - 21 mm (Clark 1951), hence the alternative vernacular 'inch' ant, and is a conspicuous component of the ant fauna where it occurs. Nest entrances take a variety of forms, the most common being either a small earth mound (Andersen 1991, Greenslade 1979) or a concealed entrance under a log or stone (Conole pers. obs.). The mounded nest entrance is usually 'decorated' with organic matter such as tiny leaves, rootlets or twigs, fruit or stones (Conole pers. obs.). In this note, I describe the decoration of a newly excavated nest mound by *M. forficata* in a coastal heathland at Cape Patton in the Otway Ranges.

Observations and discussion

On 13 March 1993 I observed a *M. forficata* worker carrying organic material to a newly excavated earth mound nest on a beach access track at Cape Patton (38 41' 25"S 143 50' 50"E). The area is covered in long unburnt, dense scrub of Prickly Tea-tree *Leptospermum continentale* and Prickly Moses *Acacia verticillata* with occasional emergent, stunted Drooping She-oak *Allocasuarina verticillata*, Brown Stringybark *Eucalyptus baxteri* and Gippsland Mallee *Eucalyptus kitsoniana*. Ground cover vegetation includes Hop Goodenia *Goodenia ovata*, Tussock Grass *Poa* sp. and Flax-lily *Dianella* sp..

The substrate is a fine grey sandy loam. Annual rainfall is between 1000 and 1400 mm (Lee 1982).

The nest mound, earth still loose and uncompacted, was constructed on the edge of the track under a eucalypt. It was approximately 100 mm higher than the surrounding ground, a truncated cone in shape and approximately 60 mm in diameter at the apex. On top of the mound to one side of the nest entrance hole were three dry fruit capsules of *Leptospermum continentale*. I observed only one worker ant bringing material to the mound during five minutes of observation, and it took the ant five minutes to carry one *Leptospermum continentale* fruit capsule to the nest from about a metre away. The total length of the ant was *circa* 15 mm, and the diameter of the fruit *circa* 10 mm.

On 4 April 1993, I found two ants still bringing decorative material to the mound. There were now approximately 20 fruit capsules of *Leptospermum continentale* on the mound, along with an amount of leaf mulch (also *Leptospermum*) and small segments of grass stalk, *Allocasuarina verticillata* leaves and *Acacia verticillata* phyllodes.

The function of the decoration of the *Myrmecia* nest mound is unclear, and I have not found a direct discussion of the phenomenon. It seems possible that, in part, the material serves to ameliorate the effect of large raindrops eroding the mound and subsequently entering the nest.

I have observed the nest mounds of other large 'bulldog' *Myrmecia* species such as *M. nigriceps* decorated with small lateritic gravel pebbles or soil crumbs, in the manner of the Meat Ant *Iridomyrmex 'purpureus'*. I have only rarely observed the 'jumper' *M. 'pilosula'* use any

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decoration other than leaf mulch, and in contrast to some 'bulldog' *Myrmecia*, this usually covers the sides as well as the top of the nest mound. Nests of the 'bulldog' *M. nigriscapa* in the Geelong area usually have unmounded entrances, often concealed at the base of living plants, and I have not observed the use of decorative material (Conole pers. obs.). I have usually found the 'bulldog' *M. pyriformis* nest entrances concealed under logs. A 'bulldog' *Myrmecia* sp. (aff. *M. 'vindex'*) at Bannockburn has nest mounds decorated all over with leaf mulch, and often a stunted, live Sweet Bursaria *Bursaria spinosa* plant growing in the mound (Conole pers. obs.). This *Myrmecia* sp. also has unmounded, undecorated nest entrances much in the manner of *M. nigriscapa* (Conole pers. obs.). I have so far been unsuccessful in locating the nest entrances of the 'jumper' *M. 'mandibularis'* group (*M. piliventris, M. fulvipes, M.* cf. *rectidans*), and suspect that this is due to very effective camouflage.

The unmounded, undecorated nest entrance of *Myrmecia* species seems most common on well drained, sandy soils in lower rainfall areas, perhaps where flooding of the nest by rain is least likely.

Author's note

The species referred to as 'bulldogs' and 'jumpers' were previously classified as separate genera, *Myrmecia* and *Promyrmecia* respectively (Clark 1951). They are currently treated as one genus, *Myrmecia, encompassing the morphological* variation of the two genera (Walton 1985). 'Jumpers' are characterised by many species having a jerky, jumping locomotory mode, and most by their small size (generally 10 mm or less total length) (Clark 1951). 'Bulldog' species generally have a normal locomotory mode, and are mostly large (15-30 mm total length) (Clark 1951).

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Alan Andersen (CSIRO, Darwin) and Ken Walker (Curator - Entomology, Museum of Victoria) made helpful comments on a draft of this note, and have assisted and encouraged my observations of ants.

References

Andersen, A.N. (1991). 'The Ants of Southern Australia. A Guide to the Bassian Fauna.' (CSIRO: Melbourne).

Clark, J. (1951). 'The Formicidae of Australia. Volume 1: Myrmeciinae'. (CSIRO: Melbourne).

Greenslade, P.J.M. (1979). 'A Guide to Ants of South Australia'. (South Australian Museum: Adelaide).

Lee, D.M. (1982) Climate *In* Duncan, J.S. 'Atlas of Victoria'. (Victorian Government Printing Office: Melbourne).

Walton, D.W. (Ed.) (1985). 'Zoological Catalogue of Australia. Volume 2. Hymenoptera'. (Australian Government Publishing Service: Canberra).

Naturalists Notes

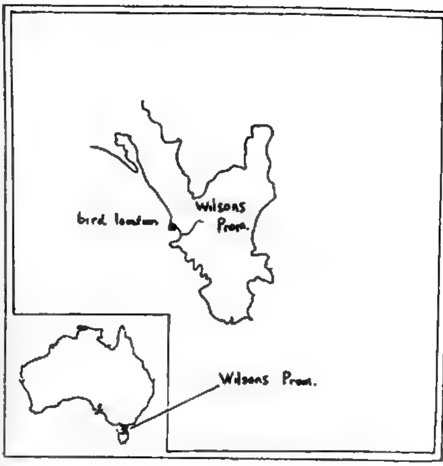
Shy Albatross

A nature note on the Shy Albatross

On a trip to Wilsons Promontory in September 1992 I came across a dead Shy Albatross *Diomedea cauta cauta*, on a beach 1 km north of the Darby River mouth on the western side of the promontory (see map).

The bird was adult, with a head and body length of 90 cm and a wingspan of over 2 m. On its leg it had an identification band that had been attached by the Australian National Parks and Wildlife Service Bird and Bat Branding Scheme. After returning the band to this authority they revealed that the bird had been banded as a nestling on the 25 March 1985 on Albatross Island which is situated off the north west coast of Tasmania. The bird was therefore just under 7.5 years and died at a distance of 204 km and at a bearing of 44° from its place of birth.

The Shy Albatross is mostly white with a slate grey mantle on the upper wing and tail, dusky eyebrow shading to pale grey



cheeks. Its underwing is mainly white with a narrow margin of black. The iris of the eye is dark brown, the bill a grayish horn with a pale yellow tip while the flesh of the foot is grey. The bird can grow up to a length of one metre with a wingspan of up to 2.5 m. It is wide ranging over the oceans of the southern hemisphere, and *Diomedea cauta* is the only member of its family to breed in Australian waters either on Albatross Island (off North-West Tasmania) or at Pedra Branca and The Mewstone (off South Tasmania).

The three *Diomedia cauta* subspecies are all recorded in Australia: *Diomedea cauta cauta* (common) has the palest head and breeds off Tasmania and on Aukland Island (New Zealand); *Diomedea cauta salvini* (rare) has a brownish grey head with a duskier underwing and breeds on Snares and Bounty Island (New Zealand); *Diomedea cauta eremita.*(a few records in Australia) has a leaden grey head and a similar underwing to *salvini.*

Information on the Australian Bird and Bat Banding Schemes can be obtained by writing to:

The Secretary, Australian Bird and Bat Banding Schemes, Australian National Parks and Wildlife Service, GPO Box 8, Canberra, ACT 2601, (Tel: 06 2500321).

References

Lindsey, Terence R.(1986). 'The Seabirds of Australia'. (Angus & Robertson.)

Readers Digest (1990). 'Complete Book of Australian Birds'. (Readers Digest: Australia.)

Simpson & Day (1993). 'Field Guide to the Birds of Australia'. (Viking O'Neil: Victoria.)

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Lightning Strike on Ironbark *Eucalyptus sideroxylon* at Myers Flat

Noel Schleiger*

The Field Naturalists Club of Victoria conducted an excursion, hosted by the Bendigo Field Naturalists Club, in the Whipstick Forest, Myers Flat area, north-west of Eaglehawk, on November 1 1992 (Fig. 1).

While observing the wildflowers at the eastern end of Rifle Range road, Rod Moors (Bendigo FNC) drew my attention to an Ironbark *Eucalyptus sideroxylon* about 15 metres high from which a strip of bark, 15-20 cm wide, had been removed (Fig. 2). Most of the bark had been stripped from the eastern side of the tree except for the upper mid-section where the strip spiralled around to the north. The inside yellow wood of the trunk and inner bark was in striking contrast to the dark red-brown bark of the rest of the tree. There was no sign of charring on the trunk or bark, and pieces of bark of various dimensions were scattered radially in all directions in the bush for over 50 metres from the base of the tree.

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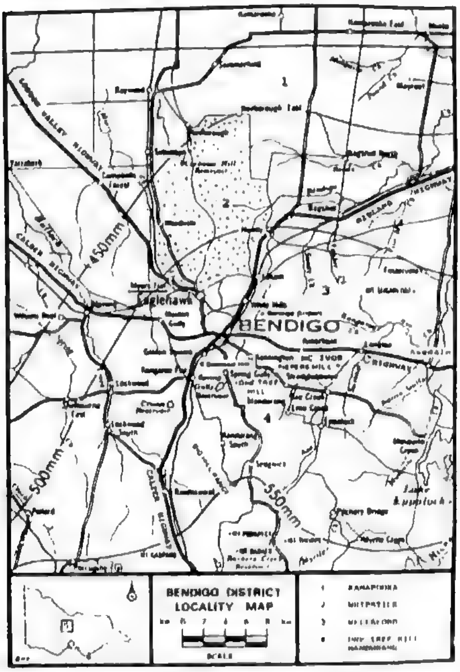

Fig. 1. Locality plan, Whipstick Forest and Myers Flat in relation to Bendigo. From 'Wildflowers of Bendigo' (Bendigo FNC 1989).

Fig. 2. The Ironbark *E. sideroxylon* at Myers Flat struck by lightning prior to 1 Nov 1992.

The freshness of the debris and the spiral nature of the stripping of bark from the trunk suggested that this was the result of a recent lightning strike. November 1st was the first fine day following thunderstorms which had crossed southern Victoria from west to east on the two previous days. Some of the FNCV members had journeyed by car the previous afternoon from Hall's Gap via Navarre, St Arnaud and Inglewood experiencing showers in the tail of the depression which was heralded in by thunderstorms on the morning of 30 October.

It is well known to residents on ironstone ridges, as found in the Whipstick and northern slopes of the Divide, that lightning is attracted to trees growing on laterite and ironstone gravel outcrops. Many of these outcrops were the courses of early Tertiary streams at a time when Victoria was experiencing a tropical climate. With higher temperatures and tropical rain, limonite was washed into the water courses and on drying cemented the pebbles of quartz to form a ferruginous conglomerate. Some of the buckshot pebbles (limonite-coated pebbles) are weakly magnetic and perhaps induce electricity toward Ironbark trees growing in these areas.

The author made observations of length (l), width (w) and thickness (t) of bark fragments in four directions radially outwards from the tree, locating the more conspicuous larger bark fragments. Volume of each bark fragment, $V = lwt$ cm^3. It is anticipated that the moisture in the bark, volatilised by the lightning strike, caused the bark to explode, fragment and be projected outwards from the top of the tree. The larger fragments are plotted in Fig. 3, with their volumes labelled in cubic centimetres. The approximate maximum volume contours are plotted assuming such measurements to be homogenous radially around the tree. Contours suggest the direction of explosion was easterly away from the tree and away from the main direction of stripping of the trunk.

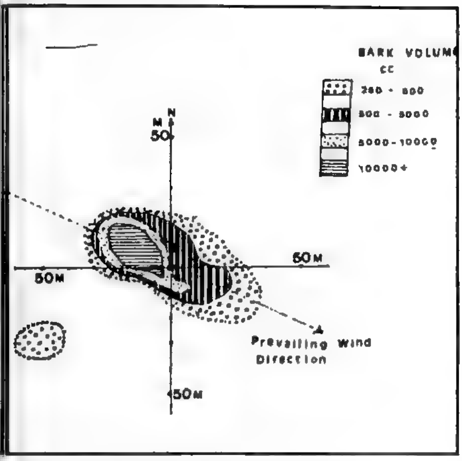

Fig.3. Distribution of Ironbark debris.

Implications from the distribution of the Ironbark debris (Fig. 3)

Prevailing wind during storm

There is a strong WNW to ESE trend in the largest bark fragments around the tree. This suggests that the dominant wind operating during the storm was from WNW to ESE.

Force in the earth's magnetic field on a conductor carrying an electric current

The coarsest bark fragments are located to the NW of the tree and there is an outlier to the SW of the tree about 50-60 cm from the bole. Applying Fleming's Left-hand Rule or Lenz's Law of electromagnetism, it is to be expected that the bark fragments should be projected westerly from the tree. The magnetic field of earth normally trends from north to south. The magnetic flux of the Earth's magnetic field would be the direction a unit north pole would move, if free to do so. When lightning strikes the tree, it is assumed electrons move vertically down the tree trunk to earth as a current I. By Lenz's Law the movement of the conductor (the tree) carrying the current should normally be to the plane of the Earth's magnetic field and the current in a clockwise direction. (The Left-hand Rule is where the centre finger represents the current direction, the forefinger the field direction, and the thumb, held mutually at right angles, the direction of movement of the conductor carrying the current, Figs. 4 and 5). As the tree cannot move, the bark fragments stripped from the trunk will move to the west of the tree. The 250-500 cc outlier could represent bark from the crown of the tree projected first westerly and then carried by the NW winds to its final position. The fact that the fragments with volume 10,000 cc + are WNW of the trunk suggests that the Earth's field here is slightly east of north (perhaps NNE). This could be due to the concentration of Ironstone pebbles in this area.

The initial speed of projection of the bark from the crown.

If we apply our knowledge of projectile mechanics to a bark fragment of volume (V) cc, mass (m) kg ejected with velocity (V) at an angle (α) to the horizontal in a direction Nθ °E from a height (h) metres up the trunk where θ^{o} represents the number of radial degrees in an easterly direction (between 0^{o} - 360^{o}), we can predict that the bark fragment would hit the ground D metres from the base of the tree, governed by the equation (1) (Fig. 6) where:

$$h + D \tan\alpha - \frac{gD^2}{2V^2}(1 + \tan^2\alpha) = 0 \quad \text{— (1)}$$

If we make V^2 explicit we have

$$V^2 = \frac{gD^2 (1 + \tan^2\alpha)}{2(h + D\tan\alpha)} \quad \text{— (2)}$$

If we consider the outlier of Fig. 2, where D = 60 m, h = 15 m, this velocity V would be a maximum if: $\frac{dV}{d\alpha} = 0$,

which gives $V^2 = gD\tan\alpha$ — (3)

Substituting for V in equation (2) we arrive at $\alpha = 23°27'$ which gives a maximum velocity of 71.46 m per sec or 257 km per hour.

So where does one stand during a thunderstorm? If you were out in the open 60 metres SW of this tree, you could have been hit with a 30 cm chunk of Ironbark flying at 250 km per hour. A thick ear would be a lucky reprieve!

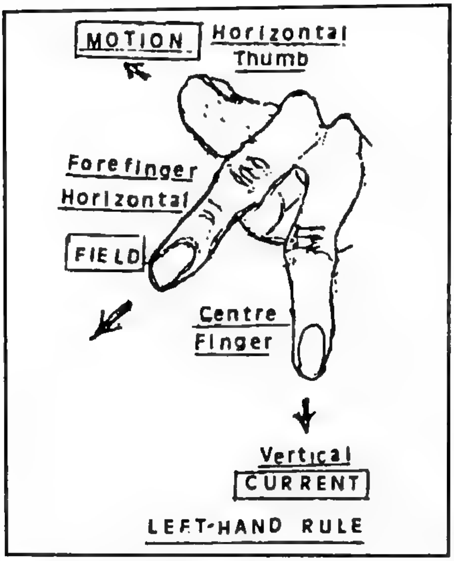

Fig.4. Lenz's Law illustrated.

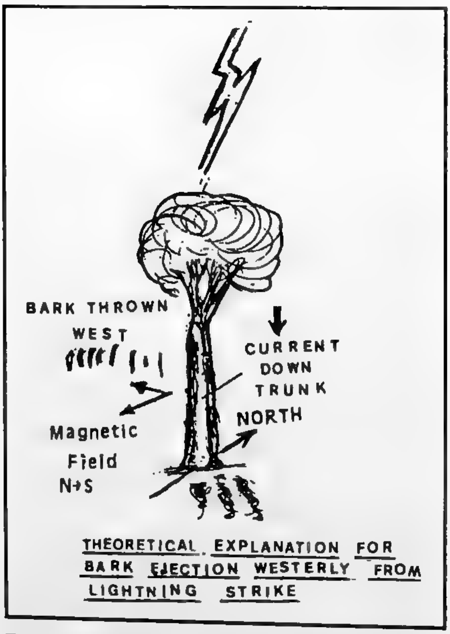

Fig.5. Lenz's Law applied to the bark distribution around the tree struck by lightning.

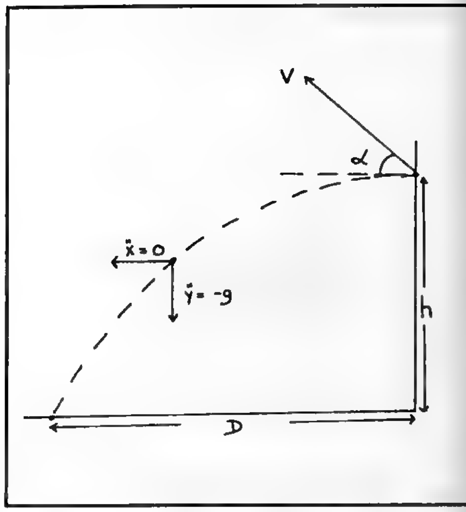

Fig. 6. Diagram to illustrate equations.

Acknowledgments

Thanks are due to Dorothy Mahler for typing the manuscript and to Ed and Pat Grey for advice to text and figures.

Explanatory Note

Rationalising equation (1)

$$2V^2h + 2V^2 D\tan\alpha - gD^2(1+\tan^2\alpha) = 0$$

Differentiating (1) for V with respect to α

$$4V\frac{dV}{d\alpha}h + 4VD\tan\alpha\frac{dV}{d\alpha} + 2V^2D\sec^2$$

$$\alpha - 2gD^2\sec^2\alpha\tan\alpha = 0$$

If $\frac{dV}{d\alpha} = 0$

$$2V^2D\sec^2\alpha - 2gD^2\sec^2\alpha\tan\alpha = 0$$

therefore

$$V^2 = gD\tan\alpha = 0 \text{ (if } 2D\sec^2\alpha \# 0)$$

or $V^2 = gD\tan\alpha$ — (3)

Australian Natural History Medallion

1993 Medallionist - Alan Reid

Alan Reid, who lives at Glenburn, Victoria, has been involved in a wide range of conservation activities and currently spends a lot of his time with Gould League work. He was a prime mover behind the publication of the Gould League Field Guides (Birds 1,2,3, etc.) to Victorian Birds, and was also one of their authors.

We congratulate Alan on his success.

The medallion presentation will be made on Monday 8 November 1993 in the Herbarium Hall and to mark the occasion a reception will be held for all FNCV members and other interested people at 5.30 in the grounds of the Astronomer's Residence - light refreshments - cost $5.00 per head.

Alan Reid will address the meeting in the Herbarium Hall at 8 pm (free).

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The Victorian Naturalist

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FNCV Calendar of Activities

December	
Sun 26- Mon 3/1	Fauna Survey Group Field Survey. **Jilpanger Scrub Survey.** Contact Ray Gibson 874 4408.
January	
Wed 19	Microscopical Group Meeting. **The Microscope for Beginners.** Astronomer's Residence 8 pm.
February	
Tues 1	Fauna Survey Group Meeting. **The Effect of Corridors and Remnants** - Andrew Bennet. Herbarium Hall 8 pm.
Sat 5	General FNCV Excursion. **Shells, Wetland Geomorphology and Birds at Edward Point Wildlife Reserve.** Leader Noel Schleiger. Own transport. Meet junction Murradoe and Bluff Roads, Melway 241B9, 10.30 am. Contact Dorothy Mahler 435 8408.
Thurs 10	Botany Group Meeting. Herbarium Hall 8 pm.
Mon 14	General FNCV Meeting. **Botany Research Projects for The FNCV** - Malcolm Calder and panel from DCNR and Herbarium. Herbarium Hall 8 pm.
Wed 16	Microscopical Group Meeting. **The Group's Micro-projector** - Bryan Waldron. Astronomer's Residence 8 pm.
Wed 23	Geology Group Meeting. Herbarium Hall 8 pm.
Sat 26	Botany Group Excursion. Contact Joan Harry 850 1347.

1994 Subscriptions and Members Survey

The 1994 membership renewal forms are enclosed with this issue and subscriptions are due on 1 January 1994.

You will note that a survey form for members interests is on the reverse side of the renewal form. We urge all members to complete this to help the Club with planning its work and activities.

Thank you from the Editors

The editors would like to thank our authors and referees for their time, effort and assistance in preparing papers for publication in *The Victorian Naturalist*. Special thanks go to Lawrie Conole for his help with proof reading.

The quality and reputation of the journal largely depends on your support and we trust this will continue in the future.

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Thanks to all members who made donations to the Club in 1993.

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The Victorian Naturalist

F.N.C.V.

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Cover Photo: Alan Reid,
ANHM winner 1993 (see page 228)

Australian Natural History Medallion 1993

Alan John Reid

Back in 1939 when J. K. Moir mooted the idea of an award as recognition and 'appreciation of some person's signal service' towards protecting our native flora and fauna, he may well have had in mind someone like Alan Reid, who has applied his special talents as an educationalist to the very important task of spreading knowledge and understanding of the natural environment, firstly to children, then to the teachers of children, and finally to the wider community.

Trained as a primary school teacher, Alan Reid quickly set about making natural history interesting and accessible. Returning in 1955 as an art and craft teacher to Colac, where he was born, he was involved in the founding of the Colac Field Naturalists Club, for whom he ran the Juniors programme. Between 1959 and 1966 he taught nature study at the Children's School Camp at Somers, and then lectured in Environmental Studies at the then Burwood Teachers' College.

In 1970 Alan Reid became Education Officer of the Australian Conservation Foundation, a position which he held for 16 years. The following year he founded the Environmental Studies Association of Victoria (now the Victorian Association for Environmental Education) and was the co-founder of the Australian Association for Environmental Education in 1980. In 1985 he was the first recipient of the Victorian Environmental Education Award. He had been a member of the Environmental Education Committee of the Victorian Department of Education, the National Trust Education Committee, the World IEA Science Study National Committee, and was Australian representative on the International Union for Conservation of Nature from 1979 to 1985.

Alan Reid's connection with the Gould League of Victoria began in 1969, and as Project Officer, Editor, Director, and currently President, he was responsible for the fundamental change in the objectives of the League. From being a bird study group designed for primary school children it has become a leader in conservation education for all levels, including the general community. Education strategies such as environmental trailing and environmental games were developed, and he wrote activity books for these purposes. Publications abounded during these years: the 'Birds of Victoria' series, the 'Survival' and 'Junior Survival' booklets, 'Gumleaves and Geckoes' diary, teaching material of all kinds, the Gould League posters, many of which he designed, as well as many articles for journals on both natural history topics and the philosophy and practicalities of environmental education.

Raising community awareness of the need for conservation has become an increasingly important part in Alan Reid's activities. His article in the 'Newsletter of the Australian Association for Environmental Education' on *The Role of Local Government in Environmental Education* became the basis for a community education conference in 1986 called 'Putting the Wheels on the Wagon', which was attended by representatives from more than 60 community organisations. As cofounder and chairman of the Nunawading Greening Australia Group he has established local heritage trails, organised community walks, information nights, and World Environment Day and Australian Day celebrations, and was very active as a member of the Gardens and Environment subcommittee of the Bicentennial Committee of Nunawading Council, succeeding in obtaining a grant to supply each Nunawading citizen with a natural history poster/planner, which he designed.

Although he has other natural history interests, Alan Reid is probably best known as an ornithologist. Together with Bill Davis, he was involved in the government purchase of the Coolart Sanctuary; and with Jack Hyett, another Medallionist, he was instrumental in procuring government involvement in the attempt to save the Helmeted Honeyeater at Yellingbo. He has kept records of the occurrence of birds in the Croajingalong National Park during annual family holidays for the last thirty years, taking particular note of the status of the Little Tern colonies. He has also been involved in an Urban Bird Study, monitoring the effects of heavy metal pollution as a possible cause of malformations and avian diseases. He is a member of the Bird Observers Club of Australia, the Royal Australasian Ornithologists Union, and was the founding member of the Australian Bird Study Association.

On his family properties at Glenburn he has developed a lake system sanctuary, as both a wildlife conservation project and a regeneration study. Here he has conducted a 25-year bird-banding study of bush birds visiting farm waterholes, and has begun an on-going study of farm fence-lines as wildlife corridors. Children, teachers, naturalists and landholders have all visited the Glenburn lakes and gained an insight into practical conservation.

Over the years Alan Reid has been an indefatigable lecturer, and leader of excursions. He has organised scores of conservation seminars and workshops. In 1981 he was appointed lead education writer for the National Conservation Strategy of Australia. In 1982 he was invited to Canada to give a paper on the range of environmental materials used in Australian schools, and in 1987 he was the keynote speaker at the inaugural conference of New Zealand Association for Environmental Education.

Alec Chisholm lamented that in his childhood 'there was no place in the curriculum for natural history'. Such is not the case today, and following in the footsteps of an earlier Medallionist, Herbert W. Wilson, Alan Reid has carried the concept of natural history education and care for the environment beyond the schools into the general community, in a manner worthy of the ideals of the founder of the Australian Natural History Medallion.

Alan Reid was nominated for the Medallion by the Gould League of Victoria.

Sheila Houghton

The Significance of Mountain Swamp Gum for Helmeted Honeyeater Populations in the Yarra Valley

A.R.G. McMahon* and D.C. Franklin**

Introduction

Eucalyptus camphora Mountain Swamp Gum or Broad-leaved Sallee was reported from low altitude sites in the Yarra Valley east of Melbourne by Simmons and Brown (1986). They mapped eleven apparently small and isolated or relict stands in the central and upper Yarra Valley, concentrated primarily around Healesville but ranging from north of Yarra Glen to the vicinity of Yarra Junction. Their observations constituted a substantial extension of range from montane eastern Victoria (*cf* Willis 1972; Costermans 1981; Brooker and Kleinig 1983; Johnson and Hill 1990), and in contrast to general perceptions of the species as an occupant of highland swamps (400 - 1600 m ASL, Costermans 1981), their locations were at low altitudes. The morphological similarity of *E. camphora* to *E. ovata* Swamp Gum has apparently contributed to poor recognition of the former, although Simmons and Brown were able to confidently assign most populations they encountered. Johnson and Hill (1990) have described the Victorian populations of *E. camphora* as *E. camphora* ssp. *humeana* largely on the basis of petiole length and the width of adult leaves.

The Helmeted Honeyeater *Lichenostomus melanops cassidix* is seriously endangered and now confined to the mid Yarra Valley (Menkhorst and Middleton 1991). Like most honeyeaters, the Helmeted feeds primarily on carbohydrates and arthropods, and these are obtained mostly from the trunks, branches and foliage of eucalypts (Wykes 1982,1985). Its staple carbohydrate is manna, a vegetative plant exudate (Paton 1980), but opportunistic consumption of nectar has also been recorded, mainly during winter. The accepted habitat of the Helmeted Honeyeater is *E. viminalis* Manna Gum riparian forest and *E. ovata* forest at Yellingbo (Cooper 1967; Wykes 1985; Backhouse 1987) and *E. viminalis* riparian forest elsewhere (Woinarski and Wykes 1982). The winter nectar source of the Helmeted Honeyeater was reported as *E. ovata* and Wykes (1982, 1985) suggested that a reduction in winter foraging options may have been one of the factors limiting the Helmeted Honeyeater population.

In this paper we report a significant stand of *E. camphora* at an additional location in the Yarra Valley. We provide some details of floristics, structure and environment of low altitude *E. camphora* communities, as these have not previously been described. We also demonstrate that low altitude *E. camphora* provides critical habitat for several threatened faunal taxa including the Helmeted Honeyeater. The information presented here was obtained in the course of a vegetation survey of the Yellingbo State Nature Reserve during 1990 and 1991 (McMahon *et al.* 1991), during other inspections of vegetation (ARGM and DCF) and during intensive studies of the entire population of the Helmeted Honeyeater from November 1989 to March 1993 (DCF).

E. camphora in the Yellingbo State Nature Reserve

Both *E. camphora* and *E. ovata* were identified at Yellingbo. The former occurred predominantly on sites subject to seasonal inundation along the Woori Yallock Creek and a number of its tributaries, Cockatoo, Macclesfield, Sheep Station and McCrae Creeks. Woori Yallock

* Ecological Horticulture, 69 Spensley Street, Clifton Hill, Vic., 3068.
** 2/17 Havelock St., Bendigo, Vic., 3550.

Creek flows north to join the Yarra River between Woori Yallock and Healesville. *E. ovata* occurred in association with *E. ignorabilis* Green Scentbark and some *E. camphora* along terraces, local drainage lines and other seasonally water-logged areas not subject to inundation.

By far the most extensive stand of *E. camphora* was in the drainage basin known as the Cockatoo Swamp. The Cockatoo Swamp is a 170 ha. floodplain along the lower reaches of the Cockatoo, Macclesfield and McCrae Creeks, most of which is subject to seasonal inundation lasting from three to ten months or more per year. The vegetation of the Cockatoo Swamp comprises a mosaic of swamp woodland and shrub thicket communities with *E. camphora, Leptospermum lanigerum* Woolly Tea-tree, *Melaleuca squarrosa* Scented Paperbark and (rarely) *M. ericifolia* Swamp Paperbark as sole or joint dominants. *E. camphora* is the only eucalypt present in the Swamp proper, though *E. ovata* and other species occur on adjacent, often poorly drained terraces and slopes. *E. camphora* occurs as a contiguous canopy or a scattered emergent virtually throughout the Swamp.

Within the *E. camphora* swamp woodland community, three sub-communities were identified:

a. Carex fascicularis Tassel Sedge - *Baumea rubiginosa* Soft Twig - sedge sedgeland; by far the most widespread and abundant sub-community, constituting the core of the Cockatoo Swamp.

b. Carex appressa Tall Sedge - *Lepidosperma laterale* var. *majus* Variable Sword-sedge sedgeland; restricted to upper reaches of the Swamp; and

c. Austrofestuca hookeriana Hooker Fescue grassland; confined to the Macclesfield Creek arm of the Swamp.

Floristics of the sub-communities are summarized in Table 1.

The sub-communities occur along a moisture gradient. Sub-community *a* occurs on saturated or permanently moist soils subject to seasonal or near-permanent inundation (one location was more or less inundated throughout the 40 months it was kept under observation, without apparent ill-effect upon the eucalypts). Sub-community *b* occurs on permanently moist soils subject to seasonal inundation. Sub-community *c* occurs on sites subject to frequent but usually brief inundation mainly during winter and early spring, but on soils that impede drainage.

Soils associated with sub-communities *a* and *b* are grey to brown silty clays of Quaternary origin, mottled in sub-community *a*. Surface iron (reddish) colouration is frequent in soil of sub-community *a* and may originate from Tertiary basalt further upstream in the catchment. Soils associated with sub-community *c* are pale grey silty loams over a mottled clay B horizon.

Structurally, the *E. camphora* community of the Cockatoo Swamp is highly variable, but in this respect the sub-communities do not differ consistently. Formations range from open forest (infrequent) through woodland to a closed grassland, the result of past disturbance as well as edaphic and drainage factors. Canopy height varies from 6 to 25 metres, with the trees mallee-like on extremely wet sites, of woodland form on drier open sites, and slender, tall and with plant densities of > 2000 per hectare on some wet sites.

The Cockatoo Swamp is almost entirely contained within the Yellingbo State Nature Reserve. However, much of it is purchased land (Backhouse 1987) formerly subject to agricultural practices. Twelve percent of the Swamp was cleared, with associated attempts to drain the land. Former grazing and burning practices may have reduced tree density and promoted the growth of *Phragmites australis* Common Reed in parts. Eucalypt dieback affects about 30% of the Swamp including virtually all of sub-community *c*. *Calystegia sepium* Large

Table 1. Sub-community floristics (major species) in *Eucalyptus camphora* woodland within the Cockatoo Swamp, summarized from McMahon *et al.* (1991). See text for characterisation of the sub-communities.

Species	Sub-community *a*	*b*	*c*
Trees			
Eucalyptus camphora Mountain Swamp Gum	x	x	x
Acacia melanoxylon Blackwood		x	
Tall shrubs			
Leptospermum lanigerum Woolly Tea-tree	x	x	
Melaleuca squarrosa Scented Paperbark			x
Medium to small shrubs			
Rubus parvifolius Small-leaf Bramble			x
**Rubus ulmifolius* Blackberry			x
Ferns			
Blechnum minus Soft Water-fern	x		
Hypolepis muelleri Marsh Ground-fern		x	
Herbs			
Lycopus australis Australian Gipsywort	x	x	
Epilobium pallidiflorum Showy Willow-herb	x		
Persicaria strigosa Spotted Knotweed	x	x	
Hydrocotyle pterocarpa Winged Pennywort	x		
Acaena anserinifolia Bidgee-widgee		x	x
Prunella vulgaris Selfheal		x	x
Senecio minimus Shrubby Fireweed		x	
Hypericum gramineum Small St Johns-wort			x
Gonocarpus tetragynus Common Raspwort			x
Dichondra repens Kidney Weed			x
Oxalis exilis Wood Sorrel			x
Veronica gracilis Slender Speedwell			x
Grasses			
Phragmites australis Common Reed	x		
Poa tenera Slender Tussock-grass		x	x
Poa labillardieri Common Tussock-grass			x
Austrofestuca hookeriana Hooker Fescue			x
Microlaena stipoides Weeping Grass			x
Graminoids			
Carex gaudichaudiana Fen Sedge	x	x	x
Carex appressa Tall Sedge	x	x	
Carex fascicularis Tassel Sedge	x		
Cyperus lucidus Leafy Flat-sedge	x	x	
Baumea rubiginosa Soft Twig-sedge	x		
Juncus procerus Tall Rush	x		
Lepidosperma laterale var. *majus* Variable Sword-sedge		x	
Empodisma minus Spreading Rope-rush			x
Baumea tetragona Square Twig-sedge			x
Dianella tasmanica Tasman Flax-lily			x

Bindweed, 'a native species' has extensively invaded disturbed sites. Nevertheless, invasion by non-native species is slight, and almost half of the Cockatoo Swamp (mainly sub-community *a)* is in outstandingly good condition.

E. camphora was also found outside the Cockatoo Swamp, in two distinct situations. Sub-communities *a* and *b* occurred as small pockets in depressions (particularly ancestral meanders) within *E. viminalis* Manna Gum tall riparian forest particularly along Woori Yallock Creek, sites sometimes alternatively occupied by a *Cyperus gunnii* Slender Flat-sedge sedgeland. *E. camphora* also occurred as a secondary eucalypt scattered through *E. ovata* forest on terraces adjacent to the Cockatoo Swamp.

The altitudinal range of *E. camphora* within the Yellingbo State Nature Reserve is 100 to 120 m ASL. The climate is low altitude cool temperate with a reliable mean annual rainfall of about 1000 mm. The valleys are subject to an estimated 50 to 100 fogs per year. The Woori Yallock Creek and a number of its tributaries are permanent streams.

The third member of the 'Swamp Gum' complex to occur in the Yarra Valley, *E. yarraensis* Yarra Gum (Simmons and Brown 1986) has not been recorded in the Yellingbo State Nature Reserve.

Swamp Gums as habitat for the Helmeted Honeyeater

Most Helmeted Honeyeater breeding territories during the study period have been in *E. camphora* swamp woodland (Table 2). Occupation of alternative habitats declined from 28% to nil during the study period.

On numerous occasions Helmeted Honeyeaters have been observed obtaining manna by licking at seepage from injury points along branches and trunks of *E. camphora.* Birds forage at these seepages from nearby perches, by clinging to bark or by hovering briefly, and may return repeatedly to particular seepages at intervals throughout the day. Helmeted Honeyeaters also spend much time working over *E. camphora* foliage and searching under peeling bark, apparently mostly obtaining arthropods.

Helmeted Honeyeaters obtained nectar from both *E. camphora* and *E. ovata* both within their territories and beyond territory boundaries. Breeding males and most breeding females were sedentary throughout the year and as the only nectar source in most territories was *E. camphora,* they were thus restricted in their nectarivory. A minority of breeding females (from zero to 33% per year) dispersed during the non-breeding season (mainly April to July), and they and floaters - immatures and adults without a breeding territory - were observed to visit and sometimes congregate in groups of up to four at nectar sources away from breeding territories. *E. camphora* flowered mainly during February to April and *E. ovata* mainly from May to September as observed at Yellingbo during monthly blossom counts (Fig. 1). In only one of the study years (1991) did more than a very small proportion of *E. camphora* flower,

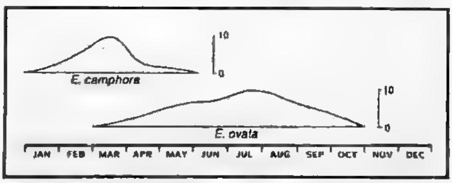

Fig.1. Flowering times of 'Swamp Gums' at Yellingbo on a scale from zero (no flowering) to ten (peak of flowering).

Table 2. Habitat distribution of Helmeted Honeyeater breeding territories, 1989/90 to 1992/93. Territories in *E.ovata/E.camphora* spanned an abrupt boundary between two distinct communities.

Dominant	1989/90	1990/91	1991/92	1992/93
E. viminalis	2	0	0	0
E. ovata/E.camphora	3	1	0	0
E. camphora	13	14	20	22

leaving the marked impression over the admittedly few years of this study that *E. ovata* flowered more consistently than *E. camphora.*

Discussion

E. camphora *in the Yarra Valley*

Some previous surveys of upper Yarra Valley vegetation (Gullan *et al.* 1980), upper Yarra Valley floodplain vegetation (Rosengren *et al.* 1983), vegetation associated with herpetofauna at Yellingbo (Smales 1981) and vegetation associated with Helmeted Honeyeaters at Yellingbo (Wykes 1982,1985) failed to detect *E. camphora,* apparently attributing their observations to *E. ovata.* Some general reviews of Helmeted Honeyeater biology have likewise failed to distinguish the species (Backhouse 1986), although recent reviewers (Smales *et al.* 1990; Menkhorst and Middleton 1991) have been alerted to the distinction.

E. camphora is widely though generally sparsely distributed through the Yarra Valley. Simmons and Brown (1986) and ARGM (pers. obs.) have recorded it upstream to Yarra Junction. It is widely scattered around Healesville. This report extends its distribution south to Macclesfield. SGAP (1991) report the species from Diamond Creek and Wonga Park in the lower Yarra Valley. Simmons and Brown (1986) considered its Yarra Valley occurrences to be generally confined to 'cold, wet sites', and our observations are consistent with this. Its dominance in the Cockatoo Swamp suggests that *E. camphora* may have been a major component of the vegetation of low-altitude, poorly-drained sites subject to marked cold-air drainage in the Yarra Valley. Flood-prone flats along the Woori Yallock Creek below Yellingbo and along the Yarra River from Woori Yallock to Yarra Glen are now virtually devoid of native vegetation but may once have supported extensive stands of *E. camphora.*

Low altitude occurrences of *E. camphora* are not restricted to the Yarra Valley. Simmons and Brown (1986) mention three low altitude sites in north-east Victoria. We have identified an extensive stand in the Bunyip River catchment along Diamond and Black Snake Creeks at 70 to 100 m ASL (not to be confused with the Diamond Creek occurrence mentioned in the previous paragraph).

These low altitude occurrences may not be so different from the montane valleys with which *E. camphora* has traditionally been associated. Indeed, marked floristic similarities exist between the Cockatoo Swamp and a relict montane marsh community at 710 m ASL on the Benambra Plains (Carr *et al.* 1987).

The moisture tolerance of *E. camphora* at Yellingbo is exceptional, probably without parallel in Victoria (*cf. E. camaldulensis* River Red Gum in the Murray River floodplain, Dexter *et al.* 1986; Chesterfield 1986).

We concur with Simmons and Brown (1986) that many 'Swamp Gums' in the Yarra Valley can be readily assigned to either *E. camphora* or *E. ovata* but that a minority cannot. Given the taxonomic and physical proximity of the two species and overlap in flowering times during autumn, the occurrence of hybrids is to be expected. However, for the most part, and especially where a relatively steep incline separated the Cockatoo Swamp from the surrounding terraces, the transition from *E. camphora* to *E. ovata* communities was abrupt, with *E. ovata* and putative hybrids confined to the terraces.

The flowering times we noted for the swamp gums at Yellingbo agree remarkably well with those reported by Willis (1972) - March to April for *E. camphora* and March to November for *E. ovata.*

'Swamp Gums' and Helmeted Honeyeaters

The differentiation of *E. camphora* from *E. ovata* explains some enigmatic observations of Wykes (1982) including the erratic flowering times attributed to *E. ovata* and the tendency for Helmeted

Honeyeaters to move to higher ground during winter - the latter associated with nectarivory at *E. ovata* at a time of year when *E. camphora* would not have been in flower. With hindsight it appears that his study area was a terrace carrying *E. ovata* forest flanked upslope by dry sclerophyll forest and below by *E. camphora* swamp woodland. The Helmeted Honeyeater territories within the study area were at least close to, if not on, the abrupt boundary between *E. ovata* and *E. camphora* communities. Unfortunately, it is unclear which 'Swamp Gum' species his extensive data on foraging and perching substrata applies to, and the demise of breeding territories that included *E. ovata* occurred before we had an opportunity to determine if any differences existed. However, there was no doubt from general observations by DCF that Helmeted Honeyeaters in territories spanning the community boundaries extensively foraged in both *E. ovata* and *E. camphora* throughout the year.

Nevertheless, there is no definitive evidence that Helmeted Honeyeaters ever bred in *E. ovata* forest in the absence of *E. camphora*. Woinarski & Wykes (1982) observed Helmeted Honeyeaters only in *E. viminalis* forest though *E. ovata* was present nearby (we have no reason to doubt the identification of *E. ovata* at their upper Cardinia Creek study site). Perhaps the most likely evidence is the reference by Lee & Bryant (1948) to a Helmeted Honeyeater specimen collected near the mouth of Cardinia Creek in what was the Koo-wee-rup Swamp. We suspect that *E. ovata* would have been the only 'Swamp Gum' present, but have been unable to trace the specimen to obtain any more detail.

Historical records of the Helmeted Honeyeater at Yellingbo and elsewhere indicate that *E. viminalis* forest was a major habitat for the bird. The retreat from *E. viminalis* and *E. ovata* areas to *E. camphora* swamp woodland during the study period was evidently only the latter stages of a retreat that is symptomatic of the taxon's decline since its discovery last century. A report of Helmeted Honeyeaters along Diamond Creek in the Bunyip River catchment (Johnson 1961) was in an area where *E. camphora* is abundant, but the record may refer to the Gippsland race of the Yellow-tufted Honeyeater *L. m. gippslandicus*. It is unclear whether *E. camphora* swamp woodland is optimum habitat for the Helmeted Honeyeater or is simply the vegetation type least subject, because of its extreme wetness, to clearing for agriculture or destruction of nest sites by grazing.

E. camphora does not provide winter nectar. *E. ovata* does, and this is exploited by floaters and some breeding females. There are few other winter nectar sources in the vicinity of the Cockatoo Swamp. Silver Banksia *Banksia marginata* and Common Heath *Epacris impressa* are both abundant in the remnants of dry sclerophyll forest near the Cockatoo Swamp. Both are popular with honeyeaters in South Australia (Ford 1983), but are rarely visited by honeyeaters at Yellingbo (DCF *pers. ob.;* see also Wykes 1982). Both dry sclerophyll forest and especially *E. ovata* forest have been more severely depleted in the Yellingbo area by clearing for agriculture than has *E. camphora*. Appreciation of the distinction between *E. camphora* and *E. ovata* adds considerably to the case for Wykes' suggestion that loss of alternative foods during winter may be limiting the Helmeted Honeyeater population. However, most territory-holding Helmeted Honeyeaters do not need winter nectar sources to survive, and survival data does not indicate that winter mortality is excessive (DCF *unpubl.*).

Other conservation values of the E. camphora *community*

Smales (1981) reported a population of the patchily distributed and uncommon Swamp Skink *Egernia coventryi* from the Cockatoo Swamp. They are to be found in the upper reaches of the *E. camphora* community, as well as in the adjacent *E. ovata* terraces (Ian Smales, *pers. comm.*). A population of the endangered Leadbeater's Possum *Gymnobelideus leadbeateri* has also been located within the Cockatoo Swamp (Smales, *in prep.*) Of some interest also is the large breeding population of the Southern Emu-wren *Stipiturus malachurus* and the Spotless Crake *Porzana tabuensis* (DCF *pers. ob.;* Ian Smales *pers. comm.*). The little-known Lewin's Rail *Rallus pectoralis* is heard quite frequently.

The Chestnut-breasted Mannikin *Lonchura castaneothorax* has been recorded sporadically over many years, and two nests have been located (DCF *pers. ob.;* Ian Smales *pers. comm.;* Peter Allen *pers. comm.*). The Mannikin occurs naturally in coastal areas of northern and eastern Australia as well as New Guinea and adjacent islands, and has apparently not been recorded breeding in Victoria previously (Emison *et al.* 1987). It is unclear whether this population is of natural origins or has escaped from aviaries, and although the latter seems more likely, its occurrence at Yellingbo, breeding in its natural habitat of rank, swampy grassland, is noteworthy.

Epilobium pallidiflorum Showy Willow-herb, a species of State significance (Gullan *et al.* 1990), is widely dispersed through the *E. camphora* community at Yellingbo.

The Cockatoo Swamp is believed to be the largest swamp woodland and the most extensive stand of *E. camphora* in the Yarra Valley, and the only one in a gazetted biological reserve. Comparable communities elsewhere within Victoria are rare and very restricted, and the most intact stands within the Cockatoo Swamp are of national botanical significance.

Conservation of the Cockatoo Swamp

Despite its reserved status, the long-term survival of the Cockatoo Swamp is not assured. Eucalypt dieback is widespread and locally severe. It is associated with psyllid infestations and colonization by Bell Miners *Manorina melanophrys,* a syndrome that is widely reported but poorly understood (Clark and Dallwitz 1974; Wylie and Bevege 1980; Morgan and Bungey 1981; Ward and Neuman 1982; Loyn *et al.* 1983; Wykes 1985; Poiani *et al.* 1990). Yet another threat may be a proposal to establish a sewerage treatment plant that would discharge treated effluent into the Cockatoo Creek upstream of the Cockatoo Swamp. It is unclear whether the replacement of septic systems within the catchment with treated effluent gathered from within and beyond the catchment and discharged direct into the waterway will result in an improvement or deterioration of water quality. Nutrient enrichment may promote eucalypt dieback by improving the nutritional quality of leaves (Landsberg 1990; M. Adams *pers. comm.).* Another concern with the proposed discharge is that it may increase summer water levels in the Swamp, stressing trees that may already be at the limits of their tolerance to moisture.

The dynamics of the Cockatoo Swamp ecosystem urgently require further research (some of which is in progress). Sensitive management of this priority area by the Department of Conservation and Natural Resources is imperative.

Acknowledgements

The work of which this is a summary was undertaken as part of the Helmeted Honeyeater Recovery Program, which is funded by the Government of Victoria. Geoff Carr, Georgina Race, Sarah Bedggood and James Todd co-authored the original vegetation study (McMahon *et al.* 1991). We are also grateful for the encouragement and assistance of others involved with the program, notably Ian Smales, Peter Menkhorst and Greg Horrocks.

References

Backhouse, G.N. (1987). Management of remnant habitat for conservation of the Helmeted Honeyeater *Lichenostomus melanops cassidix. In* 'Nature Conservation: the role of remnants of native vegetation', Eds D.A. Saunders, G.W. Arnold, A.A. Burbidge and A.J.M. Hopkins, 287-294. (Surrey Beatty & Sons: Sydney.)

Brooker, M.I.H. and Kleinig, D.A. (1983). 'Field Guide to Eucalypts. Vol 1: South-eastern Australia'. (Inkata: Melbourne.)

Carr, G.W., McMahon A.R.G., and Bedggood, S.E. (1987). 'Environmental effects of the proposed copper mine at Benambra, Victoria. The Vegetation'. (Kinhill Engineers: Melbourne.)

Chesterfield, E.A. (1986). Changes in vegetation of the River Red Gum forests of Barmah, Victoria. *Australian Forestry* **49:** 4-15.

Clark, L.R. and Dallwitz, M.J. (1974). On the relative abundance of some Australian Psyllidae that coexist on *Eucalyptus blakelyi*. *Australian Journal of Zoology* **22:** 387-415.

Cooper, R.P. (1967). Is the Helmeted Honeyeater doomed? *Australian Bird Watcher* **3:** 1-13.

Costermans, L. (1981). 'Native Trees and Shrubs of South-eastern Australia'. (Rigby: Adelaide.)

Dexter, B.D., Rose, H.J. and Davis, N. (1986). River regulation and associated forest management problems in the River Murray Red Gum forests. *Australian Forestry* **49:** 16-27.

Emison, W.B., Beardsell, C.M., Norman, F.I. and Loyn, R.H. (1987). 'Atlas of Victorian Birds'. (Department of Conservation, Forests and Lands and Royal Australasian Ornithologists Union: Melbourne.)

Ford, H.A. (1983). Relation between number of honeyeaters and intensity of flowering near Adelaide, South Australia. *Corella* **7:** 25-31.

Gullan, P.K., Cheal, D.C. and Walsh, N.G. (1990). 'Rare or threatened plants in Victoria'. (Flora Survey Group, Dept. of Conservation and Environment: Victoria.)

Gullan, P.K., Parkes, D.M., Morton, A.G. and Bartley, J.J. (1980). 'Sites of botanical significance in the Upper Yarra region'. (Ministry for Conservation: Victoria. Environmental Studies Series, Publication No. 246.)

Johnson, G. (1961). Helmeted Honeyeater Survey. *The Bird Observer* July 1961: **3.**

Johnson, L.A.S. and Hill, K.D. (1990). New taxa and combinations in *Eucalyptus* and *Angophora* (Myrtaceae). *Telopea* **4 (1):** 37-108.

Landsberg, J. (1990). Dieback of rural eucalypts: Does insect herbivory relate to dietary quality of tree foliage? *Australian Journal of Ecology* **15:** 73-87.

Lee, R.D. and Bryant, C.E. (1948). A count of Helmeted Honeyeaters. *The Emu* **47:** 230-231.

Loyn, R.H., Runnalls, R.G., Forward, G.Y. and Tyers, J. (1983). Territorial Bell Miners and other birds affecting populations of insect prey. *Science* **221:** 1411-1413.

McMahon, A.R.G., Carr, G.W., Race, G.J., Bedggood, S.E. and Todd, J.A. (1991). 'The vegetation and management of the Yellingbo State Nature Reserve with particular reference to the Helmeted Honeyeater *(Lichenostomus melanops cassidix)*'. (Report prepared for the Department of Conservation and Environment. Ecological Horticulture Pty Ltd: Clifton Hill, Victoria.)

Menkhorst, P. and Middleton, D. (1991). Helmeted Honeyeater Recovery Plan. (Department of Conservation and Environment: Victoria.)

Morgan, F.D. and Bungey, R.S. (1981). Dynamics of population outbreaks of Psyllidae (lerp insects) on eucalypts. *In* 'Eucalypt dieback in forests and woodlands.' Eds K.M. Old, G.A. Kile and C.P. Ohmart, 127-129. (CSIRO: Melbourne.)

Paton, D.C. (1980). The importance of manna, honeydew and lerp in the diets of honeyeaters. *The Emu* **80:** 213-226.

Poiani, A.J., Rogers, A., Rogers, K. and Rogers, D. (1990). Asymmetrical competition between the Bell Miner *(Manorina melanophrys,* Meliphagidae) and other honeyeaters: evidence from south eastern Victoria, Australia. *Oecologia* **85:** 250-256.

Rosengren, N., Frood, D. and Lowe, K. (1983). 'Sites of environmental significance in the flood plain of the Upper Yarra River.' (Report prepared for the Upper Yarra Valley and Dandenong Ranges Authority. Department of Geography: University of Melbourne.)

Simmons, D. and Brown, G. (1986). The distribution of some *Eucalyptus* species (the Swamp Gums) in the Yarra Valley, Victoria. *The Victorian Naturalist* **103 (1):** 19-25.

Smales, I. (1981). The herpetofauna of Yellingbo State Faunal Reserve. *The Victorian Naturalist* **98:** 234-246.

Smales, I.J., Craig, S.A., Williams, G.A. and Dunn, R.W. (1990). The Helmeted Honeyeater: decline, conservation and recent initiatives for recovery. *In* 'Management and Conservation of Small Populations.' Eds T.W. Clark and J.H. Seebeck, 225-238. (Chicago Zoological Society: Chicago.)

Society for Growing Australian Plants, Inc. (1991). 'Flora of Melbourne. A guide to the indigenous plants of the greater Melbourne area'. (SGAP: Ringwood.)

Ward, B.K. and Neumann, F.G. (1982). 'Eucalypt dieback in foothill forests of the Dandenong Ranges. Forestry Technical Paper No. 29'. (Forests Commission: Victoria.)

Willis, J.H. (1972). 'A Handbook to Plants in Victoria. Vol II. Dicotyledons'. (Melbourne University Press: Carlton.)

Woinarski, J.C.Z. and Wykes, B.J. (1983). Decline and extinction of the Helmeted Honeyeater at Cardinia Creek. *Biological Conservation* **27:** 7-21.

Wykes, B.J. (1982). 'Resource partitioning and the role of competition in structuring *Lichenostomus* honeyeater (and *Manorina melanophrys*) communities in southern Victoria'. (Ph D thesis, Monash University: Melbourne.)

Wykes, B.J. (1985). The Helmeted Honeyeater and related honeyeaters of Victorian woodlands. *In* 'Birds of Eucalypt Forests and Woodlands: Ecology, Conservation and Management.' Eds A. Keast, H.F. Recher, H. Ford and D. Saunders, 205-217. (Royal Australasian Ornithologists Union and Surrey Beatty & Sons: Sydney.)

Wylie, F.R. and Bevege, D.I. (1981). Eucalypt dieback in Queensland. *In* 'Proceedings of a conference held at the CSIRO Division of Forest Research, Canberra, August 1980.' Eds R.M. Old, G.A. Kile and C.P. Ohmart, 65-70. (CSIRO: Canberra.)

Where are Gouldian Finches after the Breeding Season?

Sonia C. Tidemann*

Introduction

Gouldian Finches *Erythrura gouldiae* occur across northern tropical Australia. During the 1970s, returns submitted by licensed finch trappers in northern Western Australia, indicated that numbers of Gouldian Finches caught, declined by about 80% over about ten years (WA Department of Conservation and Land Management). They are classified as endangered, the most recent listing being that of the Royal Australasian Ornithologists Union (Garnett 1992).

Descriptions of Gouldian Finch movements have stated that they move south or north once the wet season rains begin (Immelmann 1965) but these suggestions did not arise from studies of banded birds. Because annual mortality of Gouldian Finches may be high in the late dry-early wet season period, it was important to try to determine what they were doing during this period.

Apart from a capture-recapture programme conducted between August and October, 1986, over a variety of sites in the Northern Territory to ascertain whether Gouldian Finches occurred in any of those sites (Tidemann 1990), studies have been carried out during the breeding seasons. They have concentrated on locating breeding sites (Tidemann *et al.* 1992a), breeding behaviour and productivity (Tidemann and Lawson *in press*), population studies (Woinarski and Tidemann 1992; Tidemann and Woinarski *in press*) and parasites/disease (Tidemann *et al.* 1992b; Tidemann *et al.* 1992c; Tidemann *et al.* 1993).

In this paper I report on a series of small studies on the Gouldian Finch to investigate what the birds do in the late dry season after a fire in their breeding habitat, where birds go after rain and whether they are present in the breeding habitat during the wet season. These studies were all carried out in the Yinberrie Hills (14°08'S, 132°05'E), about 250 km south of Darwin (Fig. 1).

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Gouldian Finches in a blackened habitat

Because of the importance of preserving trees with hollows (Fig. 2) in known Gouldian Finch breeding habitat, I recommended that a preventative burning regime be adopted in areas where the finches have been found to breed (Tidemann *in press* a, b). This involves setting fire to the huge grass biomass once the seed has dropped from the *Sorghum* spp. Depending on the wet season, this is about March or April when there is still a high moisture content in the soil and a patchy mosaic is achieved without damaging the trees. This is frequently referred to as a 'cool' burn (Fig. 3) because it is lit late in the afternoon when there is little wind and the fire goes out that night. In some instances constraints prevent this type of burning from being achieved in all areas.

In October 1991, a 'hot' fire passed through the study area (Fig. 4). In the parts of the site which had been subjected to the 'cool' burn earlier in the year, the effects were less intense than elsewhere, trees retained their leaves and there was patchy grass cover. Otherwise, it was a blackened, grassless, leafless landscape. At this time of the year, the deciduous *Eucalyptus tintinnans* (utilized by Gouldian Finches for breeding sites) is losing its leaves.

Soon after the fire, several Gouldian Finces had small transmitters attached to them to try to track their movements during this time of the year. When birds were located, position and time of day were recorded plus a number of estimated measurements (cm) on the tree in which

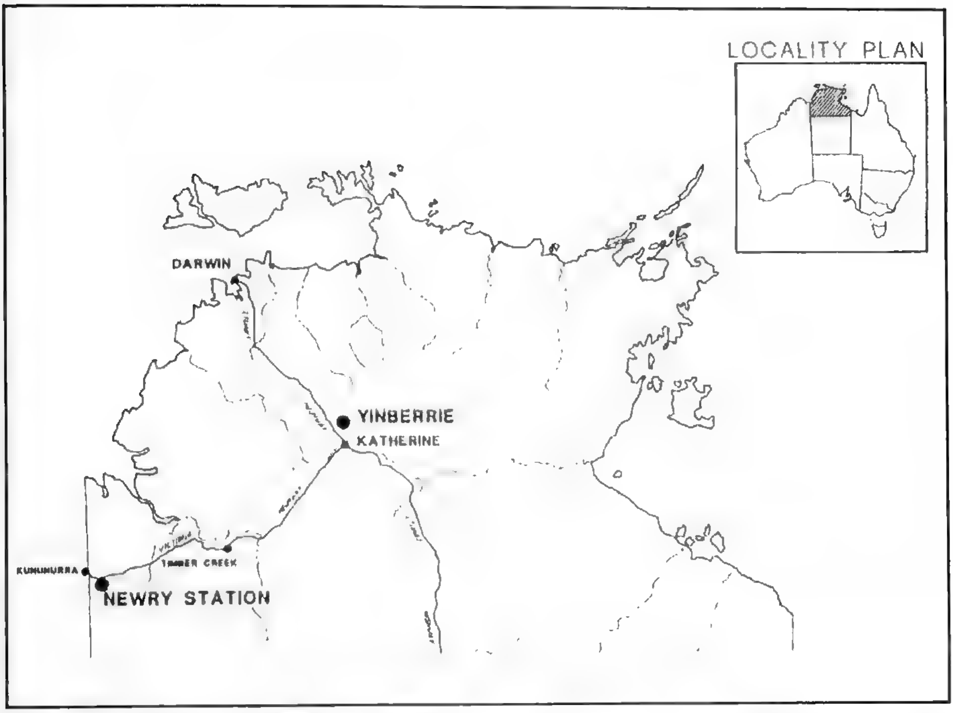

Fig. 1. Location of study site, Yinberrie Hills.

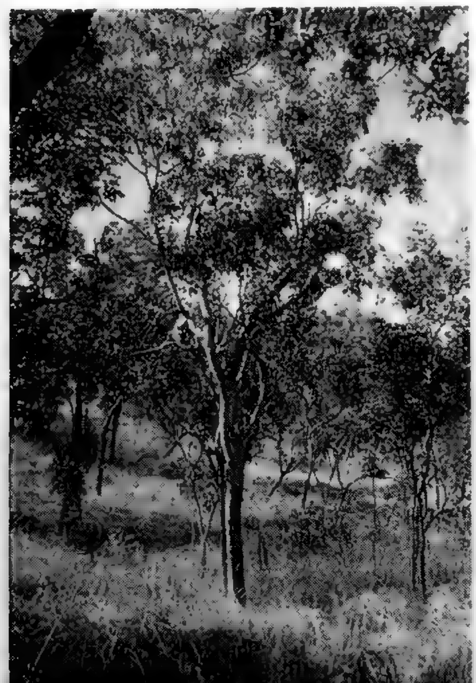

Fig. 2. *Eucalyptus tintinnans* taped to show presence of nest in one of the hollows.

Fig. 3. 'Cool' burn results in low levels of singeing.

Fig. 4. Devastation following the 'hot' fire in October.

the finches were sitting and five surrounding trees. These were: leaf length of the foliage 'clumps' at the ends of branches. These were multiplied to give an index of **shadiness.** A road, which divided the study site into the 'cool' and 'hot' burn sections was traversed to record (during 35 minute periods) where finches were and what they were doing as the day heated up. Ground temperatures (3 cm above the ground), were measured on the exposed as well as patchy grass sections.

In the cool of the early morning the Gouldian Finches sat (Table 1), often sunning and preening, in trees on both the 'cool' and 'hot' burn sides of the road. More birds sat on the 'cool' side, however, possibly because those trees were leafier and afforded better camouflage. The birds appeared to have two bouts of feeding. During the first period, most birds fed on the burnt (hot) side where there were no obstructions in the form of grass. When disturbed, the flock lifted as one mass and flew to the leafy trees in the 'cool' burn side. After the disturbance, they dropped back in small trickles to where they had been feeding before. By 0815 h, many birds were sitting on the shadier (cool) side of the road and those birds that were still feeding on the burnt (hot) side were feeding in the shade. Because the trees were leafless and the ground bare, the only shade was that given by the tree trunks and branches. The trees were effectively 'painted' on the ground by a slow-moving, pecking bunch of Gouldian Finches, distributed throughout the shadows. The members of the feeding flock kept in close proximity (10-30 cm) to each other. By mid-morning, half the birds were feeding again but most of these had now shifted to the cool burn side where there was more cover. By 1000 h no birds were feeding. They were sitting in places where there was shade. All the birds were panting.

Temperatures just above the ground were measured in the hot burn, exposed areas as well as the patchy cool burn areas. The former were hotter, with greater radiation and reflection of heat than the patchily burnt areas. The maximum temperature in the bare, hot burn area was 56°C (mean 52.5°C, n=5) by 1300 h.

Birds sought out shade in order to cope with the hot conditions during the middle of the day because they chose trees with a higher index of shadiness after 0900 h than before (t=3.47, df=36, p<0.002). No birds selected trees to sit in that were leafless after 0900 h (range: 180-8000, mean=3660, sd=2806, n=14) whereas about 25% of trees used in the early morning were leafless (range: 0-6000, mean=1137, sd=1716, n=24). Regardless of the time of day, Gouldian Finches selected the shadiest tree in a particular group (t=3.19, df=214, p<0.002) suggesting that they maximize their cover for both camouflage and shade. There was no correlation during the heat of the day between the index of shade for a tree and the number of Gouldian Finches sitting in it (r_s=0.01, n=10, p>0.5) probably because of the high variation of the index of shadiness for trees in the habitat.

Species selected for shade, in order of priority, were *Eucalytus confertiflora, E. foelscheana, E. latifolia, E. tectifica, Erythrophleum chlorostachys* mistletoe, *Eucalyptus tintinnans.* The first three species have large, broad leaves. The heterogeneity of tree species is therefore important in this habitat because one tree species does not supply all needs, in particular, nesting sites as well as shelter.

Sorghum seeds, available from about March until December, consititute the main part of the diet of Gouldian and are also eaten by other finches in the area. Although *Sorghum* seeds have about the same nutritional value as some other seeds consumed by finches (Table 2), the size (about 5 mm x 2 mm) may be the most efficiently handled in terms of time. During the wet season Gouldian Finches have been observed eating *Eriachne obtusa* (Goodfellows *pers. comm.*). Its lower nutritive value compared with *Sorghum* explains why the finches switched back to eating *Sorghum* as soon as it is available.

Table 1. Gouldian Finch activity at two sites in the study area.

Time	'Cool' Burn		'Hot' Burn		
	Sitting	Feeding	Sitting	Feeding (shadow)	Feeding
0630	90	0	4	0	0
0705	46	0	11	0	90
0740	0	16	0	0	126
0815	123	4	0	60	0
0935	43	37	2	12	0
1000	70	0	0	0	0

Table 2. Nutritional values of some seeds eaten by finches.

Seed	% nitrogen	% potassium	% moisture	% fat	% total ash
Sorghum spp.	4.3	0.6	8.7	7.0	2.9
Eriachne obtusa	2.7	0.5	12.2	2.8	1.6
Oryza oryzoides	1.6	0.2	10.0	2.4	1.5
Aristida hygrometrica	4.4	0.6	8.3	6.0	3.0
Heteropogon contortum	6.0	0.6	7.4	-	2.9

Because the terrain is rocky-pebbly, seeds are partly sheltered from fire even though they may be singed. Fire reduces the density of viable seeds (Andrew and Mott 1983), though not to the extent that the following year's standing crop of *Sorghym* is reduced noticeably. The nutritive value of the seeds must still be adequate to support the Gouldian Finches, many of which are undergoing moult at that period (Tidemann and Woinarski *in press*).

There was no movement of the birds with the transmitters away from the Yinberrie Hills during the late dry season (as has been noticed in the west of the Northern Territory). During the observation period, birds flew up to 10 km a day, seeking out drinking sites early in the morning, feeding and then, for the bulk of the day, sitting in whatever shade could be found.

It was not possible to determine where Gouldian Finches move once they leave the Yinberrie Hills, if they do, by using radio-tracking techniques. The next method tried was to watch water-holes around the area and try to pick up banded birds which would have come from the Yinberrie Hills study site.

Gouldian Finch drinking and feeding sites

On November 10-11, eight volunteers were recruited to sit at isolated water holes at varying distances radiating out from the study site (up to 13 km), to count the number of banded finches coming in to drink. A few days prior to the finch count, about 25 mm rain fell in the area. It was decided to proceed with the counts despite the now super-abundance of water (Fig. 5).

Observations were carried out from 0600 h to 0945 h on each of two mornings. At two-minute intervals, an observer made an 'instantaneous' count of the number of finch species at, or close to, the water's edge. In between the counts, the observer kept constant watch for bands on the legs of any finches.

Gouldian Finches were seen at only two of the 16 locations. One location was on the study site where an artificial water supply had been maintained for several years and birds banded regularly over that period. Despite the wide availability of water, over 200 Gouldian Finches were counted but only three were banded. At the other site, previously unstudied, about

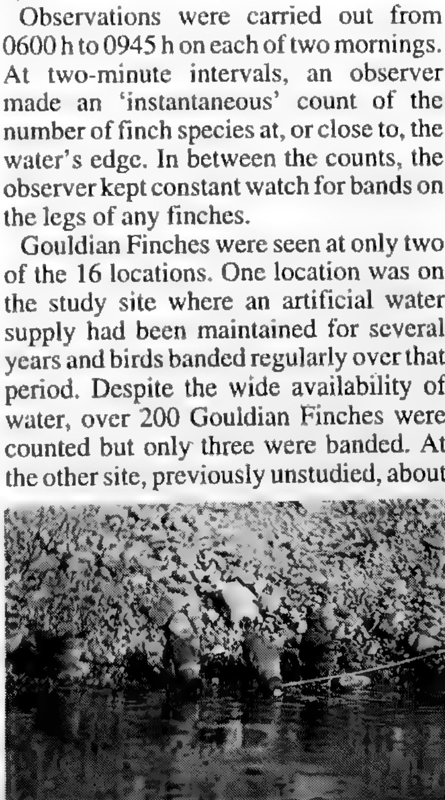

Fig. 5. Gouldian Finches drinking at a pool in the Yinberrie Hills.

12 km north-east of the study site, 33 Gouldian Finches were seen, none of which was banded.

These results fail to support the early suppositions that the birds move away from an area when the rains come. Rather, while an area supplies food, regardless of the wide availability of water, Gouldian Finches remain there.

Later in the month (November 27) *Sorghum* and other grasses had sprouted to heights of 4-22 cm. During a 90 minute count, fewer finches were seen compared with the month before (total Gouldian, Long-tailed and Masked = 44) suggesting that food supplies were becoming depleted because the seeds were sprouting. There was a difference in the areas subjected to the 'hot' burn compared to the 'cool' burn: the heights of new grass in the former ranged from 7-14 cm (mean=10, sd=1.3, n=100) while grass heights in the cool burn areas were more variable, ranging from 4-22 cm (mean=12, sd=2.3, n=100). More finches were feeding in the cool burn area (n=30) than the hot area (n=14). Possibly, the patchy presence of grass affects the rate of drainage of rain water in the 'cool' burn areas, resulting in greater variation in germination rate, and hence availability, of seeds.

The countinued presence of finches in this area is likely to be determined by the timing and amount of rain at the beginning of the wet season. For example, in 1986, Gouldian Finches were still utilizing the area during December but all birds had sprouting seeds in their crops.

Goulding Finches during the wet season

To test the hypothesis that Gouldian Finches remain in the general area during the mid wet season, five visits were made to the study area between early January and late March, 1992. On each trip, a total of 12 fixed transects, each 1 km in length (E-W) was covered. Every 100 m, the species of grass and its height was recorded at a fixed point. Later, when the grasses began to flower and set seeds, an estimate of the % flowering and % seed set was made for the flower spikes at each point. The numbers of each species of finch heard or seen along the transects was noted.

The grasses most commonly recorded were *Sorghum intrans/plumosum* and *Heteropogon triticeus.* No Gouldian Finches were seen or heard in the Yinberrie Hills until March 21. This coincided with the first seed set of *Sorghum plumosum;* the majority of plants were still flowering including *Sorghum intrans.* Few Long-tailed and Masked Finches were seen during the period but their re-appearance in the Yinberrie Hills also coincided with the appearance of the seeding *Sorghum*.

During the same period that year, and other years, there were reports of Gouldian Finches on the flats to the south and west of the Yinberrie Hills. Long-tailed and Masked Finches were frequently seen too. There the finches were feeding on *Echinochloa* spp., *Eriachne* spp. and *Brachyachne,* all of which usually set seed earlier than most *Sorghum* spp. The reappearance of the Gouldian Finches in the Yinberrie Hills as soon as the *Sorghum* has set seed suggests that, in this region at least, the birds are spending the wet season sufficiently close to be able to 'home in' rapidly to take advantage of the ripening *Sorghum* in their breeding site. They, and their young, consume *Sorghum* from then on until it sprouts beyond the handling stage, the following November-December (Tidemann *in press* a). This may not be the behaviour of Gouldian Finches in the western part of the NT and Kimberleys, however, where they do not inhabit the breeding site for as long each year.

Conclusions

Perhaps one slightly depressing conclusion is that despite an enormous amount of effort and commitment of resources to investigate the biology of the Gouldian Finch over the last seven years, there remains a number of unanswered questions.

From the results of the studies reported here, however, some preliminary suggestions for management can be made. The possible stress experience by the Gouldian Finches in the hot, leafless, bare areas during the late dry season, when water is normally in short supply, strongly supports the suggestion that preventative measures should be taken to protect the habitat and lessen a likelihood of holocaust occurring if a late dry season fire passes through the area. At this time the birds have started breeding but such a 'cool' fire has minimal, if any, effects on the birds. For example, a fire passed under a tree in which a female Gouldian Finch was known to be nesting. The female stayed on her nest. Early dry season fires have been shown not to disadvantage finches (Woinarski 1990) but rather remove the stubble layer, opening up a smorgasbord of seed below.

Beneficial future studies would be to continue the investigation of what Gouldian Finches are doing during the wet season. Because recaptures between years are low (Woinarski and Tidemann 1992), the late dry - mid wet season may be a critical period for survival. This task will require many observers and great patience!

Acknowledgements

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References

Andrew, M.H. and Mott, J.J. (1983). Annuals with transient seed banks: the population biology of indigenous *Sorghum* species of tropical north-west Australia. *Australian Journal of Ecology* **8:** 265-276.

Garnett, D. (1992). 'The action plan for Australian birds'. (Royal Australasian Ornithologists Union: Melbourne).

Immelmann, K. (1965). 'Australian Finches'. (Angus & Robertson: Sydney).

Tidemann, S.C. (1987). Gouldian Finches in the Wild. *Bird Keeping in Australia* **30:** 145-53.

Tidemann, S.C. (1990). The relationship between finches and pastoral practices in Northern Australia. *In* 'Granivourous birds and agriculture'. Eds J. Pinowski and J. D. Summers-Smith. (PWN Polish Scientific Publishers: Warsaw).

Tidemann, S. C., Boyden, J., Elvish, R. and J. & O'-Gorman, B. (1992a). Comparison of the breeding sites and habitat of two hole-nesting estrildid finches, one endangered, in northern Australia. *Journal of Tropical Ecology* **8:** 373-388.

Tidemann, S.C., Calley, M. and Burgoyne, C. (1992b). An investigation of blood smears of northern Australian Finches. *Emu* **92:** 114-117.

Tidemann, S.C., McOrist, S., Woinarski, J.C.Z. and Freeland, W.J. (1992c). Heavy parasitism of wild Gouldian Finches, *Erythrura gouldiae*, by the air-sac mite *Sternostoma techeacolum*. *Journal of Wildlife Diseases* **20:** 80-84

Tidemann, S.C. (*in press* a). Management of a threatened species - the Gouldian Finch example. *Preceedings of a conference.* (Queensland Ornithological Society: Brisbane).

Tidemann, S.C. (*in press* b). Investigating the decline of the Gouldian Finch *Erythrura gouldiae*, an estrildid finch of northern Australia. *In* Bell, B., Tidemann, S.C. Komdeur, J. and Rands, M. (eds.) 'Management of Threatened Species'. (ICBP: Cambridge).

Tidemann, S.C., McCartney, J. and Smith, I. (1993). The Gouldian Finch and air-sac mite in Queensland. *Sunbird* **23:** 36-40.

Tidemann, S.C. and Woinarski, J.C.Z. (*in press*). Moult characteristics and breeding seasons of Gouldian *Erythrura gouldiae*, Masked *Poephila personata* and Long-tailed Finches *P. acuticauda* in savannah woodland in the Northern Territory. *Emu.*

Tidemann, S.C. and Lawson, C. *(in press)*. Breeding biology of the Gouldian Finch (Ploceidae: *Erythrura gouldiae)*, an endangered finch of northern Australia. *Journal of Tropical Ecology.*

Woinarski, J.C.Z. (1990). Effects of fire on the bird communities of tropical woodlands and open forests in northern Australia. *Australian Journal of Ecology* **15:** 1-22.

Woinarski, J.C.Z. and Tidemann, S.C. (1991). The bird fauna of a deciduous woodland in the Wet-Dry tropics of northern Australia. *Wildlife Research* **18:** 479-500.

Woinarski, J.C.Z. and Tidemann, S.C. (1992). Survivorship and some population parameters for the endangered Gouldian Finch *Erythrura gouldiae* and two other finch species at two sites in tropical northern Australia. *Emu* **92:** 33-38.

Fauna Survey Group Contribution No. 16

Survey for the Yellow-bellied Glider *Petaurus australis* at Mount Cole

Russell Thompson*

The purpose of the fauna survey carried out in the Mount Cole area was to confirm earlier reports of the Yellow-bellied Glider *Petaurus australis.* Fifteen people participated at various stages of the survey from both the Fauna Survey Group and the Ballarat office of the Department of Conservation and Natural Resources.

Several areas were surveyed either where the animal was supposedly recorded in the past or in an area that had suitable habitat. Survey techniques used were daylight reconnaissance looking for feed trees and possible nesting hollows, and spotlighting after dark. Spotlighting results are summarised in Table 1. Yellow-bellied Gliders feed on insects, nectar, leaves, berries, eucalypt flower buds and fruits, and the sap of selected eucalypts. The selected eucalypt or 'feed' tree is distinguished by scarring on the trunk. These scars, shaped like an inverted triangle with side length 5-10 cm, are made when the creature bites through the cambium layer to reach the sweet sap below. When the incision becomes plugged the Yellow-bellied Glider makes a new one on the same tree. Therefore, some of the older trees have several dozen incisions made over a period of time. It is not known how the Yellow-bellied Glider selects its specific tree which may be one of many of the same species in the same area.

The central point of the survey was located at the Victoria Mill Scenic Reserve, where the camp site was situated. The reserve is 6.5 km north of Mount Cole - map reference Buangor North 1:25000, 73° 2' N , 92° 6' E.

Survey

The survey was done in three stages.

The first stage examined 3 sites, 23-24 May 1992.

Site 1, Chinaman Creek Road Area - 2 km north west of the Victoria Mill. No clear traces of feed trees were found in this area. It is an area of tall open dry forest, dominated by *Eucalyptus globulus* ssp. *bicostata, E. viminalis, E. melliodora* as well as one or two other unidentified *Eucalyptus* species. The understorey was mostly open, with *Acacia* spp. in patches.

Table 1. Spotlighting Results

Species	Stage 1	Stage 2	Stage 3
Sugar Glider *Petaurus breviceps*	1		
Mountain Brushtail Possum *Trichosurus caninus*	2		6
Common Brushtail Possum *T. vulpecula*		1	3
Brushtail Possum *(species unidentified)*	2		
Common Ringtail Possum *Pseudocheirus peregrinus*		2	1
Koala *Phascolarctos cinereus*	4		1
Swamp Wallaby *Wallabia bicolor*			5
Eastern Grey Kangaroo *Macropus giganteus*	4		
*Sambar Deer *Cervus unicolor*			1
Australian Owlet-nightjar *Aegotheles cristatus*	1		
Tawny Frogmouth *Podargus strigoides*		1	
Southern Boobook Owl *Ninox novaeseelandiae*			1
Laughing Kookaburra *Dacelo novaeguineae*		2	
Grey Fantail *Rhipidura fuliginosa*			1
**introduced*			

* 10 Nokes Court, Montmorency, Vic. 3094

Some hollow-bearing trees were present but most of the larger, older hollow-bearing trees here had been ring-barked in 1949 for forestry purposes.

Site 2, Sandy Pinch Creek - 1 km south-west of the Victoria Mill. Some large trees were seen in this area but there was no clear evidence of Yellow-bellied Glider feed trees.

Site 3, Long Gully Road Area - 3 km south-east of the Victoria Mill, 1 km south of the T.V. tower. Large specimens of *E. viminalis* and *E. obliqua* were found in this west gully site, together with a range of understorey trees and shrubs. There were a few hollow trees but no evidence of feed trees.

An area of the Buckingham Creek Road and Ridge Track Circuit was spotlighted. This covered the area 500 m to 2.5 km north-west of the Victoria Mill. The spotlight circuit was a 5 km one-way round trip. Animals detected included the following: one Australian Owlet-nightjar *Aegotheles cristatus;* one Sugar Glider *Petaurus breviceps;* two Mountain Brushtail Possums (Bobuck) *Trichosurus caninus;* two other Brushtail Possums were spotlighted, their identification was uncertain; four Koalas *Phascolarctos cinereus;* four Eastern Grey Kangaroos *Macropus giganteus.* At the lower west end of Buckingham Creek Road, a heavily scarred *E. viminalis* was seen on the edge of the road. The tree was virtually covered by scars, mostly old healed-over ones but there were some fresh lesions. The latter were 2-5 cm in diameter but not deep enough to expose the cambium layer. These lesions were attributed to the work of Sugar Gliders *Petaurus breviceps* since one was seen nearby and the lesions were markedly different from those produced by the Yellow-bellied Glider *P. australis.*

The second stage of the survey examined 3 more sites, 18-19 August 1992. **Site 4,** Philopson Creek - 3 km north-east of Victoria Mill and **Site 5** - Little Wimmera River area. These two sites had much the same structure and floristics. Both contained many large hollow-bearing trees and were tall open dry forest areas with little understorey above 1.5 m. *E. viminalis, E. melliodora* were dominant with other unidentified *Eucalyptus* species scattered about. There were no traces of Yellow-bellied Gliders at either of the above sites. A skeleton of a Wedge-tailed Eagle *Aquila audax* was found in the Little Wimmera River Area.

Site 6 - 1 km west of the Lower Wimmera picnic area, 4.5 km south-east of the Victoria Mill. A small area was surveyed on the southern side of the Wimmera River. The area formed a tall open forest of *E. globulus* ssp. *bicostata, E. viminalis, E. radiata* with some *E. obliqua.* Some hollow-bearing trees were present but no traces of Yellow-bellied Glider was seen. A Peregrine Falcon *Falco peregrinus* was observed here.

A 3 km stretch of the Dyer Track was spotlighted starting from the Little Wimmera Picnic area. This track runs parallel to the Litttle Wimmera River on the east side of site 2. The results included: one Common Brushtail Possum *Trichosurus vulpecula;* two Common Ringtail Possums *Pseudocheirus peregrinus;* one Tawny Frogmouth *Podargus strigoides;* two Laughing Kookaburras *Dacelo novaeguineae.*

The third stage, 27-28 March 1993, looked at one site.

Site 7 was an area 1-2 km north-east of the Victoria Mill starting where Water Race Road crossed Hickman Creek down to the McGee Track intersection, a distance of 1.5 km. The area was tall open semi-dry forest where *E. obliqua, E. globulus* ssp. *bicostata* were dominant. There were few hollow-bearing trees and no traces of Yellow-bellied Glider feed trees. A small unidentified snake was seen and a Brushtail Possum was disturbed in broad daylight. A Swamp Wallaby *Wallabia bicolor* and three Echidnas *Tachyglossus aculeatus* were also seen at this site during the day.

As in the first stage of the Mount Cole

Survey the Buckingham Creek Road and Ridge Track Circuit were spotlighted and the following were observed: one Koala *Phascolarctos cinereus;* one Ringtail Possum *Pseudocheirus peregrinus;* three Common Brushtail Possums *Trichosurus vulpecula;* six Mountain Brushtail Possums (Bobuck) *Trichosurus caninus;* five Swamp Wallabies *Wallabia bicolor;* one Sambar Deer *Cervus unicolor;* one Southern Boobook Owl (Mopoke) *Ninox novaeseelandiae;* one Grey Fantail *Rhipidura fuliginosa.*

Birds detected in the last stage of the survey included: Wedge-tailed Eagle *Aquila audax;* Peregrine Falcon *Falco peregrinus;* Sulphur-crested Cockatoo *Cacatua galerita;* Long-billed Corella *C. tenuirostris;* Crimson rosella *Platycercus elegans;* Boobook Owl *Ninox novaeseelandiae;* Tawny Frogmouth *Podargus strigoides;* Australian Owlet-nightjar *Aegotheles cristatus;* Laughing Kookaburra *Dacelo novaeguineae;* Pink Robin *Petroica rodinogaster;* Scarlet Robin *P. multicolor;* Grey Fantail *Rhipidura fuliginosa;* White-browed Scrubwren *Sericornis frontalis;* White-throated Treecreeper *Cormobates leucophaea;* Yellow-faced Honeyeater *Lichenostomus chrysops;* Spotted Pardalote *Pardalotus punctatus;* Australian Magpie *Gymnorhina tibicen;* Pied Currawong *Strepera graculina;* Grey Currawong *S. versicolor;* Australian Raven *Corvus coronoides* and a Feral Pigeon *Columbia livia.* A pair of Peregrine Falcons were seen attacking a banded racing pigeon on the side of the Mount Cole Road, halfway between Mount Cole and Raglan.

Discussion

In the final analysis the Yellow-bellied Glider was not detected during the survey of the Mount Cole area. The sites examined covered a relatively small area of potential Yellow-bellied Glider habitat. Other locations in the area warrant further investigation at some stage in the future.

However, a noteworthy discovery was made during the survey. **This area was the most westerly recording to date of the Mountain Brushtail Possum (Bobuck) *Trichosurus caninus.*** The animal was encountered in the wetter, higher altitudinal forest areas, at approximately 600 m and higher. Where found, the animal proved to be relatively common.

Fig. 1. Mountain Brushtail Possum (Bobuck) *Trichosurus caninus.* Photographed at Mount Cole by Andrea Dennis.

A Census of the Plants of Deal Island, Kents Group, for 1884

John Whinray*

Kents Group is in eastern Bass Strait about halfway between Wilsons Promontory, the southernmost part of the Australian mainland, and Flinders Island. Its largest island is Deal, with an estimated area of about 1800 hectares.

Deal is made up of many granite hills and ridges. In the southern half these usually have extensive areas of bare stone with skeletal soils making up the balance. Only in gullies have alluvium and wash formed deep soil. Much of the northern half was covered with limesand that blew up from the bared seabed during the last glacial period. It has weathered from the crests of most of the hills and ridges. However, it also persists on their sides and in some gullies. Limestone has formed from the sand and it outcrops in various spots from Barn Hill, the western point of the island, to above Freestone Bay on its mid-east coast. Areas of bare granite, and skeletal soils, are less common in this half of the island.

The census and its collectors

A census or list of the plants of Deal Island was published in 1885 in the *Papers and Proceedings of the Royal Society of Tasmania.*

> It was laid on the table by Mr Justice Dobson, who enlisted the services of the Superintendent of the lighthouse on the Island, Mr Johnstone, to collect and send him specimens of all plants growing there.

Baron von Mueller identified the specimens and prepared the census[1]. The idea of asking lightkeepers to procure plant specimens was not Dobson's. On 4 December 1881 he concluded a letter to Mueller as follows:

> I have not overlooked your suggestion as to the Lighthouse Keepers collecting & drying specimens of plants & I hope to be able to give effect to it[2].

While the specimens were attributed to a 'Mr Johnstone', all of those found so far at the National Herbarium of Victoria were labelled as collected by Judge Dobson. There was no 'Mr Johnstone'; it was Robert Jackson who was the superintendent at Kents Group from 1878 to the end of 1885, and who continued thereafter as head lightkeeper when the position of superintendent was abolished[3].

It would seem reasonable to infer that Jackson was the collector even though no correspondence of the period survives in the records of his employer[4]. However, his letterbook is held at the Queen Victoria Museum in Launceston. On 9 June 1884 Jackson replied to a letter penned a week earlier by his superior, the Master Warden of the Marine Board of Hobart. In part Jackson's note read:

> Sir, Me and my wife will be only too happy to make a collection of plants such as the island produces and have them ready for forwarding by the next vessel or sooner if possible[5].

As he wrote, the vessel that had brought the post, rations and the lighthouse stores from Hobart was unloading at Deal Island[6]. By referring to the 'next vessel' he meant the stores boat which was due in four months' time. A collection could have been sent earlier, depending on whether a passing vessel had anchored at Kents Group, the only all-weather anchorage of the area, and whether the work had been completed. The list of specimens collected by the Jackson's was tabled by Mr Justice Dobson at the meeting of the Royal Society of Tasmania on 17 November 1884:

> The plants were forwarded to Baron F. Von Mueller, who prepared the census[7].

* Flinders Island. 7255

The collection would have had to travel from Kents Group to Hobart, to have been forwarded to Dobson and posted to Melbourne, to be determined by Mueller and then the list returned to Dobson in Hobart. All of that would have taken at least several weeks. The last stores vessel for 1884 reached Deal Island on 12 October and left the next day. The *S.S. Wakefield* then steamed to Goose Island Lighthouse before reaching Hobart on 16 October[8]. Jackson did not pen a covering note for the collection. He probably addressed the package and included it with the other official correspondence despatched on the vessel. The state of the examined specimens supports the likelihood that they were gathered between June and October.

The lighthouse's lists of employees merely note Jackson as married and having an increasing number of children, eight by 1887[9]. When mentioning his wife in the log book, he always referred to her as 'Mrs Jackson'[10]. Fortunately they married in Tasmania and the record shows that in January 1869 Mary Anne Willett was a spinster, eighteen years old, when she wed the mariner Robert Jackson who was thirty-four. At that time she was unable even to sign her own name and so all there is to show of her hand are the two crosses that she made on the register[11]. Her lack of education sets her apart from the usual female collectors who worked in Australia during the Nineteenth Century[12].

At the meeting during which the census of Jackson's records was tabled, a list was given of presentations to the Tasmanian Museum. The items under 'Minerals, etc.' included 'A collection of Marsupial bones and pumice stone, etc., from Deal Island, Kent's Group, Mr Johnston.'[13] The collection, of which that sentence is the only trace, was certainly also the work of Robert and Mary Anne Jackson. Why would the Jacksons have sent those specimens to Hobart?

In December 1883 they helped the crew of a yacht that included the Kents Group in its cruise. The supply vessel of June 1884 which brought to Deal Island the request for plant specimens, also supplied a copy of the account of the cruise ship which had been published almost five months before in *Australasian.* The relevant section read as follows:

> A naturalist would be interested by the discovery [on Deal Island] of vast quantities of bones and eggs, seemingly in perfect preservation, but which crumble to impalpable dust so soon as touched, in a rift caused by great rains, and also by some singular specimens of vegetation to be found on the group[14].

The first comment might have prompted the Jacksons to send a collection from the site with their plant specimens. The final section might have reminded Dobson of his remarks of December 1881, quoted above, about obtaining plant specimens from Lighthouse Keepers, and have resulted at last in his requesting the plant specimens.

The Jacksons plant records

Whilst it is pleasing to give Mary Anne Jackson, and her husband, their due as plant collectors more than a century after their work was done, it is unfortunate that the published list is the only complete record of their gathering. So far, nineteen of their fifty-nine specimens have been searched for at the National Herbarium of Victoria but only eleven of these could be found.

Their most interesting plants were the Banded Greenhood *Pterostylis sanguinea* and the Spicy Everlasting *Ozothamnus argophyllus.* The collections were the first Tasmanian records of these Australian mainland species and both specimens are held at the National Herbarium of Victoria. The greenhood has since been found on seven other islands in Banks and Bass Straits but is not yet known from the Tasmanian mainland. While the everlasting has been found on six more islands in Banks and eastern Bass Straits, it too has not so far been recorded on mainland Tasmania.[15]

Five of their plants remain the only

records ever made for Deal Island. These are the Spicy Everlasting *Ozothamnus argophyllus,* the orchid Pink Fairies *Caladenia latifolia,* the Common Everlasting *Chrysocephalum apiculatum,* the Veined Helmet-orchid *Corybas diemenicus* and the Pale Turpentine-bush *Beyeria lechenaultii* [16].

In 1872 Canon Brownrigg used Tasmanian common names when noting the Mangrove *Myoporum insulare* and the Boobialla *Acacia sophorae* on the steep slope at the head of Browns Bay on Deal Island[17]. The Jackson's collection of the Boobialla was both the second and last record of it for the Kents Group. The Musk Daisy-bush *Olearia argophylla,* which they found for the first time on Deal, was finished off by the severe bushfire of December 1972. While neither their specimen nor the one obtained by the F.N.C.V.'s expedition in 1890 has survived, mine taken in 1970 is extant. It is held at the State Herbarium in Adelaide and the Australian National Herbarium in Canberra.

Of the thirty shrubs and trees collected by the Jacksons, only the four mentioned above no longer grow on Deal Island.

A Census of the plants of Deal Island, June to October 1884

A list of Jackson's records, with the names brought up-to-date, is given below in the order of publication of 1885. Only four of them require any discussion.

Their Brown-top *Eucalyptus obliqua* is, I believe, a mis-determination probably caused by inadequate material. I have combed Deal, and nearby Dover Island too, without finding anything except the Shining Peppermint *Eucalyptus nitida.* As well, the Brown-top is not known from anywhere else in the Straits. So the Shining Peppermint is given instead on the list.

The Bulrush *Typha angustifolia* is given as *Typha* sp. as there is no specimen from Deal Island. I recorded but did not collect Bulrushes in lower Forest Creek in 1970.

The name used for one of their collections of Everlasting species was *Helichrysum ferrugineum.* It is now known as *Ozothamnus ferrugineus.* As there is no specimen of it, but there is one of *Ozothamnus argophyllus,* the latter is listed.

Mueller used the name *Aster stellulatus* for the Jackson's collection of a Daisy-bush and also for a collection taken in 1890 by the F.N.C.V.'s expedition. These are the only records ever made at Kents Group of the Star Daisy-bush *Olearia stellulata.* No other small Daisy-bush was collected in either 1884 or 1890[18]. Only two small species have otherwise been found on Deal Island: the Dusty Daisy-bush *Olearia phlogopappa* and the Coast Daisy-bush *Olearia axillaris.* The latter species, which has not been recorded for Kents Group since 1803, has leaves that are too narrow to have been mistaken for those of the Star Daisy-bush. However, the Dusty Daisy-bush does have leaves similar to those of the Star Daisy-bush. It was first found on Deal in 1803, where it still grows, but is also found on Erith and Dover Islands. So I assume that Meuller used the name *Aster stellulatus* broadly enough to include the Dusty Daisy-bush. The latter is, accordingly, listed in its stead[19].

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Dr J. H. Ross kindly looked up some of the Jackson's specimens at the National Herbarium of Victoria. Mrs Rhonda Hamilton, of the Queen Victoria Museum, kindly shewed me Robert Jackson's letterbook. Many people and institutions have helped with my trips to Kents Group. Of particular note were Miss Maureen Christie, the late Lord Talbot de Malahide, the late Mr George Swallow, and the Australian Geographic Society.

References

1. *Papers of the Proceedings of the Royal Society of Tasmania* 1885 (1884): 282-283.
2. W. L. Dobson to Baron von Mueller, 4 December 1881, RB MSS M1, National Herbarium of Victoria, Melbourne.
3. A marginal note on Robert Jackson to Master Warden, 10 February 1887, Correspondence with ......lighthouse keepers, Marine Board, MB 2/5/8, Archives Office of Tasmania, Hobart; Log book kept at Kents Group by Robert Jackson, MB 2/52/4 and MB 2/52/5, AOT; Letter book on lighthouse matters,

MB 2.32.2, page 124, 31 December 1885, AOT.

4. The letter books on lighthouse matters are extant from November, 1884, MB 2.32.2. The first letter to Kents Group is dated 9 February 1885.
5. Item 1965/79/15, Archives of the Queen Victoria Museum, Launceston.
6. Log book kept at Kents Group ..., MB 2/52/5, 9-11 June 1884.
7. *Papers of the Proceedings of the Royal Society of Tasmania* 1885 (1884): xcii-xcvi.
8. Log book kept at Kents Group ..., MB 2/52/5, 12 & 13 October 1884; Hobart Mercury, 17 October 1884, page 2, c. 1.
9. Lighthouse returns of men employed, MB 2/20/2, pp 136 & 137, AOT
10. For example the entry on 5 December 1885 in Log book kept at Kents Group ...... MB 2/52/5.
11. Registrar General's Department, RGD 1, No. 1 of 1869, AOT.
12. Five pertinent chapters, including Ann Moyal, Collectors and Illustrators ...., 333-356. *In* 'People and Plants in Australia'.(1981) Eds D.J & S.G.M. Carr. (Academic Press: Sydney.)
13. *Papers of the Proceedings of the Royal Society of Tasmania* 1885 (1884): xciv.
14. Letter book of Robert Jackson 13 June 1884, 1965/79/15, page 48, QVM; 'Cruise of the Janet' by Australian, Australasian 19 January 1884, page 78, c.2.
15. Specimens for Dover, Flinders, Cape Barren, Kings, Clarkes and Badger Islands are held at MEL, HO & CANB. My material from Erith Island, November 1992, shall be dispatched to MEL. Samples of the everlasting from Dover, Erith, Flinders, Babel and Cat Islands are held at MEL, HO, AD & CANB. I recorded it on Storehouse Island in 1967.
16. The following sources are used here and in later comments about the occurence of plants at Kents Group: Robert Brown's specimens of 1803 (British Museum and Kew) and his 'Primitiae Florulae....Kents Group....1803, British Museum, Brown MSS 10, folios 124-134, London; Allen's few specimens for 1878 (NSW & HO); D. Le Souef (1891). Expedition of the Field Naturalists' Club to Kent Group, Bass Straits. *The Victorian Naturalist* **7**: 121-131; A.H.E. Mattingley's specimens of 1937 (MEL); Colin Garreau (1958). Holiday Excursion in the Kent Group. *The Victorian Naturalist* **75**: 128-130, and lists of his collections in letters penned to him by J.H. Willis. Not even one of Garreau's tiny samples was retained at MEL; Dr Mary Gillham's list for Deal Island, 16 March 1959, Library, CSIRO Division of Wildlife Research, Canberra; and my field notes and specimens of fourteen visits between December 1969 and January 1993. My specimens to 1988 are at MEL, AD, CANB, NSW, HO.
17. Canon Brownrigg (1972). 'The Cruise of the Freak.......' (Launceston), pp. 39, 40.
18. *Papers of the Proceedings of the Royal Society of Tasmania* 1885 (1884): 282-283; *The Victorian Naturalist (1891)* **7**:121-131.
19. Robert Brown collected and recorded the two species in 1803: Robert Brown's specimens of 1803 (British Museum and Kew) and his 'Primitiae Florulae....Kents Group....1803, British Museum, Brown MSS 10, ff 124-134, London.

Species list for Deal Island, Kents Group, for 1884

Clematis microphylla DC.
Bursaria spinosa Cav.
Comesperma volubile Labill.
Geranium solanderi Carolin
Zieria arborescens Sims
Correa reflexa (Labill.) Vent.
Beyeria lechenaultii (DC.) Baill.
Phyllanthus gunii J.D. Hook.
Allocasuarina monilifera (L. Johnson) L. Johnson
Tetragonia implexicoma (Miq.) J.D. Hook.
Carpobrotus rossii (Haw.) Schwantes
Stackhousia monogyna Labill.
Pomaderris apetala Labill.
Pultenaea daphnoides Wendl.
Goodia lotifoli Salisb.
Swainsona lessertiifolia DC.
Acacia mucronata Willd., ex H.H. Wendl.
Acacia sophorae (Labill) R. Br.
Acacia verticillata (L'Her.) Willd.
Acaena novae-zelandiae Kirk
Calytrix tetragona Labill.
Leptospermum scoparium J.R. & G. Forster
Leptospermum laevigatum (Sol. ex Gaertner) F. Muell.
Eucalyptus nitida J.D. Hook.
Melaleuca ericifolia Smith
Kunzea ambigua (Smith) Druce
Pimelea linifolia Smith
Banksia marginata Cav.
Olearia argophylla (Labill.) Benth.
Olearia phlogopappa (Labill.) DC.
Ozothamnus argophyllus (A.Cunn. ex DC.) A. Anderb.
Ozothamnus turbinatus DC.
Chrysocephalum apiculatum (Labill.) Steetz
Senecio lautus G. Forster ex Willd.
Leucopogon parviflorus (Andrews) Lindley
Cyathodes juniperina (J.R. & G. Forster) Druce
Epacris impressa Labill.
Stylidium graminifolium Swartz
Goodenia ovata Smith
Alyxia buxifolia R. BR.
Myoporum insulare R. Br.
Callitris rhomboidea R. Br. ex Rich.
Caladenia latifolia R. Br.
Pterostylis sanguinea D. Jones & M. Clements
Cyrtostylis reniformis R. Br.
Corybas diemenicus (Lindley) H.G. Reichb.
Dianella revoluta R. BR.
Typha sp.
Juncus pallidus R. Br.
Luzula meridionalis Nordensk ssp. *flaccida* (Buchenau) Nordensk
Lepidosperma gladiatum Labill.
Gahnia trifida Labill.
Austrofecstuca littoralis (Labill.) E. Alexeev
Spinifex sericeus R. Br.
Microsorum pustulatum (F. Forster) Copel.
Asplenium obtusatum G. Forster
Pellaea falcata (R. Br.) Fee
Pteridium esculentum (G. Forster) Cockayne
Brachyscome diversifolia (Graham ex Hook.) Fischer & C. Meyer var. *maritima Benth.*

Bees and Native Insects Associated with Leatherwoods (*Eucryphia* spp.) in Tasmania

G. Ettershank*

In 1989, my wife and I were employed by the Forestry Commission Tasmania, funded by the National Rainforest Conservation Programme. We were to find out what insects were associated with the flowers of Tasmania's premium honey-producing plant, the leatherwoods (*Eucryphia* spp.). Our brief also included determining how many insects used the flowers, and to resolve if the insects were affected by introduced honeybees. In a second season we were employed to look at flower phenology and nectar quality. Our results are reported in full elsewhere (Ettershank and Ettershank 1992); the following is a brief summary with some unreported side comments!

Eucryphia lucida is the major species used by the Tasmanian beekeeping industry. Other plant species in lowland areas provide some nectar earlier in the season. This enables build-up of hives for the main crop, leatherwood honey. Total honey production in 1987-88 was 801 tonnes, returning $1.3 million; 61% of this was leatherwood honey (Australian Bureau of Statistics). Of equal importance, the hives are built-up on the leatherwood resource to be used for pollination services in fruit orchards and other crops in spring.

The domesticated honeybee, *Apis mellifera* L., was introduced to Australia by the early colonists, and it is fairly certain that it was soon feral. It has since become widespread in Australian bushlands. Whether it affects native insects or the pollination biology of native plants has been widely debated, but there has been little scientific work addressing these questions.

The genus *Eucryphia* has a Gondwanan distribution, with three species in South America, one in NSW, one in northern Queensland and two in Tasmania. Of the Tasmanian species, *Eucryphia lucida* is a small tree reaching 15-25 m, and is found as an understory species in thamnic and implicate temperate rainforest and mixed forest from sea-level to the central plateau (elevation about 1000 m.). *Eucryphia milliganii* is usually a shrub or a small tree up to 15 m high, occupying a similar niche in higher altitude communities (it also occurs in isolated patches at lower altitudes, where it is a small tree). Both species require high rainfall and are intolerant of repeated fire. The two species are sympatric at some locations and there appears to be some hybridization (Neyland and Hickey 1990). The flowers of the leatherwood are simple, white with a red to brown spray of anthers in the centre. Although a few flowers can be found at almost any time of year, flowering is most profuse in summer, when the trees are literally covered with a white blanket of flowers.

Tasmanian rainforests support a great diversity of arthropods (insects, spiders, mites and their kin). This includes a high proportion of endemic species. Both the fauna and flora evolved in the absence of the honeybee, *Apis mellifera.* Thus it was of considerable biological interest to investigate the possible interactions between the native fauna and the recently (*circa* 200 years) introduced honeybee.

To determine the species present, we collected only arthropods that were actually in the flowers. These were later mounted and labelled and sent off for identification to various experts on the many groups. To our considerable surprise, there were 133 species of arthropods associated with the flowers, where a mere half dozen had been known before. Table 1 shows the distribution among the various orders.

Finding out how many insects used the flowers presented a considerable problem. Originally we had intended to use ladders and count insects directly. This proved a

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failure, due to the disturbance of the insects when erecting the ladder and the precarious nature of the task when balancing on a ladder placed on the insubstantial forest floor.

Instead, we counted insects using 10X50 binoculars, on 100 flowers, from a distance of approximately 10 to 20 m. Trees were selected that we judged carried enough flowers to allow the 100 flowers to be examined on one tree; occasionally, further flowers on an adjacent tree had to be examined to make up the 100 flowers. The same tree was not necessarily used in successive counts. Only flowers where there was a clear view of the whole flower were examined.

We adopted this method of censusing insects using binoculars as the only practical way to sample insects over the entire canopy and without disturbance. The method was relatively quick - a tree could be assessed in five minutes or less - so movement from flower to flower by insects was minimised.

We selected sites on the coast, at Cockle Creek in the south and on the Gordon River in the west, both away from beekeeping sites. In the highlands, we chose sites near to and away from managed hives. When we analysed the 41 sets of data we obtained by our counts, the results were again rather surprising.

When we compared lowland sites and highland non-beekeeping sites, there were statistically significantly more native insects and honey bees on the lowland sites. That there should be more native insects could be expected - the climate is milder and the flowering season longer. The greater usage by honeybees compared to highland sites was a puzzle - these were feral bees. In fact, the highest usage by honeybees was at our site up the Gordon River, 25-30 km from the nearest beekeeping site, far outside the flight range of hive bees.

Comparing highland non-beekeeping and beekeeping sites, there was no significant difference between the number of native insects in the two areas, but there were, not surprisingly, significantly more bees in the beekeeping sites. However, usage was low, averaging only a couple of bees and half a dozen native insects per hundred flowers! At no time did we see any aggression or interference between any species (Ettershank & Ettershank 1992).

Table 1. Conspectus of species collected.

Class Insecta		
	Orthoptera	1
	Hemiptera (est)	5
	Thysanoptera	3
	Neuroptera	1
	Coleoptera	38
	Diptera	39
	Lepidoptera	5
	Hymenoptera	31
Class Arachnida		
	Araneae	9
	Acarina	1
	Total	133

At the end of our first season, we seemed to have some interesting results and a couple of rather bizarre conclusions. For example, we had noticed that if bees had access to any other flowers at all, they would forage on them in preference to leatherwoods - we once saw bees flying a holding pattern waiting to forage on a lonely Scotch Thistle in flower, while thousands of nearby leatherwood flowers had scarcely a bee on them, despite the strong smell of leatherwood nectar. Perhaps leatherwood was not a very good food source for bees? Honey yields from the apiaries are quite high, but perhaps the bees gather leatherwood nectar as there is nothing else available most of the time in the Highlands in summer. Certainly there are usually plenty of leatherwood flowers - a large tree can have as many as 3000 flowers.

The following season we set out to get more data on the plants themselves. We laid out four transects to determine the number and flowering pattern of the trees and set out to learn more about the pattern of flowering and seed set. Some flowers were covered with insect-proof bags at the bud stage to see if they had to be insect pollinated to set seed. We sampled large numbers of flowers to determine nectar quality. We also captured bees leaving and returning from hives to see what and how much nectar they carried back to the hive.

Our transects showed that in the various forest types, there were between 500 and 1400 leatherwoods per hectare, but only 20-30% of these flowered, that is only the taller, emergent trees or those exposed to sunlight by edge effects in clearings. Most trees were small, with only a few large ones.

We were able to define the stages of flowering. Flowers are initially male, then become receptive (female). We found that nectar was available from both stages of the flower, for an average of thirty days.

Buds covered with insect-proof bags did indeed set seed, which germinated as well as other seed. These seeds may have been self pollinated, or could have received pollen falling from flowers higher on the tree.

The data on nectar quality were most interesting. Nectar was removed from single flowers using micro-pipettes, then the sugar content determined with a refractometer. Male flowers on average yielded 15 microlitres of nectar (15.6% sucrose), female flowers 5.7 microlitres (18.1% sucrose). Although there is a fair volume of nectar, its sugar content is rather low compared to other Australian native plants (Table 2), and very low when compared with exotic, domesticated plants (Table 3).

We sampled hive bees as they left or arrived at the hive by catching them and storing them over dry ice. In the lab, they were weighed, dissected and their honey and pollen loads determined. On average, the nectar load was 28.2 mg, and pollen load 3.6 mg. The sugar concentration of the nectar exceeded 62% (the upper limit of the refractometer) except in a very few cases (53%, 57%, 59%). There was no correlation between the weight of the bees and the nectar loads. Of the two days sampled, on the first the nectar smelled and tasted of leatherwood; on the second day, it was clear that the bees were bypassing leatherwoods to feed on flowering eucalypts!

Honeybees have clear preferences for foraging. Kevan and Baker (1983) report that bees will not fly until the temperature exceeds 10°C. They also cannot taste sucrose below 10% concentration, setting a lower limit on their feeding. This has energetic implications - bees use 10-11 mg of sugar per hour in flight, so foraging on dilute nectar would result in a negative energy flow to the hive (Kevan and Baker 1983). Free (1970) estimates that the energetic cost of evaporating water from nectar below 20% sucrose is greater than the energy value of the honey produced.

Bees also prefer closer sources to more distant ones - bees can make several trips per hour to sources 2-3 km away, but only one if the source is 14 km away. It is interesting to look at the time and energy invested in making honey from clover. One pound (450 g) of white clover honey represents 17330 foraging trips, 8.7 million flowers at 500 flowers per trip of 25 minutes, and 7221 bee hours of labour (Kevan and Baker 1983).

Leatherwood nectar is clearly a marginal food source. Bees seem to use it if they have to (which is most of the time) but prefer other sources of nectar.

We concluded, from this study, that:

- there is no evidence of adverse effects of current beekeeping practices on the native fauna associated with leatherwood flowers
- managed hives do not appear to increase competition with native insects for nectar on leatherwood flowers.

Obviously, the data from this study apply only to the insects associated with leatherwoods - extrapolation to other species would be imprudent.

References

Ettershank, G. and Ettershank, J.A. (1992). 'Tasmanian Leatherwoods (Eucryphia Spp.) - Floral Phenology and the Insects Associated with Flowers.' Tasmanian NRCP Technical Report No. 11. Forestry Commission, Tasmania, and Department of the Arts, Sport, the Environment and Territories, Canberra.

Free, J.B. (1970). 'Insect Pollinators of Plants.' (Academic Press; London and New York).

Kevan, P.G. and H.G. Baker. (1983). Insects as flower visitors and pollinators. *Annual Review of Entomology* **28:** 407-453.

Neyland, M and J. Hickey. (1990). Leatherwood silviculture - implications for apiculture. *Tasforests* **2(1):** 63-72.

Table 2. Nectar produced by some Australian plant species (from various authors). Numbers in the body of the table give the volume of nectar per flower in µl and sucrose concentration (%). This information is drawn from a number of sources all of which are acknowledged in Ettershank G. and Ettershank J. A. (1992).

Species	March	June	Sept	Dec
Adenanthos argyrea			4.1(30.4)	1.3(27.8)
A. cygnorum	0.7(22.3)	0.5(7.0)	7.0(21.7)	
Anigozanthos humilis			7.0(21.7)	
Banksia attenuata				100.2(15.5)
B. prionotes	67.8(18.2)	16.0(16.1		
Calothamnus quadrifidus		5.8(26.7)	5.0(25.4)	
C. sanguineus		0.9(25.7)		
Dryandra carduacea			17.4(27.9)	
D. sessilis		27.1(22.5)	43.5(25.2)	
Eucalyptus drummondii		0.5(21.1)	9.6(23.8)	
E. macrocarpa				82.0(12.0)
E. wandoo		1.1(20.7)		

Table 3. Nectar produced by various exotic plant species. Numbers in the body of the table give the volume of nectar per flower in µl and sucrose concentration (%). This information is drawn from a number of sources all of which are acknowledged in Ettershank G. and Ettershank J. A. (1992).

Species	Volume µl	Concentration % sucrose
Rape	8.16	32
	10.05	39
White clover	4.2-9.9	37-44
Cotton spp.	8.0	34
	30-50	26
	12.0	24
Citrus spp. Young flowers	#	13-17
Older flowers	#	31
Alfalfa	0.34-1.04	31
	0.24-1.28	38-51
Vetch	1.2	55
Beans	#	42.59
Lupins	#	19-34
Sweet clover	#	22-52
Black currant	1.22-2.35	25
	4.4	23
Gooseberry	1.22	34
Blackberry	3.5-5.4	28-31
Apple	2.76-6.01	25-55
Apricot	5.1	5-25
Peach	#	20-38
Pear	0.8	2-37
Plum	0.9-1.65	10-40
Sour cherry	0.76-2.2	15-40
Sweet cherry	3.6	21-60

Volume of nectar not reported

Fish Need Trees

J. D. Koehn*

In most considerations of the conservation of terrestrial vertebrates, some assessment is made of vegetation, and trees in particular, as a major form of habitat and an environmental component which is essential for their survival. The loss of this habitat component (both alive and dead) is often cited as a cause for the demise of many species and its general ecological importance is regularly emphasised. It is often cited as vital for particular species (eg. Leadbeater's Possum) and included in management plans (Macfarlane and Seebeck 1991).

Unfortunately, due to their hidden nature, there is a general lack of understanding of the attributes which are important to aquatic ecosystems. However, as with terrestrial vertebrates the primary cause of decline of fish species is habitat alteration and degradation (Koehn and O'Connor 1990a) and like terrestrial vertebrate habitat, fish habitat also includes trees and other vegetation, both in the water (living and dead) and on the surrounding land. Aquatic ecosystems are dependent on this vegetation for their well-being. Trees and other woody debris are generally known by the term 'snags' when they are found in rivers and are an important habitat attribute since there are many specific examples of fish which need to utilise such snags. For example they can provide spawning sites for many species like Murray Cod *Maccullochella peelii*, which have adhesive eggs that they lay on hard surfaces such as submerged trees (Cadwallader and Backhouse 1983). Freshwater Blackfish *Gadopsis marmoratus* lay their relatively small number of eggs in the safety of hollow logs (Jackson 1978). If such spawning sites are not available then the successful reproduction of the species may be under threat.

Some fish species prefer to live in and around trees which are in the water and their numbers can often be directly related to the amount of available habitat. For example, numbers of Freshwater Blackfish have been positively correlated with the amount of wood debris in the stream (Koehn 1986). In a more general sense, fish need such objects in a stream in order to avoid predators, sunlight and fast water velocities, and to maintain their position in the stream by using the object as a marker which may also designate a territory.

Objects such as snags in a stream also create a diversity of habitats. They vary the depth and water velocity within a stream by re-directing the water flows so that gutters, holes and pools are created and aggregations of woody debris build up around them. This diversity of habitat provides for the needs of the various species and ages of the fish present. Snags also provide attachment sites for stream invertebrates which process organic matter and form an important link in the food chain. They are particularly important habitat attributes in deeper, lowland streams where the substrates are generally made of finer particles, are more uniform, and provide less suitable habitat than upland streams.

The source of trees which provide such vital functions within a river system is the riparian vegetation zone along the river banks and most snags in the stream originate from this zone. This vegetation zone also performs a wide variety of other functions including the obvious example of harbouring terrestrial invertebrates which can form a major dietary component for many fish species. A very important but less obvious function is that of providing organic matter from vegetation such as leaves, bark, twigs, etc. This

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organic material forms the major energy input to the aquatic ecosystem, particularly in upland streams (Hynes 1970). It is processed by a variety of microbes and stream invertebrates which allow such energy to be passed up the food chain and the trapping of such organic material amongst trees and wood debris in the stream allows additional time for processing.

The shading of the stream by bank vegetation is another important function. As fish and aquatic invertebrates have no control over their body temperature, the metabolism of the ecosystem is primarily a function of the water temperature. In summer, high temperatures combined with low flows and lowered oxygen levels can produce water conditions unsuitable for fish. Stream shading can assist substantially in buffering against high temperatures.

The erosion of river banks and surrounding land and the subsequent sedimentation of stream beds poses a major threat to our rivers (Koehn and O'Connor 1990b). Sedimentation can cover or fill many of the habitat attributes usually present and needed by fish (logs, pools, boulders, etc.) and may smother spawning sites and eggs. The loss of vegetation within the catchment from general land clearing, forestry operations and agriculture have also increased the amount of sediment in streams. The root systems of bank-side vegetation are important for holding stream banks together, preventing bank erosion and providing in-stream cover. This vegetation also acts as a buffer against surrounding activities and helps to filter sediment, herbicides, pesticides and other chemicals which may be in the run-off from surrounding land.

Catchment vegetation also affects the amount of water available to streams. The amount of run-off from the catchment is dramatically increased when the vegetation in that catchment is removed. After this initial increase, run-off is likely to be severely decreased for a long period (up to 35 years) as vegetation regrowth occurs (O'Shaughnessy and Jayasuriya 1991). Decreased stream flow can lead to decreased fish habitat areas (see Tunbridge 1988). Acting as a sponge, surrounding vegetation can also slow sudden run-off to allow it to reach the stream in a more constant manner. Land clearing has also been recognised as a major cause for increased salinisation in many areas and the consequent increased stream salinities can lead to areas of water which are unsuitable for fish habitation (Anderson and Morison 1990).

The widespread land clearing which has occurred since European settlement has affected most Victorian river catchments. Such land clearing has often continued up to the water's edge, causing the loss of riparian vegetation. There has also been a widespread loss of snags from within rivers because of the practice of snag removal as a river management procedure. This has often been carried out with little consideration for the environmental consequences and which is even questionable on a hydrological basis (Young 1991). The impact of this process on conservation of aquatic fauna has long been recognised by aquatic biologists and 'The removal of wood debris from Victorian rivers and streams' has recently been listed as a Potentially Threatening Process under the Flora and Fauna Guarantee Act (1988). The loss of snags together with the loss of the surrounding vegetation which could supply replacement snags ultimately leads to a long-term loss of this habitat attribute.

The replacement and protection of riparian vegetation should be made a priority in future revegetation schemes. This task has been recognised and started in some areas but needs to be accelerated in order to reverse damage which has already occurred. The regeneration time for River Red Gums to reach maturity, for example, means that it will be a considerable time before replacement stands can be established. A width of 30 m is most commonly recommended for stream buffers, although this should be increased under adverse conditions (eg. in steep country or with highly erodable soils) (Clinnick 1985). While any vegetation is better than none at all, native endemic plant species have many advantages over introduced plants. Our native stream invertebrate fauna has evolved to process native vegetation, and native vegetation generally provides a constant supply of organic matter rather than the 'feast or famine' supply from introduced deciduous trees. Native hardwood trees can also provide long-term in-stream habitats, and often have branch hollows which can be used as habitat and spawning sites. Some introduced plant species such as willows can also cause problems by overgrowing streams and causing blockages.

Trees and other native vegetation play a vital part in the well-being of fish populations and it is essential that aquatic ecosystems be given consideration in vegetation management.

References

Anderson, J.R. and Morison, A.K. (1990). Environmental consequences of saline groundwater intrusions into the Wimmera River, Victoria. *Journal of Australian Geology and Geophysics* **11:** 233-52.

Cadwallader, P.L. and Backhouse, G.N. (1983). 'A Guide to the Freshwater Fish of Victoria'. (Government Printer: Melbourne.)

Clinnick, P.F. (1985). Buffer strip management in forest operations: a review. *Australian Forestry* **48:** 34-45.

Hynes, N.B. N. (1970). 'The Ecology of Running Waters'. (Liverpool University Press.)

Jackson, P.D. (1978). Spawning and early development of the river Blackfish, *Gadopsis marmoratus* Richardson (Gadopsiformes: Gadopsidae) in the McKenzie River, Victoria. *Australian Journal of Marine and Freshwater Research* **29:** 293-298.

Koehn, J. D. and O'Connor, W. G. (1990a). 'Biological Information for Management of Native Freshwater Fish in Victoria'. (Government Printer: Melbourne.)

Koehn, J. D. and O'Connor, W. G. (1990b). Threats to Victorian native freshwater fish. *The Victorian Naturalist* **107:** 5-12.

Macfarlane, M.A. and Seebeck, J.H. (1991). Draft Management Strategies for the conservation of Leadbeater's Possum *Gymnobelideus leadbeateri*, in Victoria. *Arthur Rylah Institute for Environmental Research Technical Report Series* No. 111. (Department of Conservation and Environment: Melbourne.)

O'Shaughnessy, P.J. and Jayasuriya, M.D.A. (1991). Water Supply Catchment Hydrology Research Status Report 1991. (Melbourne Water.)

Tunbridge, B.R. (1988). 'Environmental Flows and Fish Populations of Waters in the South-western Region of Victoria'. (Department of Conservation, Forests and Lands, Arthur Rylah Institute for Environmental Research: Melbourne.)

Young, W.J. (1991). Flume study of the hydraulic effects of large woody debris in lowland rivers. *Regulated Rivers: Research and Management* **6:** 203-211.

Fig.1. Bankside vegetation is essential for the well-being of a stream.

Fig.2. Trees in streams are an important habitat attribute for fish.

No More Blackberries!

Robyn Watson*

As Jim Willis comments in his talks on Baron von Meuller's life, it is ironic that a man of such vision may be best remembered for the planting of blackberries along tracks across the Great Divide in Victoria. The Baron's vision has left legacies such as the Royal Botanic Gardens, now hailed for their landscape qualities, the protocol for systematic collection and notation of our flora, enabling Victoria, through Jim Willis, to be the first state to publish a comprehensive flora, thus markedly advancing the understanding of the Victorian flora.

If he had known the weedy implications of his resourceful sowing of blackberries for the hungry traveller, the Baron would have been the first to turn back and address the issue. And what would he have done? The question of blackberry control has usually fallen into the 'too hard' basket for so long that this weed has been accepted into our lifestyle in the landscape. And why not? After all, we have had a relatively short history of learning to be colonisers. The European invasion could be described as weedy in itself. In a short snatch of time we have dramatically changed a landscape that had experienced a far slower change under the management of the indigenous people. Learning to control the changes and deciding what changes we have to live with, are issues that span all facets of our society.

We made little progress in the non-chemical control of blackberries until the late 1980's when methodical research came to fruition and the release of a biological control agent became a reality. So far the release of this agent has been promising, with a degree of successful control now established for some varieties (there are at least eight blackberry varieties in Victoria). But just as we learnt with myxomatosis and the rabbits, our manipulation of organisms and therefore, genes, only means we are buying a window of time. Sure enough the blackberries will begin to survive such treatment simply because the rust fungus provides a selection pressure that will promote the resistant strains and they will be the ones to survive. Therefore biological control is a short term holding bay. But are we doing anything else?

In Erica, Central Highlands of Victoria, Alan McMahon, an FNCV member, and his neighbour, Celia, started tackling the blackberry problem on the lower slopes of a steep fern gully flanking a stream on their properties. Here the vegetation type is wet eucalypt forest (Mountain Ash *Eucalyptus regnans,* Mountain Grey Gum *E. cypellocarpa*) with a cool temperate understorey (Musk Daisy-bush *Olearia argophylla,* Hazel Pomaderris *Pomaderris aspera,* Austral Mulberry *Hedycarya angustifolia,* Snowy Daisy-bush *O. lirata,* Rough Tree-fern *Cyathea australis,* Soft Tree-fern *Dicksonia antarctica),* flanked the stream on their boundaries which abut state forest. Each developed their own techniques and both have retained the hallmarks of their approaches adjusting them as they learn to read the responses of the bush.

Both Alan and Celia were faced with the problem of the slopes being completely over-run with blackberry and mature understorey plants emerging under a blanket of blackberry. Both appreciated the role the understorey plays in the ecosystem for the local fauna. Some fauna had learnt to live with the blackberry including the Eastern Whipbird *Psophodes olivaceous,* White-browed Scrubwren *Sericornis frontalis,* Silvereye *Zosterops lateralis,* Brown Thornbill *Acathiza pusilla,* Eastern Yellow Robin *Eopsaltria australis* and Long-nosed Bandicoot *Perameles nasuta.* To eradicate the blackberry in one hit is undesirable as it may in turn eradicate habitat for the local fauna.

* VCAH Burnley, Swan St, Richmond, Vic 3121

Alan clears small pockets by cutting with secateurs and digging up the roots, using a trowel and sometimes pliers. If the space cleared is under mature understorey trees, seedlings germinate and start filling the gap. In other places he plants seedlings of local species, some germinated from seed, others obtained from a local nursery.

Celia also works with secateurs and pliers in a similar way but favours lifting blackberry canes back over the parent plant just before they tip layer. Canes which have been cut off are piled on top of the plant causing the canes underneath to die back through lack of light. Then small understorey seedlings and ferns, including Kangaroo Fern *Microsorum pustulatum*, Bats-wing or Oak Fern *Histiopteris incisa* and Mother Shield-fern *Polystichum proliferum*, establish themselves under the edge of the blackberry and fill this space. The blackberry is then eased further and further back to form an almost dead bundle. This can then be removed and left to decay once the indigenous vegetation has re-established itself. Celia takes a walk regularly with her stake and lifts and pushes back the blackberry. A little bit today means less tomorrow and exercise is integrated into bush regeneration. In four years her fern gully boundary has almost completely recovered.

When faced with a wall of blackberries, Celia cuts a track into a mature tree-fern that is being smothered. The gap that is created by pulling the canes off the tree-fern allows it to start seeding or sporing into the gap made under the blackberry edge. She again pushes back the blackberry edges once young ferns or other indigenous seedlings are established. Alan cuts and pulls up the roots of the blackberries in a mosaic style, leaving areas of blackberries as habitat for the birds that nest and the small mammals that build runs into the blackberry.

Both Alan and Celia have avoided chemical control because of its unknown impact on the fauna eating and living in the blackberries. Instead they are replacing blackberry habitat with the local vegetation so that there is minimal impact on the fauna. Already animal species, such as Swamp Wallabies *Wallabia bicolor* and Pilotbirds *Pycnoptilus floccosus* are coming back into the area.

In the cleared areas, most of the understorey species are coming up from seed. Whether these are from a dormant soil seed bank or from natural seed fall from nearby parent trees, it is not possible to ascertain since the seed banks of these forests are not well studied.

There is little opportunity for seedling establishment exists because the forest floor is turned over by lyrebirds. Indeed, wherever Alan created any gaps the lyrebirds quickly moved in and scratched up his planted seedlings. To overcome this problem strong stakes were placed around the seedlings. A new approach was also used. This involved cutting a hole within the blackberry; planting a seedling that will overgrow the blackberry; keeping vigilant watch to ensure that the seedling is kept blackberry-free and using the blackberry as a 'tree-guard' from the lyrebirds.

For some reason the old adage that weeds are part of life has stuck well with our culture and millions of dollars are spent each year on removing them, whether they be in crops or in the local bush. Weed control is always a big item on the budget of both farmers and public land managers, yet we have been slow to take an innovative approach to deal with this economic problem. Why run up a chronic weed control bill? In medicine we are learning to take preventative approaches; any well run business will always look for ways to reduce overheads. Yet in weed control the support for innovative control measures has always been mediocre. Once the power of chemicals was discovered we have embraced this technology to the full. Chemical control will always be part of the solution for some problems, but there are other ways and everyone can do their part. Alan and Celia were innovative and through hard work and trial and error are now successfully addressing the blackberry issue in their native bush without resorting to chemicals.

Early Spring in the Northern Brisbane Ranges National Park

Gretna Weste*

The northern end of the Brisbane Ranges carries a rich, diverse flora, and is most easily approached from Bacchus Marsh. Reid's Road leads from rolling green hills where sheep and cattle graze, turns a corner and rises abruptly into the dissected plateau of the Brisbane Ranges. The vegetation presents a sharp contrast because the escarpment is covered, not with grass suitable for grazing, but with small twisted, scrubby Stringybarks and a great variety of grey-green sclerophyll shrubs, most of them less than 1 m high. The Ordovician sands are pale-coloured, almost white in parts, shallow, infertile and scattered with rocks. When damp, the ground is rich in lichens, but these are much less obvious when the soil dries out.

Reid's Road becomes Wallace Road from which many tracks lead into the forest. All are labelled, and marked on the maps, so that easy, pleasant walks lead into this most unusual bush. At the end of August in 1993, on an FNCV Botany Group excursion, many of the different shrubs were in flower. The scrubby trees which formed the overstorey were a mixture of Stringybarks *(Eucalyptus macrorhyncha,* Red Stringybark and *E. baxteri* Brown Stringybark), Peppermints *(E. dives* and *E. radiata)* and Ironbark *(E. tricarpa)* with occasional trees of Messmate *(E. obliqua)*, Scent-bark *(E. ignorabilis)*, Long-leaf Box *(E. goniocalyx)* and Snow-Gums *(E. pauciflora)* and in the shallow gullies, Swamp Gum *(E. ovata)*.

Underneath the trees were many Acacias. Indeed the wattle bloom was outstanding, colouring the forest with gold. The Rough Wattle *Acacia aspera* was most common, but there were many shrubs of the Myrtle Wattle *A. myrtifolia,* the Spike Wattle *A. oxycedrus,* the Ploughshare Wattle *A. gunnii,* the Gold-dust Acacia *A. acinacea* and Prickly Moses *A. verticillata.* On the ground grew the Thin-leaf Wattle *A. aculeatissima.* Among the trees the Golden Wattle *A. pycnantha* was prolific and provided both colour and perfume with its large, rich gold balls. Mitchell's Wattle *A. mitchellii* was common here as in the Grampians, its reddish pods proclaiming a much earlier flowering.

Apart from the wattles there were clusters of flowering shrubs along the tracks, such as the Sticky Boronia *Boronia anemonifolia* which grew in bushes from half to one metre high, covered with pink and white star-shaped flowers; the Rosy Baeckea *Baeckea ramosissima,* ablaze with purple-pink Tea-tree like flowers; the Dense Mint-bush *Prostanthera decussata* with violet-blue flowers just appearing. The Common Heath *Epacris impressa* which had been flowering since April, still carried large spikes of white, pink or deep red bells. Flowers were just opening on the Beard Heaths *Leucopogon virgatus* and *L. glacialis,* and on Pink Bells *Tetratheca ciliata.* There were occasional bushes of Common Correa *Correa reflexa* and of the shrubby Platysace *Platysace lanceolata* with pink buds and white flowers carried like tiny umbrellas.

The ground was covered with a variety of plants such as the lovely Blue Orchids *Caladenia caerulea* flowering only a few centimetres above the light grey soil. White Marianth *Rhytidosporum procumbens,* Blue Hovea *Hovea linearis,* a prostrate blue pea, and Honey-Pots *Acrotriche serrulata* with green and white honey-laden bells hidden under the foliage, and Scented Sundew *Drosera whittakeri.* These grow as tiny patches of sparkling red foliage, the leaves covered with sticky tentacles to catch insects, but form large white, scented flowers. Bush-

* Botany School, University of Melbourne, Parkville 3052.

peas carpeted the ground - *Pultenaea pedunculata* and *P. humilis* - but would not flower for another month. The taller Daphne Bush Pea *P. scabra* was almost in bloom. The Bushy Parrot Pea *Dillwynia ramosissima* was in full flower, prickly but obviously grazed. Golden Guinea-flower *Hibbertia prostrata* was also in flower.

Among the large shrubs, the Austral Grass-tree *Xanthorrhoea australis* was prominent on the ridges, and typical of the sclerophyll understorey of open forests in southern Australia. fires had been absent for about 25 years, so these carried full grass skirts. Some were between one and two m in height and hence more than 200 years old. A few had flowering spikes covered with buds of the white lily-like flowers, while others showed the remains of last years spike with beak-like capsules. At intervals Prickly Hakea *Hakea sericea,* covered with pink and white flowers, formed inhospitable barriers to penetration. The endemic Brisbane Ranges Grevillea *Grevillea steiglitziana* was about to burst into flower, and indeed one shrub exposed on the roadside was covered with deep red flowers among the prickly holly-like leaves.

Along parts of the track Grass-trees had died, their coarse, grass-like leaves were a rich cinnamon brown and collapsed in a heap on top of the trunk. The Stringybark trees overhead carried gaunt, dead branches and on the ground, Sedges, Rushes and tussocks of Poa Grass replaced the colourful scented shrubs such as Heaths and Peas. These were areas invaded by the Cinnamon Fungus *Phytophthora cinnamomi,* an introduced, microscopic water mould which spreads often from infested road gravel, or rain water carrying the swimming spores. The spores penetrate the roots causing root rot and later death of many of the Heaths and Peas, and dieback of the Stringybark trees. After walking this infected track all boots and shoes were brushed free of dirt with disinfectant.

One Wallaby and one Koala were spotted among the trees, Crimson Rosellas, White-throated Tree-creepers and Grey Fantails were observed, but doubtless others were frightened by so many *Homo sapiens* on this delightful Spring day. Even the Wolf Spider remained in its hole.

Book Review

A Field Companion to Australian Fungi

by Bruce Fuhrer

Publisher: *Field Naturalists Club of Victoria, Melbourne 1993. Hardcover, RRP $19.95.*

Available from: *FNCV c/- National Herbarium, Birdwood Avenue, South Yarra, Victoria 3141.*

This most sought after book was first published in 1985 and has been out of print for some time. This new edition is a reprint of the original text plus recent name changes as an errata sheet prepared with the assistance of the National Herbarium's mycologist, Dr Tom May. Information includes identification, the natural habitats of fungi, indication of size and whether they are edible or not. The photographs are of superb quality allowing easy identification of 138 of Australia's fungal fruiting bodies. There is also a very useful photographic key to guide the user in the field. All fungi hunters will welcome the re-publication of this book.

Editors

Flying Colours

Common Caterpillars, Butterflies and Moths of South-Eastern Australia

by Pat and Mike Coupar

Publisher: *New South Wales University Press 1992.*
R.R.P. *$19.95 (hardcover)*

Children of my generation knew that the Emperor Gum caterpillars fed on the leaves of the Peppercorn tree and eventually were transformed into a large pinkish fawn moth with conspicuous eye spots on the wings. The more observant ones amongst us suspected that the looper caterpillars that were to be found on cypress hedges turned into the well camouflaged grey moths that sat flat on tree trunks or cement sheeting walls. Ghost moths and Swift moths spent their youth in tree trunks or underground as revealed by protruding exuviae. That was probably the sum of our knowledge. Now, thanks to the painstaking raising techniques and meticulous photo- graphy of Mike and Pat Coupar, we can associate many more caterpillars with their adults.

Flying Colours falls open naturally at Part Two which contains coloured photographs of 67 moth species from 16 families and 23 butterflies from five families including the Skippers. Best represented amongst the moths are the geometrids with 18 species and the noctuids with twelve. It is interesting to speculate why more than half of the moth specimens come from the last three superfamilies of the checklist (Bombycoidea, Sphingoidea and Noctuoidea); are they the most spectacular, easiest to rear, or most common in south-eastern Australia?

Each species occupies a full page with a large colour photograph of the caterpillar and another of the adult in a natural pose. No pinned specimens are used. The remainder of the page contains a common and a scientific name, occurrence data which includes distribution and habitat, notes on the foodplant, and a description of caterpillar, pupa and adult including dimensions and flight period. Each family is introduced with a short paragraph that gives general details and an assessment of the difficulty or ease in rearing specimens. No superlatives are adequate to describe the quality of the photographs.

Even though the coloured plates immediately catch the eye, the text in Part One should not be ignored. There are fairly standard descriptions of life cycle, nomenclature, structure, camouflage, predators and parasites. These provide a completeness for any purchaser who has no other butterfly or moth book. However the strength of this section must be in the finding, collecting and rearing of specimens where the authors reveal their secrets garnered over many hours of frustrating experimentation. Another innovation is the page of caterpillar silhouettes from which it should be possible to distinguish the families represented in the book.

Australia has over 20,000 species of lepidoptera classified into 82 families in 31 superfamilies; five of those families include the butterflies and skippers. Butterflies are well catered for in field guides, specialised texts and picture books but, with so many species to be seen, we will never have enough moth books, particularly in the genre of *Flying Colours*. In this regard Oliver Twist definitely asked the right question.

Congratulations are due to all associated with the production of this volume but especially with the authors who worked hard to produce a surprisingly affordable book on a subject not previously covered in this part of the world. It is highly recommended for the field naturalist, bushwalker and school or municipal librarian. As a reviewer I was pleased to find one typographical error in the index which amused me. Welsh expatriates can search for it after they have digested the information and beauty of the rest of the book.

Ian Endersby

Obituary

Urwin Mackay Bates

Urwin was born at Dobie near Ararat in 1911 and raised on a farm. At the age of 17 years he came to Melbourne and joined the S.E.C. as an electrical operator. After completing a Diploma of Electrical Engineering at R.M.I.T. night school he worked in the Protection Section of the S.E.C.. as a design engineer until his retirement at the age of 60 years.

Retirement gave Urwin the opportunity to enjoy his many interests such as repairing switch toys for the Noah's Ark Toy Library for handicapped children, assisting TOC H in the installation of alarm systems for people at risk living alone. Urwin mended many things for many people and obtained great satisfaction from doing so.

Urwin joined the FNCV in 1976 and was Chairman of the Microscopical Group for thirteen years. He had an inventive mind and was an amateur inventor. His electrical training made him a meticulous operator and all his projects were carefully planned and executed. Urwin conducted lectures at the University of the Third Age on the construction and use of the microscope. Microscopy and Entomology were two of Urwin's many interests.

He took a keen interest in the world around him, particularly all things scientific. Urwin died on 22 June 1993 and showed this interest when he willed his body for the furtherance of medical science. The Microscopy Group has lost a fine Chairman and a good Group member, he will be missed.

Elsie C. Graham

Miss Patricia Carolan

We are sorry to advise members of the death of Patricia Carolan on 21 September 1993. Miss Carolan had been a member of the Club since 1958.

David Howells Fleay

It is with regret that we advise the death of David Fleay on 7 August 1993. He has been a long-time member of the FNCV and wrote many articles for the journal from 1928-1967. He will be especially remembered for his work at Healesville Sanctuary. Our condolences are extended to his family and friends.

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In which is incorporated the Microscopical Society of Victoria
Established 1880

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

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