I.F.F.A
Indigenous Flora & Fauna Association

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President's letter

The Four R's

Revegetation, regeneration, restoration and rehabilitation are terms commonly used interchangeably with little regard to what they actually mean. They are all admirable and have their place in environmental management, yet in reality how we go about achieving them involves different sets of skills, different expectations and very different outcomes.

Revegetation is probably the easiest to describe and the most commonly practiced. Put simply, it is putting desired vegetation into an area where it has been removed. Horticultural skills such as weed control coupled with correct selection, placement and provision of the correct condition for growth of plants are the paramount considerations. The time frames needed to judge success are by necessity long, and may not be achieved in the lifetime of the present crop of practitioners. With present knowledge the usefulness of this method is confined to establishing a limited range of species and extending the boundaries of existing vegetation.

Regeneration, from a purely ecological point of view, is stimulating recruitment to literally restart natural processes within existing vegetation. Young plants replace older plants and the cycle of life continues. While regeneration is a naturally occurring event, in many ecosystems many of stimuli of natural regeneration have been removed and we have to intervene to stimulate regeneration. The skills needed here are much more ecological and decidedly less horticultural. Knowledge of plant and animal biology is critical as is an understanding of processes that stimulate regeneration such as fire and disturbance. Time frames to success are much shorter than for revegetation as the goal is much simpler, young plants or animals coming along to replace older individuals.

Restoration is the Holy Grail to many in our 'field', literally meaning bring back the bush to its original configuration. With so many of our ecosystems radically changed since European settlement and an almost universal lack of understanding of what the original bush was like, there needs to be serious questions asked about the feasibility of this technique. What are the benchmarks for success? How will we know if what we have 'created' resembles what was originally there? The mind boggles at the skills needed to achieve restoration. Are the levels of ecological, taxonomic and horticultural knowledge even obtainable?

This brings us to *Rehabilitation*, essentially restoration with a different endpoint. Rehabilitation accepts that what we end up with may not be the same as what it was. However, it still contains many of the elements that allow the ecosystem to function as a whole and in many respects resembles the original. Most importantly, it allows us to move ahead, continue to improve our techniques, make mistakes and change our minds as new information comes to light. We are not bound by a strict set of rules that mandates that we can or can not do certain things. Rehabilitation also allows us to use any tools at our disposal whether ecologically or horticulturally based to achieve our goal.

One common mantra that has pervaded the ecological management community for 20 years or more is that 'DISTURBANCE IS BAD'. Is this so? Why do we believe this? Even cursory observation of healthy bushland shows us that disturbance is an integral part of the natural processes of function and regeneration. Maybe someone forgot to tell all the animals that what they are doing in the bush is bad! Maybe we need to hear some of the experiences of people who know something about disturbance in its many forms before we rush to conclusions. The first time I really took the concept of disturbance being beneficial seriously was at a talk by Beth Gott. She was discussing Koori land management and

interactions on the plains of Victoria. The vision she put into my head of lines of women and children with digging sticks searching for the next meal triggered something wonderful in my brain. I started to see disturbance everywhere, not backhoes and rotary hoes, but shallow-soil disturbance. Was shallow-soil disturbance the key to successful regeneration and ultimately rehabilitation?

In this issue of Indigenotes, **Deb Reynolds** explores some of the literature and concepts behind disturbance and the regeneration of our grassland forbs. This article is fascinating reading and sure to stimulate debate. Several studies are presently being carried out that are using disturbance coupled with direct seeding to achieve rehabilitation in grasslands. Do we need to mimic the process that the Koori used to rehabilitate our grasslands? Maybe you can contribute to the debate - either through Indigenotes or our website?

It is also very pleasing to announce that Victoria University will be cohosting **Beth Gott** who will be presenting to us some of her most recent work on determining burning regimes for vegetation. Many of you have been asking for Beth to come and speak with us and I am sure it will be standing room only at her presentation to us in March. Beth is a true inspiration and the depth of her work and understanding of what our role is in ecology is something many of us can only hope to achieve.

Also in this issue **Elizabeth Donoghue** takes asks some pertinent questions about the use of tree guards, and **Robert Bender** reviews "Fungi Down Under" Fungimap's guide to the fungi of Australia.

— Randall Robinson, President

Review:

Aboriginal fire management in south-eastern Australia

The seasonal timing and frequency of Aboriginal burning is embedded in various ecosystems according to Beth Gott, from Monash University's school of Biological Sciences.

Beth is an ethnobotanist who has worked in Hong Kong, USA and southern Australia, frequently with archaeologists. She has compiled data bases of Aboriginal plant use in south-eastern Australia, and has published articles and books on Aboriginal ethnobotany and ethnoecology.

In a paper in *Journal of Biogeography*[*] Gott reviews the historical and ecological evidence for Aboriginal burning in south-eastern Australia. She makes a convincing case that burning was deliberately used by Aborigines to promote the growth of useful tuberous plants for harvesting.

Gott suggests that the digging for roots following the flush of tuberous plant growth after a fire loosened and aerated the soil and turned litter and ash into it, making it more suitable for the further growth of the tubers.

According to Gott "Those plant communities where burning and gathering of food plants occurred for many thousands of years became adapted to the Aboriginal regime. Species and communities were selected which thrived with certain patterns of fire, both in frequency and seasonal application. Thus modern studies of such communities with the perspective of their long evolutionary history can reveal the intervals and seasons at which they were burned before European alteration of the landscape, and can illuminate the results of research."

She concludes "If we manage for biodiversity, we need to realize what the benchmarks are, and how that biodiversity was selected by thousands of years of Aboriginal management. Burning for fuel reduction at the same times and intervals as the Aborigines will preserve biodiversity, burning at other times and intervals can have unintended consequences.

You can find out more about Beth's research and how to deduce appropriate fire regimes for your remnant vegetation by coming to IFFA's workshop with Beth. Details on the back cover.

* Aboriginal Fire Management In South-eastern Australia: aims and frequency. Gott. B. Journal of Biogeography (2005) 32, 1203-1208.

Workshop summary

The EPBC Act

On the 28th of October 2005, a small number of people not fortunate enough to be holidaying over the cup weekend, gathered in one of the tutorial rooms at Burnely. They were there to learn the basics of one of the most powerful federal environment Acts in Australia- The EPBC Act (1999). With Lyndall Kennedy from WWF guiding us through, we learned that the EPBC Act is triggered by any action that is likely to have a significant impact on any of the seven matters of Environmental Significance:

- World heritage values of World Heritage properties.
- National Heritage values of places on the National Heritage List
- The ecological character of declared Ramsar Wetlands
- Listed (EPBC) threatened species and ecological communities
- Listed (EPBC) migratory species
- Nuclear actions that are likely to have a significant impact on the environment
- Commonwealth marine areas and Commonwealth managed fisheries.

Ultimately any decision is made by the Minister, however he/she must place equal importance on social, economic, sustainable development and environmental factors that may be impacted by a decision. If a breach occurs, the penalties are harsh – The maximum penalty for an offender is up to 7 years jail and/or a fine up to $550,000 for an individual or $5.5 million for a company.

Thereon there are 5 stages of the assessment and approval process; Referral, Controlled Action Decision requiring either a Approval Not Required Decision, a Manner Specified Decision or a Approval Required Decision; Assessment Decision, Environmental Assessment and EPBC Act Approval. And then there are exceptions! As with most legal terms, the language used can be very exclusive and anyone not normally familiar with it can immediately feel out of their depth. However, the explanations and examples from Lyndall gave us the confidence to work in groups on an example submission. This was a very interesting process as once each group relayed back their findings, thinking originating from different expertise and personal and professional experience had enabled extensive coverage of the impacts and issues involved.

Lyndall went on to discuss examples of cases that had been fought by WWF and won through persistence and intelligent use of the Act. The exacting of conservationists revenge brought a smile to the lips of all and it became clear that the pen and sword analogy was hugely relevant when it came to environmental destruction. However, for all its virtues, one of the short-comings of the Act is that it relies on reactive enforcement and it is environmentally minded community groups, individuals and organisations such as WWF that actively bring to the attention of DEH possible EPBC breaches.

And what about the Lists that determine wether or not a species or ecological community is of Environmental Significance? The minister maintains the lists (Threatened species and Communities and Migratory species) and updates them by making decisions based on information submitted and nominations received for listing and delisting of species and communities. Most recently *Cullen parvum* has been delisted, Western Basalt Plains Grasslands was rejected (again?) and has been renominated as Western (Basalt) Plains Natural Temperate Grasslands, Yellow Box Red Gum Grassy Woodland is a nomination currently under consideration. Those ecological communities that are currently open for public consultation (Until 3rd Feb 2006) are Central Gippsland Plains Grassland, Forest Red Gum Grassy Woodland, Temperate Lowland Plains Grassy Wetland and Murray Valley Grassland of the Riverina Bioregion. Then there are the Key Threatening Processes defined as those threatening process that could cause a species or ecological process to find itself on the endangered list and not just conservation dependent.

And what is IFFA's role in all of this? I believe IFFA, with its assemblage of experience and knowledge is the perfect platform for the discussion and compilation of submissions for:

- Those ecological communities and species whose future is open for public consultation.
- Nominations for listing of communities and species. (Is the information submitted for the

delisting of *Cullen parvum* a true indication of the long term survival of these plant populations?)

- Nominations for Key Threatening Processes.(The current processes list is mostly made up of feral species including goats, pigs, rabbits, cinnamon fungus, chytrid fungus, yellow ants, red ants, cane toads, cats and foxes, with human activities such as greenhouse gases, land clearance and turtle bycatch making up a small component of it. It seems to me that human activity is should bear a little more of the destruction burden including such activities as; derocking and fluproponating of native grasslands in the name of serrated tussock control, consistent overgrazing on private land, introduction of exotic salt tolerant grasses and lock up management of conservation reserves being just a few that come immediately to mind.

So that is my take on the day – inspirational, educational and great potential for use by IFFA. Let's do another one when everyone is back from holidays!

Louise Williams

Guides available from WWF

Snippets, news reports and longer articles needed for Indigenotes!

Artwork and photos too!

Prize worth $200 for best IFFA website posting.

See page 15 for details!

The Use and Abuse of Tree Guards

Elizabeth Donoghue

On Christmas Day I added to the family stock of Christmas-Day-drama-stories by going for an after-lunch walk along the top of the escarpment at the Hopkins Falls at Wangoon, near Warrnambool, where I got into an argument with some local land-owners over their revegetation project. Specifically we argued because they came across me pulling tree guards off plants that didn't need them and were, in my opinion, at risk of losing their lives from suffocation. I was also removing the broad-leaved weeds thriving in the thick mulch with which they had plastered the soil, and they didn't mind that so much. But they did feel strongly about the tree guards.

I am moved to write about it because the incident was for me the culmination of years of frustration about the almost universal, and usually unthinking, use of tree guards in revegetation projects.

I can't be the only person who has mourned the loss of plants, still enclosed in their plastic sleeves, which have long succumbed to competition from the weeds which thrived in the misty plastic microclimate thereby provided, unseen because the guards hid them from view. Or the only person who has in frustration removed very old guards from very tall saplings, or from large tussocks of grass which could long have been spilling over the ground providing habitat, or from tangles of ground-covers like Bidgee-widgee which should have been spreading out as nature intended, again providing habitat, conditioning the soil, holding moisture, and helping to prevent erosion and weed invasion.

Nor would I be the only person who has seen regenerating indigenous plants sprayed out between tree-guards, sacrificed because being outside the guards, spray contractors didn't recognise them as desirable vegetation.

And I've lost count of the number of old tree guards I've come across, empty but for a dead stick remaining inside: the guard having failed to provide any guarantee of plant survival.

I believe it is high time that we had some general critical analysis of, and discussion about, the need for and the correct use of tree guards. We tolerate the untruth that nothing indigenous that we plant is going to survive and grow unless it is given a tree guard.

This I think is particularly important because planting is more often than not left to people who lack specialist knowledge. The points I would like to see discussed and taken up to encourage better technical practice in revegetation are:

1. What are the drawbacks and dangers inherent in the undiscriminating use of tree guards?
2. In what circumstances and for what purpose should they be used?
3. What are the alternatives and how do we choose the most suitable form of protection, if and when the plants need protection?

Disadvantages of tree guards

The drawbacks and dangers of using tree guards might, I believe, outnumber the advantages of using them.

The problems I see with tree guards are:

They create an artificial microclimate, which is sometimes not best for the health of the plant.

Humidity around plants which are not adapted to it can lead to infestation with micro-bacteria such as rots, and fungi that are dangerous to the plant. They can also encourage the growth of foreign plants which thrive on it – such as *Tradescantia*, many of the exotic Asteraceae, sub-tropical climbing weeds such as Cruel Vine, and warm-season grasses like Kikuyu. Much of Victoria is dry, windy at times and lacks constant humidity. Why provide young plants with humidity and shelter from the wind when nature doesn't?

The people at the Hopkins Falls expressed a fear that without their milk cartons, the plants would be unable to withstand the wind.

But I would argue that by enclosing their young plants in milk cartons, they were diminishing the chances of those plants *ever* being able to withstand the wind.

Plants which grow naturally on such escarpments in Western Victoria are biologically adapted for a tough, windy environment. Otherwise of course they would never have survived to be part of that particular plant community. Plants adapted to windy places tend to branch low, to have a characteristic leaning or gnarly form, to have a generous ratio of width to height, and to have thickened cell walls. It is probably the wind itself which enables them early on to develop the strength to survive in their natural environment: the buffeting helps to thicken the cells in their developing trunks, and to not elongate their tissues. The open exposure means that they are not reaching tall for sunlight and becoming straight and whippy.

The young plants I saw on Christmas day were already too tall and leggy, with too few lateral branches for their height, because crammed into a milk carton they had been unable to develop their natural adaptations to wind. Indeed, their lack of light and space had forced them to do the opposite, to elongate, trying to reach the light too quickly.

It is sometimes argued that the tree guards are necessary because natural existing bush would shelter young seedlings from extreme elements. However, this does not happen, for example, after fires. At least some plants, or perhaps more accurately, some species, regenerate on bare burnt ground. Also, while we cannot know what exactly our sites looked like when they were covered with relatively undisturbed remnant bush, there is an increasing awareness that many of today's bushland areas are probably over-treed and over-shrubbed, and hence more closed and sheltered than they may have been (Dean Platt pers. comm.). This is likely to be due to a lack of natural clearing processes such as fire, to the sort of ecological imbalance that can lead to heavy invasions of shrubs such as *Kunzea ericoides*, and to the large numbers of relatively young and also coppiced regrowth trees which have returned after a century or so of formal or informal logging.

Tree guards are frequently left on for too long, and this destroys the long-term survival chances of the plants.

Tree guards are frequently not removed for far too long, if at all. We organise planting days, but not guard removal days. Over-stretched parks staff have other priorities.

So as the plants struggle along in their prisons, they begin to mature without developing the habit of growth: strong lateral branching, or twisted trunks etc., which might enable them to survive as healthy plants to age and reproduce. It is often difficult (for example on rocky or steep sites) to install tree guards properly; over time many collapse inwards on top of the plant. Often the plant dies; always it is stressed.

When there is a major storm, or floods, or gales, it is the reveg plants which usually fall over (as well as coppiced regrowth trees). They simply have not been able to develop the features which should give them the strength to withstand the conditions to which they are biologically adapted.

Tree guards inhibit shorter-lived or smaller plants like grasses from bending over or spreading out as nature intended them to do, so when they set seed, it doesn't fall at a distance, or get carried away by animals or people, so increasing the population and the area covered by indigenous vegetation.

I was shocked to discover that milk cartons are not supposed to ever be removed. One major manufacturer of revegetation products claims that they need

The Use and Abuse of Tree Guards – *continued*

not be removed because they are bio-degradable. Over what period of time do they break down? What about the waxy surface? Does it break down?

The use of tree guards is often incompatible with achieving natural planting patterns

Grasses, for example, grow in close clusters. You don't see one Wallaby Grass per square metre. They come up together. We still get too much regularity in plantings, so that 3, 5, 10 years down the track they look little if anything like the landscape they were meant to reproduce. You can't easily cluster things if you are putting a guard around each one. You can't stand back and see whether you are getting a more natural pattern of groups of shrubs, minglings of understorey plants, groups of trees with gaps between etc., if all you can see is a forest of plastic.

Tree guards are unsightly

Tree guards look terrible. Milk cartons look worse than terrible. They look like junk. There seems to me to be something insulting about making revegetation unsightly. We should be thinking not only about the "feel good" of planting, or the erosion control, or habitat provision, but about the landscape, how nature originally designed a woodland or a stretch of riparian scrub, about what it should look like. If we start off tolerating ugliness, if we are really planting milk cartons, how can we be sensitive to the design nuances of a particular site and its plants? Landscapes by their very nature are supposed to be beautiful. We also detract from the surrounding landscape, which might indeed be beautiful, by inserting into it a whole lot of plastic, or milk cartons.

And when they are not removed, the ugliness continues, even after any function the tree guards may have performed has ceased to exist. And what more derelict and ugly sight is there than old, sagging tree guards around tall leggy plants?

Confronted with a forest of tree guards, we can't see the wood for the trees

If we are focussed on the little plants in the tree guards, we tend not to see or care about what is in between. Plants which pop up between the tree guards are often indigenous. They are often things that we have been unable to get at the nursery. So they are the potential source of species diversity. Being of absolutely local provenance, they often contain the necessary genetic material for adaptation to the conditions there. They've come up often because their propagules have been liberated by the pre-planting weed control. But because they are not inside the guards, they are considered not to be "The Plants" and are often walked on, or sprayed out, or grazed.

Uses and choices

I know that tree guards have their uses, but we need to think about these, too.

The usual argument for using tree guards has always been protection from grazing – usually by rabbits, and sometimes by kangaroos or possums.

Instead of automatically using tree guards, revegetators could take the following into consideration:

Are the plants really at risk of being grazed?

Not every site is infested with rabbits. Most urban sites lack kangaroos. If possums are present, they are likely to eat selectively: they favour, for example, casuarinas and eucalypts.

Groups organising and undertaking planting should be encouraged not to install tree guards as a matter of course, but to ask: Are rabbits a problem on this site? And/or possums and/or kangaroos? And do we need to put guards around every plant, or just some, for example casuarinas and eucalypts?

If grazing is likely to be a problem, is the use of tree guards the best protection?

The DPI 2004 (revised 2005) Information Note LC0104, *Tree planting and aftercare*, by David Perry and Michelle Butler, argues that the best protection from rabbits is to undertake a thorough pre-planting and continuing rabbit control program. They point out that one rabbit warren affects about three hectares of land. So a rabbit control program will have many benefits extending beyond the particular revegetation site.

Rabbit proof fencing can sometimes be a better option, particularly because it allows close grouping of plants, allows natural growth, does not create an artificial microclimate, does not hide the young

seedling and any problems which it is encountering allows any natural regeneration to occur between plants, and is nowhere near as unsightly. The problem with rabbit-proof fencing is that it can prevent the movement of other small animals, particularly reptiles. It is heart-breaking, and too common, to see a blue-tongue lizard trapped in a chicken-wire fence.

Where inhibiting the movement of other animals is unlikely to be a problem, the cost of tree guards may in fact be greater than that of fencing. My colleague Dean Platt points out that while fencing is expensive, tree guards are expensive too, and where large numbers of plants are being planted, there will be a point at which the cost of tree guarding each individually will be greater than the cost of fencing the whole plot.

I'm not sure what the answer is here, but I don't think it's plastic or milk-carton guards. It must be possible to design a fence that will keep rabbits out and yet allow reptiles to move freely. Or at least we can promote the use of open-mesh tree guards, or larger tree guards where they are absolutely necessary.

Cockatoos and corellas can be a problem in country areas. Once again, loosely constructed wire or plastic mesh cages, covering a number of plants, and to be removed as soon as a root system is established (a matter of weeks or months), or open mesh tree guards, again to be removed early on, would possibly be a better alternative.

In conclusion……

I would be interested to hear what others think. It seems that many of us who work in the conservation field are so busy with priorities like protecting remnant vegetation that we don't worry too much about revegetation projects. But we do harness community energy for revegetation, and we might as well do something about ensuring that that energy contributes as much as it can to the common goal of land and biodiversity protection, and restoring habitat and landscape values.

If you would like to reply to Liz, or give your opnion on this matter, visit IFFA's website (www.iffa.org.au), select discussion forum and then practical issues, and then Treeguards use and abuse and then click on reply. —Ed.

Acacia news

Acacia – not Racosperma!

The debate has been going on for a considerable time, with interested parties making submissions to the International Botanical Congress.

This extract is taken from the Worldwide wattle web site: www.worldwidewattle.com

"On 16 July, 2005, the Nomenclature Section of the XVII International Botanical Congress in Vienna, Austria, voted to accept the Spermatophyta Committee's recommendation to conserve the name Acacia by retypifying it with a new type as proposed by Orchard & Maslin (2003). This decision was subsequently ratified at the Plenary Session of the Congress on 23 July. This means that when Acacia is formally split, the new type will be *A. penninervis* and the name Acacia will be retained for the almost 1000 species currently ascribed to Acacia subgenus Phyllodineae. The majority of these species occur naturally within Australia, however a number of them are extensively utilised for economic and other purposes, or occur as environmental weeds, in many countries around the world. Further information concerning this matter will appear here shortly. In the meantime, Worldwidewattle wishes to express its gratitude to the literally hundreds of people who have recently expressed their support for the Spermatophyta Committee's recommendation."

Phew.

Acacia Symposium
(26-28 August, 2006)

Acacia 2006: Knowing and Growing Australian Wattles
(organised by the Australian Plants Society Vic. Inc. and the National Herbarium of Victoria)
Saturday, 26 August: Horticultural Sessions. Conference Dinner.

Sunday, 27 August: Garden Visits - local gardens to enjoy wattles and other species.

Monday, 28 August: Scientific Sessions - co-hosted by National Herbarium of Victoria: Research papers on current studies such as taxonomy, genetics, pollination, conservation, weediness, utilisation.

Tuesday, 29 - Saturday, 2 September: Post Conference tour of country Victoria (self-guided day tour maps will also be available).

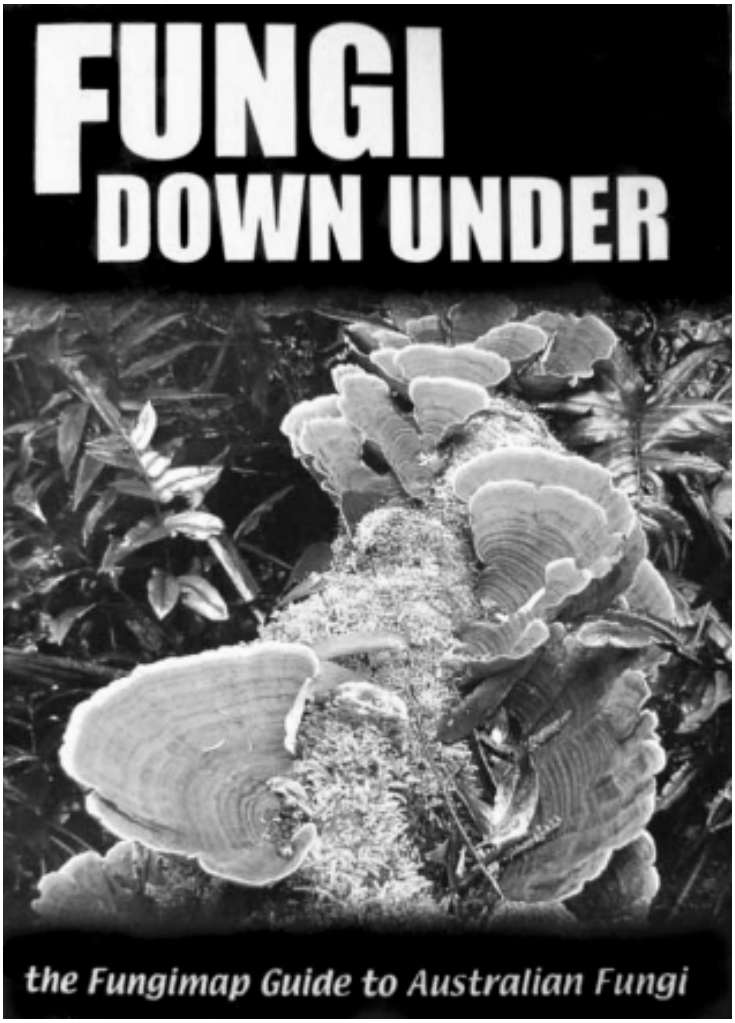
Contact: Marilyn Gray: marilyngray@hotmail.com. tel. 03 9728-4256 (business hours) or 03 9728-5891 (after hours).

Book review:

Fungimap Guide

Reviewed by Robert Bender

Pat & Ed Grey, of the Field Naturalists, as part of a team including Leon Costermans, who designed the book, and Tom May, who leads the Fungimap project, have produced an excellent field guide to support volunteer fungi sightings. Its 146 pages contain a page on each of the 100 species currently being reported on by volunteers.



Each page has beautiful clear photos with comments on identifying characters, distribution map compiled from the 20,000 records already collected since the project started in 1995, detailed descriptions of cap, gills/pores, stem, rating as common or rare, whether found singly or in groups, a general description of its normal habitat and comparisons with similar-looking species to point out how to recognise the differences. There is an introductory section on the field of fungi, how they reproduce, how they find their food (some are wood-rotting, some are parasites, others have a symbiotic relationship with tree or shrub species), fruiting seasons, the different types of caps and spore-holding structures, and an account of how fungi are classified, what information should be collected to record a sighting and a page illustrating different cap shapes and densities of gills for the gilled species.

At the back o the book there is a four-page glossary, a pronunciation guide to scientific names and a section on the origin of the names of the species included in the book, a bibliography of books and websites, an index and an explanation of what the Fungimap project is about and how it is organised. The book is divided into the two major groups of fungi, ***Basidiomycota*** (which house their spores under caps) which are on pages with a red stripe across the top contain-ing common and scientific name and ***Ascomycota*** (which display spores across the entire surface of the fruiting body) which have a blue strip.

The whole book is a brilliant support for eager ama-teurs who want to help with this valuable mapping project. For the first time it is possible to distinguish which species are common (the *Oudemansiella radi-cata* [Rooting Shank] with 600 records is the most commonly reported), and which are rare (some have only one record to date) and how widely distributed each species is. It is likely that many more fungi exist in any given area than those already found, which will only be discovered if more volunteers take up reporting their sightings.

Fungi Down Under is only available from the Royal Botanic Gardens and can be orded from the Fungimap website at http://www.rbg.vic.gov.au/fungimap, along with a number of other fungi books.

Literature Review

The role of soil disturbance in promoting the recruitment of grassland forbs

By Deborah Reynolds

Sustainability Group (Faculty of Science, Engineering and Technology)

Degree of Bachelor of Science (Honours)

June 2005

Disturbance processes are an ecological prerequisite to many essential ecosystem processes. These processes promote plant germination, seedling recruitment, growth, reproduction and maintenance of floristic and faunal diversity (Wootton 1998). The natural processes that cause soil disturbance include anthropogenic sources, animals, plant death and a variety of natural disasters and cyclical climatic events (Fox & Fox 1986; Grime & Hillier 1992; Jones 1992). The nature and definition of disturbance is interpreted in ambiguous ways by many researchers. The most appropriate definition that clearly outlines the main parameters is from Picket and White (1985) "A disturbance is any relatively discrete event in time that disrupts ecosystem, community or population structure and changes resources, substrate availability or the physical environment." This definition is very generalized and the scale and process by which it occurs needs further clarification in each instance (Pickett & White 1985). Researchers have examined disturbance in many different ways and it is often looked at from many different angles in the same article. Predominantly, disturbance in relation to native grassy ecosystems is seen as:

1. Land clearance (Kirkpatrick, McDougall & Hyde 1995; Williams 2005);
2. Grazing pressure (Belsky 1992; Hobbs & Huenneke 1992; McIntyre, Huang & Smith 1993; McIntyre & Lavorel 1994b; McIntyre, Lavorel & Tremont 1995; Lunt 1997; Verrier & Kirkpatrick 2005);
3. Fire (Hobbs *et al.* 1992; Lunt 1997; Morgan 1998b; Carlsen, Menke & Pavlik 2000; Morgan 2001; Jutila & Grace 2002; Keeley 2002; Clarke & Davison 2004; Gott 2004);
4. Soil disturbance (Hobbs & Atkins 1988; Hobbs *et al.* 1992; McIntyre *et al.* 1994b; Foster 2001; Clarke *et al.* 2004; Hofmann & Isselstein 2004);
5. Animal diggings (Pyrke 1994; Claridge & Barry 2000; Garkaklis, Bradley & Wooller 2004);
6. Addition of nutrients (Hobbs *et al.* 1988; Gurevitch & Unnasch 1989; Hobbs *et al.* 1992; Kitajima & Tilman 1996; Fynn, Morris & Kirkman 2005):
7. Vehicle damage (McIntyre *et al.* 1995; McIntyre & Martin 2001);
8. Essential service installation and maintenance (Christensen & Burrows 1986; McIntyre & Lavorel 1994a; McIntyre *et al.* 1994b; McIntyre *et al.* 2001);
9. Mowing/slashing (Foster 2001; Jutila *et al.* 2002; Hofmann *et al.* 2004; Fynn *et al.* 2005; Verrier *et al.* 2005);
10. Weed removal and herbicide use (Gurevitch *et al.* 1989; Hester & Hobbs 1992; Forcella 2000; Jutila *et al.* 2002; Hofmann *et al.* 2004);
11. Removal of specific plants such as dominant species or weeds (Gurevitch *et al.* 1989; Hester *et al.* 1992; Lofgren, Eriksson & Lehtila 2000; Schultz 2001) and
12. Creation of bare soil by removal of leaf litter (McIntyre *et al.* 1993; Kitajima *et al.* 1996; Baar & Kuyper 1998; Foster 2001; Jutila 2003; Clarke *et al.* 2004).

Soil disturbance is a key process in many ecosystems, triggering germination and stimulating recruitment. However, this action is seen as controversial to some researchers including a significant number investigating restoration management in Australia (Kutt *et al.* 1995; Eddy 2002). There are numerous examples in North America that strongly indicate that soil disturbance is not only beneficial but critical to maintaining ecosystem structure and function (Jutila *et al.* 2002; Keeley 2002; Montalvo, McMillan & Allen 2002; Roxburgh, Shea & Bastow Wilson 2004), Africa (Fynn *et al.* 2005) and Europe (Lavorel 1999; Lofgren *et al.* 2000; Turnball, Crawley & Rees 2000). While there is data that shows disturbance can reduce the number of natives at a site over time and encourages weeds (Evans & Young 1972; Hobbs *et al.* 1988; Hobbs *et al.* 1992; Davies 1998; Wijesuriya & Hocking 1998; McIntyre *et al.* 2001; Williams 2005) there is additional data that shows some native species benefit from soil disturbance (Hobbs *et al.* 1988; Cropper 1993; Morgan 2000; McIntyre *et al.* 2001). There are strong indications world-wide that grassland species, whether introduced or native respond positively to the stimuli of soil disturbance (Christensen *et al.* 1986; Huston 2004).

There is evidence world-wide that grasslands, which once occupied 42% of the world's landmass (Smith & Smith 1998), share the same need for disturbance as all other major biomes to maintain ecosystem health. There is strong argument that most of these grassy ecosystems are anthropogenic or have an anthropogenic component and therefore their very existence is inter-related to human disturbance and in particular soil disturbance (Mulvaney 1991; Gott 1992; Jones 1992; Anderson & Rowney 1999; Keeley 2002; Gott 2004; Raish 2004). The need for soil disturbance is exhibited in the successful germination and recruitment of many grassland forbs, following disturbance

of soil (Hobbs *et al.* 1988; Cropper 1993; McIntyre *et al.* 1994a; Kirkpatrick & Gilfedder 1998; Robinson 2003).

The likely reasons for recruitment in disturbed soil and the supporting data is often not discussed in any detail and for the most part is ignored by most authors (Cropper 1993; Morgan 2000). Grassland management guidelines have discouraged soil disturbance due to a lack of understanding of this critical process (Kutt *et al.* 1995; Eddy 2002). This has lead to the now traditional practice in Australia of fencing off grasslands, with little intervention, except an occasional burn or herbicide control of weeds (Kutt *et al.* 1995; Rolls 1999; Eddy 2002). To understand why soil disturbance works it needs to be viewed as a natural process that has evolved with the ecosystem. There are several key ways that soil disturbance or changes in soil composition occur, that need to be considered to understand their effects on biological processes as a whole and on the specific affects on the life cycles of individual plants.

Physical disturbances

Animals

Invertebrates (insects) and vertebrates all have the potential to impact on many stages of a plant's life cycle. Many animals create physical disturbance through their daily activities of grazing, foraging for food, defecating and excavating tunnels for homes, impacting on flora constantly. Studies in the United Kingdom of a temperate grassland found vertebrates (rodents) preferred to graze on continuous swards of grasses, large seedlings and seeds, usually killing them but leaving open areas alone. In comparison, molluscs only grazed small seedlings, rarely killing them. Both animal types only exploited about 30% of seedlings they encountered (Hulme 1994). This implies that open areas are safer for germinating seeds and the impacts of these animals are survivable for 70% of the plant population. Another study looked at the soil seed bank, finding that insects and molluscs had no effect on the number of germinable seeds present, while rabbits negatively affected the numbers of eight forb species germinal seeds present. Insects and molluscs had no impact on the number of seedlings germinating or surviving longer than two years. However, rabbits exclusion allowed more seedlings to germinate initially but over time (two years) there was no significant difference between the exclusion plots and rabbit inclusion plots (Edwards & Crawley 1999). This shows us that grazing and the creation of bare soil did not disadvantage recruitment of these grassland species. In the U.S.A. persistence of native forbs over exotics was enhanced due to soil disturbance by pocket gophers (Hobbs *et al.* 1988). In sheep grazing areas where sheep compacted the soil, no populations of forbs existed (Rice 1987). Pocket Gophers have been found to churn over between 1 - 8.5 kgm² of soil annually (Anderson 1987) creating many seed microsites (Chambers & MacMahon 1994). Other common animals in these same grasslands include badgers, buffalo and prairie dogs, create patches of bare ground and/or soil disturbances routinely (Collins & Uno 1985). Animal impacts on their surroundings have been looked at by several researchers around the world and recognized as causing patch disturbance in many environments (Platt 1975; Collins 1989; Reader & Buck 1991). For example gophers, badgers, moles, rats and rabbits in Mediterranean environments dig over soil creating mounds, troughs, exposing buried seeds, loosening the soil and creating irregular surfaces (microsites) that are perfect safe sites in which seeds may germinate.

Australia has the world's worst record for allowing mammals to become extinct. The figures say it all - of the 59 world mammal species recorded since the 1600's that have become extinct, 27 (45%) were Australian (May, Lawton & Stork 1995; Attiwill & Wilson 2003). Our grassy plains have lost at least three known endemic species, the Plains rat (*Pseudomys australis*), White-footed rabbit-rat (*Conilurus ealpipes*) and
Lesser stick-nest rat (*Leporillus apicalis*) (Flannery 1990; Menkhorst & Knight 2001). The animals that would have been present on the plains but are no longer present in this ecosystem complex are the Toolache wallaby (*Marcropus Greyi*), Bridled nailtail wallaby (*Onychogalea fraenata*), Eastern hare-wallaby (*Lagorchestes leporides*), Rufous-bellied or Tasmanian pademelon (*Thylogale billardierii*), Tasmanian Bettong (*Bettongia gaimardi*), Southern or Rufous bettong (*Aepyprymnus rufescens*), Eastern quoll (*Dasyuris viverrinus*), Spot-tailed quoll (*Dasyurus maculates*), and Eastern chestnut mouse (*Pseudomys gracilicaudatus*) (Wakefield 1971; Seebeck 1984; Menkhorst *et al.* 2001; Commonwealth of Australia 2002a).

There are 744 species of birds recorded in Australia and 345 have been found in Western Victoria but according to Victorian governments data 72 are endangered or rare (Sattler & Creighton 2002; Commonwealth of Australia 2005). There should be many ground birds such as the Plains wanderer (*Pedionomus torquatus* listed as Nationally endangered), Brolga (*Grus rubicunda*), Bush stone-curlew (*Burhinus grallarius*), Australian bustard (*Ardeotis australis*), Malleefowl (*Leipoa ocellata*), Painted button-quail (*Turnix varia*), Little button-quail (*Turnix velox*), Red-chested button-quail (*Turnix pyrrhothorax*), Stubble quail (*Coturnix pectoralis*), Brown quail (*Coturnix ypsilophora*), King quail (*Coturnix chinensis*), Ground parrot (*Pezoporus wallicus*) and Emu (*Dromaius novaehollandiae*), almost all of them are gone or rarely seen on the plains now (Middleton 1971; Pizzey & Knight 1997; Commonwealth of Australia 2002b). Their presence in the plains was barely noted by naturalists let alone the ecological and environmental roles that they played. The animals at the top of the food chain have

gone and many others are missing. Some of them may have been indicator or keystone species for the grassy ecosystem's health (Attiwill *et al.* 2003). With so many species gone from the grassland ecosystem and if interdependence (symbiosis) between animals and plants occured then the existence of the remaining species with in this ecosystem must be negatively affected.

Under pre-European conditions herbivorous small mammals occurred in high densities and would have foraged in a spatially patchy fashion (Fox 1982; Clarke, Myerscough & Skelton 1996). There are some isolated grassland marsupials still surviving in Western Australia (W.A.), New South Wales (N.S.W.), Tasmania and Victoria, which can give us some insights as to their impacts in healthy grassland. Research by Pyrke (1994) in Tasmania focused on rare or endangered species and showed that diggings of Eastern barred bandicoots (*Perameles gunnii*), Tasmanian bettongs (*Bettongia gaimardi*), Southern brown bandicoots (*Isodon obesulus*) and Long-nosed potoroos (*Potorous tridactylus*) created shallow holes and mounds in their quest for food, having significant effects on the recruitment of local forbs at the expense of grasses. Forb seedlings were also more prevalent on mounds. Mounds had a lack of litter, warmer soil, greater light penetration and less above and below ground competition from surrounding plants, which led to increased seed germination (Platt 1975; Collins 1989; Reader *et al.* 1991). Bandicoot diggings were found to be greatest in summer. This coincides with the highest seed production times for grassland forbs, giving many seeds an opportunity to find an optimum microsite for germination. Seeds germination in the Autumn of a year with good to average rainfall had the highest success rate or recruitment (Pyrke 1994). Research in N.S.W. looked at the effects of animals and the lack of them in a dry heath environment, discovering that unfenced plots had a higher long term recruitment rate and supported Pyrke's findings that soil disturbance by bandicoots provided safe sites for dispersed seed (Clarke *et al.* 1996) (n.b. these environments lacked introduced herbivores). In W.A. it was found that a single Woylie (*Bettongia penicllata*) on average could displace 4.8 tonnes of soil annually with between 38 to 114 diggings per night. This foraging to 15cm depth alters the soil characteristics by making it more permeable to water and redistributes seeds and nutrients throughout the pile (Garkaklis, Bradley & Wooller 1998, 2000). Many small mammals need dense cover for shelter but sparser areas for food foraging (Claridge *et al.* 2000). These examples show that the impact of Australia's native animals was and is significant to the recruitment and survival of our indigenous plants. The plants and animals have evolved together for at least 30 million years from when Australia became an island, so it makes sense that they have a symbiotic relationship (Knox *et al.* 2001). Interestingly Pyrke (1994) also found that simulated shallow disturbance of soil is more effective at stimulating germination and generates a higher recruitment rate compared to natural animal diggings.

Humans

It took at least 60,000 years to reach a human population of one billion worldwide (Miller 2000). Humans have become the dominant species but exactly when did we start changing our environment to suit our needs? Our ancestors were nomadic hunter-gatherers surviving by killing animals for meat and foraging for edible plant food sources . The majority of wild food sources were plants that are easily found whereas meat was an erratic food source as it took a lot of time and energy to obtain (Klein 1993; Rowley-Conway 1993). Our nomadic existence also ensured that we ate different plant foods when in season and didn't out-strip the supply for next year.

In Africa evidence has been located from an 8,000 year old site that the human population at that time consumed at least 44 different varieties of plants in a short time period (Wendorf, Close & Schild 1993). Through necessity brought on by wars and poverty Europeans have carried on the tradition of eating wild indigenous plant foods (Cribb & Cribb 1987). Native Americans (Indians) existed from the late Pleistocene (11,650-10,250 years ago) as small mobile groups of hunters and gatherers exploiting many plants and animals.

About 7,500 years ago until the mid-1500's America was under the influence of varying climatic conditions. This forced the Indians to rely more on food plants and local resources to survive, evidenced by archeological finds of mortars, pestles and other milling artifacts (Erlandson & Glassow 1997; Keeley 2002; Raish 2004). There is documented usage of 100-200 plants as food sources during this time period (Timbrook 1984; McCrawley 1996). Plant food sources were fruits, berries, stems, barks, leaves, flowers, seeds and roots. The majority of plant foods could be obtained via harvesting when ready, but roots needed to be dug up. Grasslands in America were known to be food sources of bulbs, corms and tubers of geophytes (Anderson *et al.* 1999). Geophytes are vascular plants that die back to underground storage organs during unfavorable growing periods (Rundel 1996). Much of the harvesting activity by ancestral peoples by necessity involved soil disturbance.

Introduced diseases and new waves of colonizing people have decimated indigenous populations worldwide with a subsequent flow-on effect to loss of knowledge of many plant food sources and the harvesting techniques. Consequently little documentation of the thousands of years of environmental food knowledge was obtained, before most of the people who knew it, were gone (Simmons 1979; Dawson 1981 [1881]; Jones 1992; Raish 2004). Research

in the United States (U.S.) shows wild plant foods prior to European contact were an important part of the native diet and for survival (Brown 1991; Cordell 1997). Research by Anderson and Rowney (1999) showed that digging for *Dichelostemma capitatum* (Blue dicks), an indigenous root food source and harvesting at 50% intensity ensured the best recovery of numbers and weight compared to no harvest or harvesting all the corms in an area. Blue dick is a forb that inhabits a wide variety of ecosystems including grasslands and thrives in open disturbed areas frequently appearing post fire. Huge quantities of corms and other roots were gathered from sites that were visited annually over a long time. Today there are many rare and endangered geophytes in the U.S. suggesting the possibility that the lack of a human disturbance regime is partly to blame (Rundel 1996; Anderson *et al.* 1999). The loss of knowledge and processes such as soil disturbance has undoubtedly directly altered the dynamics of long-term functioning in these anthropogenic grasslands.

The story is very similar in Australia with archaeological evidence in Keilor (on the basalt plains) of aboriginal occupation nearly 30,000 years ago (Presland 1983) and a burial found there has been accurately dated to 12,000 (+/- 100) years old (du Cros 1990; Brown 1992). The indigenous population was again very quickly decimated post European contact and so was the knowledge of local food sources and harvesting techniques (West 1971; Gott 2004). Most of our information comes from early explorers who tell of woodlands (10% overstorey cover) occupying about 60% of Australia's land (Graetz, Fisher & Wilson 1992) and many thousands of acres with no trees only grassy plains with wildflowers (Brown 1977; Hellyer 1987 [1861]; Rolls 1999). Aboriginal people were noted as healthy and well nourished (Grey 1841; Bride 1898) with many references made to aboriginals living principally on wild roots and tilling the land (Curr 1883; Presland 1980; Gott 1982; Clarke 1985). There are many different root food sources noted but the Murnong or Native yam (*Microseris sp*) appears to be the most common in Victoria (Dawson 1981 [1881]; Gott 1983).

When Europeans first arrived, accounts say there were millions of Murnong all over the plains (Presland 1977) with native women harvesting them seen spread as far as the eye could see, each having a load as much as they could carry (Presland 1980; Clark 1998) and they sometimes formed piles of yams three feet high (Dawson 1981 [1881]). Major Thomas Mitchell in 1839 describes views south and east of the Grampians as "a vast extent of open downs….quite yellow with Murnong" and "natives spread over the field digging for roots" (Mitchell 1839; Presland 1977, 1980; Clark 1998). The roots were a reliable food source available throughout the year and easily dug up (most roots are found in the top 10cm of soil) with digging sticks (Gott 1982, 1983). Many different roots were used and from the total number of native grassland forb species identified (1104), 258 (23%) of them were root food sources (Cribb *et al.* 1987; Low 1988; Gott 2005; Victorian Government 2005). But some researchers have implied that Australia's environment was not disturbed except via animals before Europeans arrived (McIntyre *et al.* 1994a, 1994b). This is patently not true as there are sufficient early references to suggest that digging and patchy soil disturbance was an essential and natural part of the environment.

Fire

Weather instability via thunderstorms and lightening has had environmental impacts worldwide, evidenced via the fossilized charcoal layers found all over the world prior to human's known evolution (Singh, Kershaw & Clark 1981; Baisan & Swetnam 1997). A single thunderstorm can light many fires via lightning in minutes (Cheal, Day & Meredith 1979). Human's observation of fires' effects and the repeated fire events over time led to our ancestors learning to use fire to their benefit. Evidenced by small fire heaths in caves next to human remains (Bowler 1970; du Cros 1990) and by increased amounts of charcoal in the sediment layers of time periods where man was known to exist in these areas. This is true for all continents of the world (Singh *et al.* 1981; Klein 1993; Erlandson *et al.* 1997). As a consequence fire has become an essential process that maintains the ecosystems of America's savanna, temperate grasslands, chaparral, Southern pine forests, Western forests and Northern coniferous forests; (Miller 2000) Africa's savanna, grasslands and woodlands (Klein 1993; Solomon, Berg & Martin 1999) and in Australia, every environment except rainforests (Heywood 1989; Knox *et al.* 2001; Attiwill *et al.* 2003). The different European cultural perceptions of fire have led to it being generally discouraged in the landscape. Due to altered fire regimes our flora has been allowed to accumulate large amounts of biomass over long periods of time that burns in a far more destructive fashion than the previous practices allowed (Singh *et al.* 1981; Mensing, Michaelsen & Byrne 1999; Solomon *et al.* 1999). Fire reduces biomass and helps to maintain temperate grassland ecosystem functions.

In America the native Indians used fire to maintain a safe environment for their populations. Removing biomass regularly (via burning) around their camps ensured they had easy access to water, hunting areas and maintained good vision of their surroundings for safety from predators (Bears, Wolf packs and Large cats)(Roper & Graber 2001) or enemies (warring tribes)(Davis 1988; Keeley 2002). Regularly burning large areas over time promoted fire adapted plant species and ensured a predictable supply of fresh grassland species such as geophytes, forbs and

grasses. The fresh new plant growth following fire attracts many animals into the area ensuring easier organized hunting. The seeds of native forbs and grasses were a staple food and fire promoted that food source predictably (Keeley 2002; Raish 2004). Taming and using fire in a managed way, benefited humans. It provided warmth, the ability to cook plus preserve food and the stimulation of a fresh food supply of both plant and meat products.

In Australia there is a similar story. There is charcoal in the sediments from before human's arrival indicating lightning's effects on the landscape, followed by about 40,000 years ago an increase in the fire frequency (Kemp 1981; Singh *et al.* 1981). At least 54% of the fires in North West Victoria and up to 97% in New South Wales (for 1975) were caused by lightning (Cheal *et al.* 1979; Horton 1982). Aboriginal people learnt to manage fire as a tool, keeping the landscape clear for easy passage, promoting underground tuber's growth and allowing seedlings to germinate for new crops of seeds plus fruit and bringing in animals for hunting (Christensen *et al.* 1986; Gott 1992; Jones 1992; Aplin 1999; Gott 2004). Aboriginals managed fire with precision, burning specific areas at specific times in a mosaic pattern with some areas rarely burnt and others like clockwork, always done by elders and put out quickly and easily if it strayed into a area that they didn't want burnt (Stokes 1846; Thompson 1949; Gott 1992). Our flora has evolved to need fire to rejuvenate it with many plants encouraging fire via shedding of bark and the building up of biomass. Fire will occur eventually whether we as humans want it or not (Mutch 1970; Attiwill *et al.* 2003).

Our animals have also adapted to the regular burning regimes as they usually breed following a fire due to the increased availability of food (Horton 1982; Claridge *et al.* 2000; Garkaklis *et al.* 2004). Burning in an Australian environment will usually increase the indigenous plants numbers and improve the overall diversity while negatively impacting (failure to seed) the introduced plants present (Hobbs *et al.* 1992; Lunt 1997; Corr 2002). Removing biomass and exposing bare soil regularly via burning promotes underground tubers (geophytes), stimulates grasses and forbs to set seed and is essential for many seeds to germinate in Australia's grassland environments (Hobbs *et al.* 1992; Lunt 1997; Morgan 1998b, 2001).

Our grassland flora has evolved with regular fire coupled with herbivory, including grazing animals and ongoing periodic soil disturbance by both animals and humans.

This review will be continued in the next edition of Indigenotes, or see IFFA's website. It cover plant responses to soil disturbance and the implications for introduced plants and management.

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A note about EVC's

A future edition of indigenotes will contain a critique of the EVC approach to classifying vegetation. What are your thoughts? A discussion forum has been started on the IFFA website (www.iffa.org.au) to evaluate the weaknesses and strengths of the approach.

There is also a link to the only extant evaluation of how well EVC's perform. Have a look!

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Saturday 18 March 12:30pm for a 1pm start through till 4pm,

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Contributions to *Indigenotes* should be sent to the editor — the deadline for the next issue is 15th February 2006. Contributions must be in electronic form, either on PC formatted floppy disk or CD or can be sent to the editor by email.