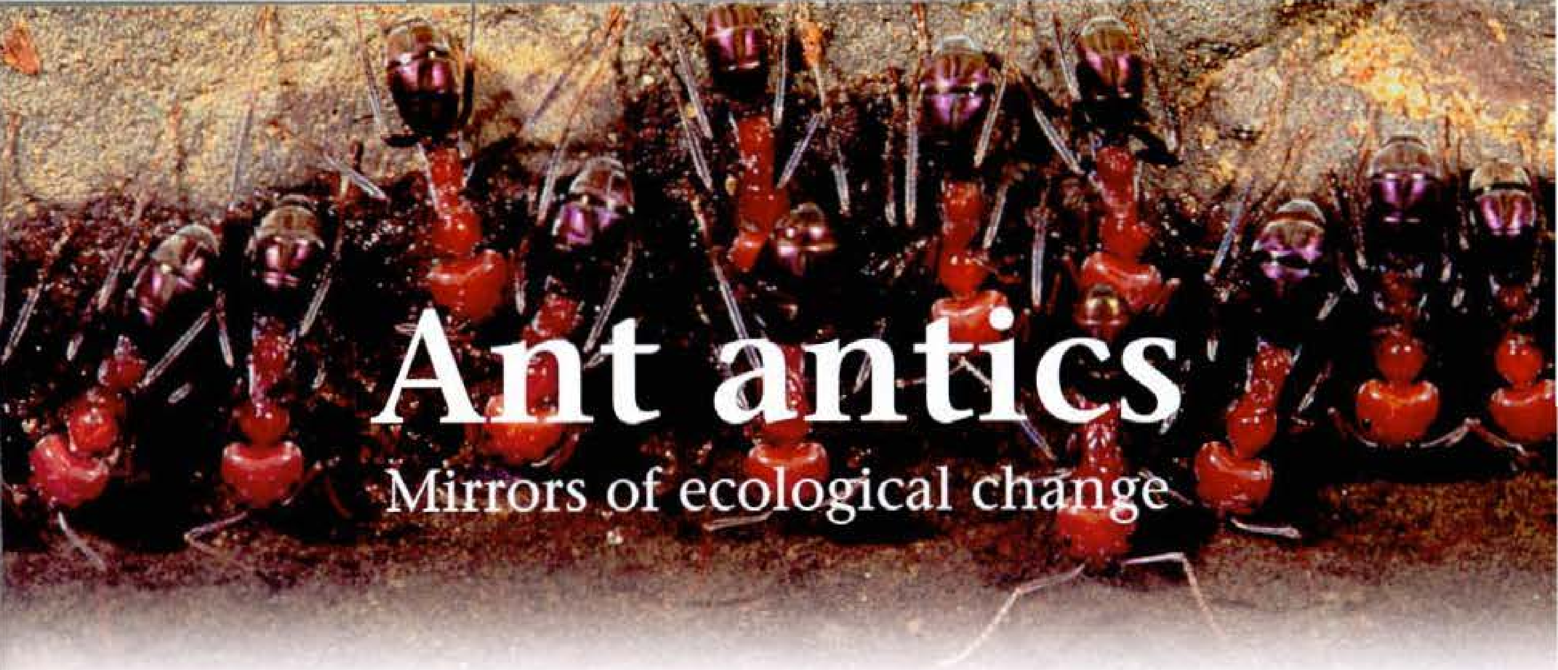


Ant antics

Mirrors of ecological change

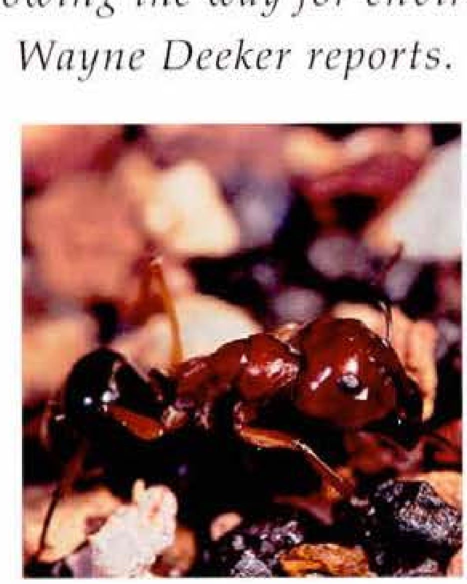
During minesite rehabilitation work in the Northern Territory, the activities of ants are showing the way for environmental management. Wayne Deeker reports.

Ants may live in sophisticated societies, but when it comes to managing change, they waste no time on meetings. Each group of ant species has its own set of contingency plans for responding to particular environmental disturbances. As ecologists learn to predict and interpret these rapid responses, monitoring ant populations is shaping up as an efficient way to assess environmental change. This includes gauging the success of habitat rehabilitation projects.

Dr Alan Andersen, from CSIRO's Division of Wildlife and Ecology in Darwin says ants are potentially reliable indicators of environmental change in Australia. He is testing this potential during rehabilitation work at the Ranger uranium mine near Kakadu National Park in the Northern Territory.

Already an inconsistency in the normal pattern of ant succession has alerted him to a problem highlighted by one of Ranger's revegetation trials. The ground was receiving insufficient sunlight because a burning regime had not been implemented to control the growth of acacias.

In the past, such a problem might not have been noticed until the vegetation itself began to run rampant, blocking out the less-competitive species. That's because ecologists had no simple indicators of ecological wellbeing. Thorough evaluation required systematic investigation of most of an ecosystem's main species and interactions. Collecting such information, even at a single site, involves a massive effort. In recent decades, however, a better way has emerged: measuring the environment through indicator species.



Jiri Lochman, Lochman Transparencies

One day the health of ecosystems across Australia will be be diagnosed with the help of the humble ant.

Because ecosystems are interconnected, understanding a few key species groups often gives clues to the health of the broader environment. Invertebrates, long used by aquatic ecologists, are usually the best kinds of indicator species. This is because invertebrates are so numerous, and because the varied roles they play in many ecosystems links them with most other organisms. Their rapid and dramatic responses to change make them valuable to scientists as natural 'measuring' devices. As a result, scientific interest in invertebrates has increased in the past decade or so.

Ants aplenty

Australia has more than 4000 species of ants, with up to 150 occurring in a single hectare. This makes Australian ant communities the richest in the world.

Ants are the main drivers of many ecological processes. They touch almost every species in some way, through interactions with soils, vegetation and other fauna.

As scavengers, ants are vital to energy turnover and nutrient cycling. Their relentless gathering of organic matter circulates nutrients through the ecosystem, and their tunnels and nests aerate and mix the soil.

Mutually beneficial (symbiotic) relationships between plants and animals often help plants to survive, thus shaping the composition of natural communities. Ants have many mutualisms with plants. In Australia, seed dispersal by ants (myrmecochory) is particularly important, involving more than 1500 plant species. In addition, ants are important seed predators of other plant species. For example, it is common for species of eucalypts to have 90% or more of their seeds eaten by ants.

Ants directly affect fauna as predators, prey and competitors. They also indirectly affect herbivory by regulating the composition of plant-feeding insects. The great variety of other arthropods which mimic ants, including numerous spiders, hemipterans and mantids, attests to the functional importance of ants in Australian ecosystems.

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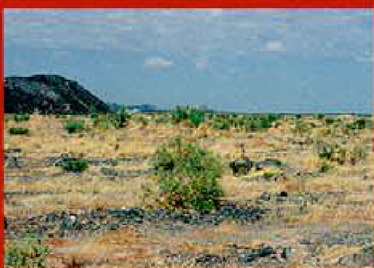

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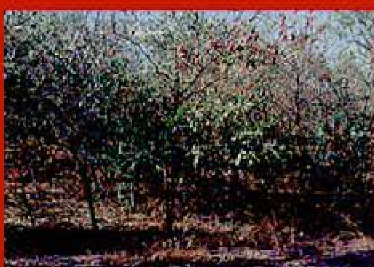

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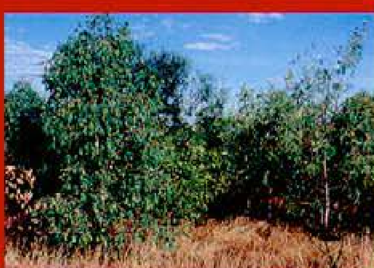

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Dr Alan Andersen found that ant succession at Ranger's revegetation trials had stalled. Acacia shrubs were too dense in the absence of control techniques to open up the canopy.

1. The waste rock dump before revegetation.

2. Revegetation after two years. The vegetation includes grasses and seedlings of woody species.

3. After four years the vegetation is dominated by fast-growing acacias which have suppressed other plants. Andersen's work indicates that a management burning regime is needed to open up the canopy and allow succession to resume.

4. A site adjacent to 3, but subject to burning after two years. The fire has prevented dominance by acacias, and allowed shrubs and trees to establish.

Considering the important role of ants in many ecosystems, you might think they'd be temperamental and difficult to work with. According to the scientists, however, they are perfect candidates for experiments 'in the field'.

Ants are easy to capture because their ground-dwelling habits make pitfall trapping simple and effective. Andersen places medical specimen jars, partly filled with preservative, into the ground to rim depth for a few days, then screws them shut and takes them for sorting. Another plus is that ants are not attracted to preserving alcohol. This means that the proportion of each kind of ant trapped will reflect population densities, not their penchant for alcohol!

Different species of ants exhibit distinct, physical differences. This means they can be identified by people without specialist training. Also, ants can easily be grouped into sex and age classes because almost all ants outside the nest are adult female workers.

Which ant are you?

Ant taxonomy in Australia is incomplete, so the capture of countless unknown species could constitute a logistic nightmare, with identification consuming most of researchers' time. But Andersen says that with ants, field workers don't need to name species. Instead, they can be sorted into genera and then classified into one of seven functional groups, each defined by their habitat requirements and competitive interactions (see diagram on page 9).

These functional groups enable ant communities from across Australia to be meaningfully compared, even if they have no species in common. Andersen says the main value of ants as indicators is that changes in the abundance of each functional group following known disturbances can be predicted.

Most Australian ant species nest in and forage over the ground. Minor groundcover disturbance can severely change soil exposure and litter levels, affecting all ants to some degree, but particularly the active, dominant groups which influence all the others.

The dominant functional group consists mainly of the large-colonied, aggressive *Iridomyrmex* genus. Ants from this group are particularly numerous in arid regions, accounting for up to 70% of trappings, and consuming most of the resources. Its dominance results from the speed with which its workers gather food in the high temperatures and open habitats of the arid region, and from their aggressive nature.

Disturbance, for example fire, will often reduce an *Iridomyrmex* population, weakening its dominance and freeing resources for other groups. It is the resulting high abundance of 'weedy' subordinate and opportunistic ants that indicates specific habitat changes that might otherwise be invisible.

What that can be inferred from the presence of subordinate groups varies with location. Different climatic zones and vegetation types have different 'normal' functional group mixes. For example, forests and shaded habitats

Trials study life after mining

Lessons learned during revegetation trials at the Ranger uranium mine will assist the development of a rehabilitation plan to be implemented when mining ceases in about 20 years' time. The aim is to establish ecosystems comparable with those naturally occcurring in the region.

Ranger's uranium deposits are located in a 79 km^2 area in the lowlands of the Alligator Rivers Region, about 230 km east of Darwin, surrounded by Kakadu National Park. Mining began in 1980. Three thousand tonnes of yellowcake are produced annually from the first ore body. Mining of a second body of ore is expected to extend the life of the mine until about 2012.

The mining operation incorporates an open cut pit, tailings dam, stockpiles of ore and construction materials, dumps of waste rock, sediment and water retention ponds, and a processing plant. It affects about 3 km^2 of the land. When mining is completed and the infrastructure removed, it is anticipated that the operational areas and structures will be covered with a landform constructed of waste rock and below-ore-grade material. A water-filled pit and other sediment control ponds are also part of the rehabilitation plan.

favour the poorly competitive, opportunistic, and cryptic (litter-dwelling) groups over *Iridomyrmex*. The particular habitats under scrutiny at the moment are the tropical woodlands and open forests of the Kakadu region. Here, Andersen is applying his knowledge of ant behaviour to assessing the success of minesite rehabilitation at Ranger.

Rehabilitation at Ranger

The Ranger uranium mine adjoining Kakadu has been controversial from the beginning. One of the sensitive issues remains the ecological effects of mining in a World Heritage area.

Ranger's environmental performance has been monitored by the Office of the Supervising Scientists (OSS), a federal body created specially for the job. Ranger is an important test case, with the future of further mining ventures in the region possibly hanging on its outcome.

The aim of rehabilitation at Ranger is to re-establish, as far as practicable, ecosystems comparable with those occurring naturally in the region, according to an agreed Northern Territory-Commonwealth objective. Should this be achieved, the area could be incorporated into Kakadu without spoiling its environmental integrity.

Rehabilitating a World Heritage area is an ambitious and pioneering project. According to Andersen, previous minesite rehabilitation programs elsewhere in the country often simply aimed to produce a landscape that 'looked green', but was not necessarily self-sustaining. To restore a functioning ecosystem, however, is much more difficult. Success at the Ranger site is therefore likely to set new standards of environmental rehabilitation.

Andersen has been working with the OSS to assess the value of ants as bioindicators. The study, rather than specifically assessing the Ranger site, is a practical test of Andersen's technique. It aims to characterise the link between ant diversity and disturbance, comparing ants with the composition and diversity of other faunal groups, and with major ecological processes (nutrient cycling and seed dispersal). One of the few related studies (at a rehabilitated bauxite mine in Western Australia) found that ant diversity was strongly correlated with the abundance of many other insect groups.

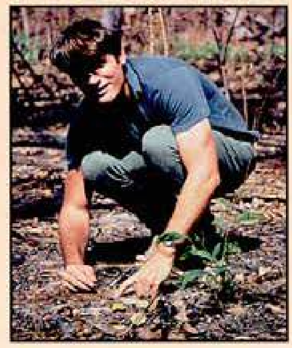
Andersen's own results have showed that ant succession at Ranger's revegetation trials has stalled at an early stage, with the ant groups present still resembling those usually found only a few years after disturbance. He says the reason for the blockage is that acacia shrubs have grown too dense in the absence of controlling fires or other management techniques. A management burning regime is needed to open up the acacia canopy, allowing succession to resume, and hopefully eventually restoring full ecosystem function.

Further research is needed before ants are adopted universally as environmental indicators. Andersen hopes to see his technique incorporated into future regulatory standards for assessing environmental impact and restoration success. Already, state government forest management agencies in New South Wales and Queensland have begun ant sampling programs to monitor ecological impacts of forestry practice.

It seems probable that one day researchers in Australia will diagnose the health of an ecosystem with the help of the humble ant. Perhaps we'll also learn to respond to environmental problems more rapidly.

Laid-back research

Conducting research in a tourist area can have its difficulties, Dr Alan Andersen (pictured) has found.



One day, while working at a study site, he heard a group of tourists on a nearby track. To avoid attracting them to the site, and possibly disrupting his experiments, he hid behind a low bush.

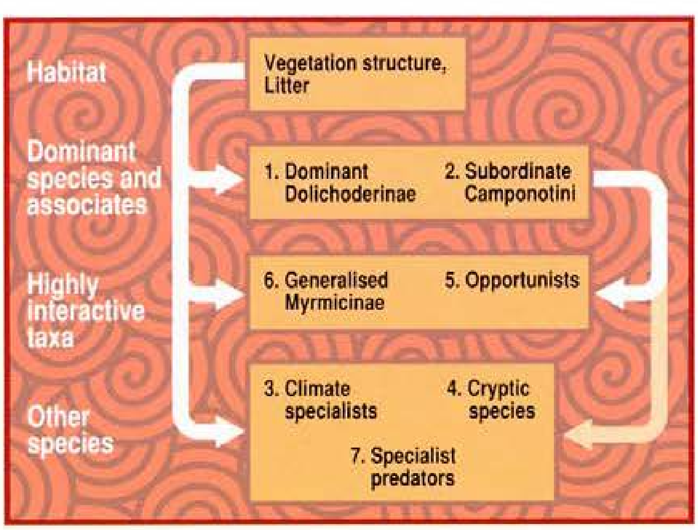
He listened as the tourists came closer, chatting away, until they were directly opposite. To his dismay they stopped, having noticed some flagging that was marking his pitfall traps.

'I wonder what that's for?' he heard someone say.

'Maybe we should ask that bloke hiding behind the bush,' came the reply.

Andersen sheepishly raised his head, and explained with embarrassment that he worked on ants, and that he was lying on the ground to get a closer look at a particularly interesting species.

Not a bad response . . . At least he got the lying part right!



A simplified model of ant community organisation in Australia, showing interactions between habitat variables and functional groups of ants. The arrows indicate the direction and magnitude of interaction. (Modified from Anderson, 1990)

More ant antics

Andersen AN (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.

Andersen AN (1993) Ants as indicators of restoration success at a uranium mine in tropical Australia. *Restoration Ecology*, September:156-167.