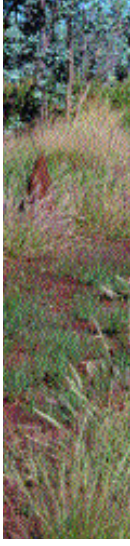
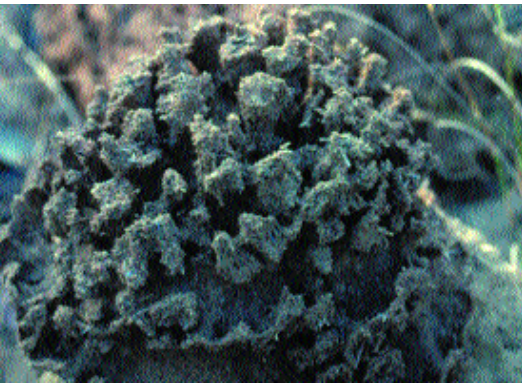


Just add termites

Graeme O'Neill discovers the restorative powers of termites, the earthworms of Australia's arid zone.



Tropical termites recycle large quantities of plant biomass into the soil and their tunnelling activities maintain soil porosity.

From a human perspective, termites are social insects with distinctly antisocial habits. They are ubiquitous in Australian landscapes, and some of the continent's 350-plus species stand their ground when humans colonise their territory. It's a moot point as to who is invading whom.

In suburbia, termites and their talent for 'recycling' cost hundreds of millions of dollars a year, but in natural ecosystems their benefits are invaluable. They may even merit recognition as 'keystone' species, a term coined by American biologist and author Professor Edward O Wilson to describe species whose loss can cause ecosystems to collapse, and other species to become extinct.

This may be the case in Australia's tropical north, where a project at Darwin's Tropical Savannas Cooperative Research Centre (CRC) is exploring the role of termites in maintaining ecosystem health and restoring land damaged by overgrazing or mining. Dr Garry Cook and Dr Tracy Dawes-Gromadzki of CSIRO Sustainable Ecosystems are part of the project team.

Cook says Australia's northern cattle-grazing industry relies heavily on the productivity of tropical savanna grasslands and woodlands. But heavy grazing in some areas has caused soil erosion and changes to dominant plant species, and a consequent reduction in water infiltration and plant growth.

Revegetating mine dumps is also a challenge in the tropics. Mine dumps are often low in nutrients, with thin soils commonly contaminated by heavy metals and acid drainage: a hostile environment for plants.

Vanguards of restoration

Cook says termites are the 'earthworms' of Australia's arid and seasonally arid regions, and manipulating termite density and activity may speed the restoration of degraded areas, or make ecosystems more resilient to disturbance.

He says tropical termite groups that variously specialise in eating grasses, leaf litter, wood and other organic matter recycle large quantities of plant biomass into the soil. They also keep the soil porous with their tunnelling, allowing water to infiltrate the soil profile, rather than evaporate. (In the intense tropical heat, evaporation rates typically exceed precipitation by a factor of two to three.)

'In areas with little vegetative cover, such as during the early stages of mine-site rehabilitation, the density of macropores in the soil is low,' Cook says.

'Macropores have a disproportionately important role in letting water into the soil: without them, rainwater runs off and the soil stays dry.'

The combination of high evaporation and runoff rates in the tropics, and the absence of macropores, makes it difficult for plants to survive. Using termites to

Heavy grazing in some areas of tropical savanna grasslands and woodlands has eroded and reduced water infiltration and plant growth. Manipulating termite density and activity may speed the restoration of degraded areas, or make ecosystems more resilient to disturbance.

create macropores would create rapid infiltration, which is critical to maintaining ecological processes.

'In our early work we found that if we put out mulch, in the form of dried grasses, on degraded soil, termites moved in rapidly and began creating macropores with their workings, allowing water to infiltrate,' Cook says.

'We also found that within a few weeks, mulched areas were colonised by other invertebrates such as centipedes, millipedes, native cockroaches, earwigs and ants, which all help to rebuild soil processes.

'We're trying to distinguish the direct effects of mulching from those due to invertebrates, by establishing plots with a range of treatments. Some have mulch, others have been left bare, and we have treated both mulched and bare sites with a commercial termiticide that also kills off other invertebrates.

'In similar savanna ecosystems in Africa, research has shown that the presence of termites greatly amplifies the benefits of mulching: they're a keystone group.'

Cook received some unexpected results from the early phase of a mulching experiment designed to run from the end of the 2001 dry season and through until the end of the wet. He discovered that the termites prefer to move in and eat the mulch when it is dry.

'They don't like the mulch when it is wet and beginning to decay,' he says.

When **soldiers** go **underground**

DR Tracy Dawes-Gromadzki of CSIRO Sustainable Ecosystems has become a dab hand at flushing our termites.

Her surveys and cattle-exclosure experiments near Charters Towers in northern Queensland are helping to determine whether declining productivity of perennial grasslands is linked to the loss of termites and other soil invertebrates.

Her chief interest is the four functional groups of termites: wood, grass, debris and organic-matter feeders.

'I've spent lots of time developing sampling methodologies,' she says. 'Some termite species are fairly inactive or cryptic, making them difficult to find.

'When I go into an area, I establish a set of one-hectare plots, and spend up to four hours searching the different niches. I also check out cattle-dung pads.

'Grass-eating termites such as the cathedral termite, *Nasutitermes triodiae*, and magnetic termite, *Amitermes meridionalis*, build mounds. Wood-eaters such as *Coptotermes* feed on standing trees or fallen trunks and branches. I just open up a mound or a log and take a few soldiers for identification.

'Other species are totally subterranean. I sample them with 30 cm wooden stakes laid on the surface, or buried vertically in the soil. I also lay toilet rolls on the surface, or bury them in the ground, because some species like the soft cellulose.'

Dawes-Gromadzki returns three months later, collects soldiers for identification, and rates the level of damage to her baits on five-point scale: zero for untouched, five for totally consumed.

'I've also been studying changes in community structure with soil type and vegetation,' she says.

'For example, some areas might have a greater proportion of grass versus wood feeders, which can be an important indicator of how that ecosystem functions.

'I also dig pits or small trenches in the soil, to get an estimate of the abundance of other invertebrates such as beetles, centipedes and earthworms. Given that tropical soils tend to be so hard in the dry season, I've been quite surprised to find so many earthworms.'

Top: Tracy Dawes-Gromadzki is studying links between perennial grasslands and termites and other soil invertebrates.

Above: A mound of the grass-eating termite, *Nasutitermes triodiae*. The dominant termite group in a particular area may be an important indicator of how that ecosystem functions.

Above: Alaric Fisher of the Northern Territory Parks and Wildlife Service is part of a team investigating whether termites and other soil invertebrates influence organism such as birds, mammals and reptiles.

Below: Lizards and ants inhabit abandoned termite mounds, while other birds and arboreal mammals such as possums live in tree limbs hollowed out by a partnership between termites and wood-rotting fungi.

'Termites can actually colonise quite dry soil, so depending on the season, we might see a different suite of invertebrate species colonising mulched areas.'

For the want of a termite . . .

Cook is developing another termite project with Northern Territory Parks and Wildlife Service vertebrate ecologist Dr Alaric Fisher, also with the Tropical Savannas CRC.

This project will investigate whether the nutrient cycling and soil conditioning activities of termites and other soil invertebrates indirectly influence the diversity of other organisms higher up the food chain, including birds, mammals and reptiles.

Cape York's endangered golden-shouldered parrot, *Psephotus chrysopterygius,* nests in termite mounds, as do several kingfisher species.

Certain lizards and ants also inhabit abandoned termite mounds, while other birds and arboreal mammals such as possums make their homes in tree limbs hollowed out by a partnership between termites and wood-rotting fungi. Many vertebrate species also eat termites.

Fisher is interested in conserving biodiversity on grazing properties outside national parks, and is trying to relate traditional measures of land condition, including pasture condition, to local biodiversity in plants and animals, both vertebrates and invertebrates.

The new project will measure biodiversity in areas with different levels of grazing intensity. Typically, areas with high grazing intensity and the greatest impacts on grass and soil are close to permanent water sources. Grazing intensity declines with increasing distance from water.

'In the Mitchell grasslands across northern Australia, some native animals and plants are actually advantaged by grazing, so the best way of measuring these effects is to study areas that have been subjected to different grazing intensities,' Fisher says.

'Fire and grazing are the big drivers of landscape condition in the north. Pastoralists are becoming more interested in using fire to manage grazing, and we want to determine how the various components of biodiversity respond to grazing pressure. Do some termite species decline under light grazing, and are others favoured by grazing?

'When we drive through heavily grazed areas of the bush, there appears to be a significant increase in the number of mounds that are built by one or two termite species.

'Are they feeding on cattle dung, which is rich in nutrients? And have other termite species that feed on grass become less abundant because of their competition with cattle?'

Fisher says an intriguing possibility is that termites may indirectly influence vertebrate biodiversity through their effects on soil fertility and permeability, which in turn affects plant growth and diversity.

If so, then termites and other invertebrate fauna may play a critical role in maintaining ecosystem health and preventing soil degradation and the decline of vertebrate biodiversity throughout the tropical savannas.

Just as the keystone in an arch prevents its collapse, so termites in tropical savannas may underpin the health of entire ecosystems. Reinstalling the keystones, by attracting termites into localised degraded areas in grazing lands or mine sites with palatable mulches may be the first step towards repairing damaged ecosystems and restoring their biodiversity.