Learning from nature's recyclers

Termites are well known for their love of fenceposts and floorboards, and as the creators of terra-cotta castles that rise like rockets from Australia's sunbaked savannas.

It's true that termites both annoy and amaze, but with some 3000 species worldwide – more than 350 of which are found in Australia – most of them simply perform the mundane task of breaking down organic materials and restoring their nutrients to the soil.

The termites' expertise in this area has captured the attention of ecologists who are exploring the insects' multiple roles as restorers of ecosystems, important agents of soil formation and maintenance, and indicators of rehabilitation success after landscape disturbance such as mining.

One mining company with a special interest in termites is the Commonwealth Aluminium and Minerals Co. (Comalco), which mines bauxite and kaolin (china clay) at Weipa on the northeastern side of Queensland's Cape York Peninsula. In 1967, four years after shipping its first load of bauxite, Comalco began a program to rehabilitate the mined land. More than 6000 hectares have since been revegetated.

Comalco worker Charlie Williams measures a termite mound in an area that has been rehabilitated after mining. Preliminary results of a study begun early in 1995 demonstrate a rapid development of native termite populations in areas rehabilitated for more than one year.

Bauxite mining involves removing the topsoil to expose the aluminium-rich materials, which are removed for processing. Rehabilitating the mined areas involves replacing the topsoil layer and planting appropriate vegetation. At Weipa, a range of vegetation including pasture, exotic forest and shrub legumes has been used. Since the mid-1970s, many mined areas have been replanted to native woodland species.

Comalco's environment officer at Weipa, Paul Warren, says the type of vegetation established after mining is determined in consultation with the Napranum Community in accordance with the Queensland Government's Environment Management Overview Strategy (EMOS).

Under the EMOS guidelines, rehabilitated mine-sites must comply with three broad principles. Unless alternative agreements are reached, the sites should support a land use similar to that prior to disturbance; they should be be self-sustaining; and the surface and ground waters that leave the area should not be degraded to a 'significant extent'.

Planting a 'garden' that needs to be managed to survive is not good enough. For an ecosystem to be self-sustaining, major ecological processes must be re-established. The processes include:

- satisfactory growth and development of the plant and animal communities including ecosystem-level nutrient recycling processes;
- development of an appropriate level of biodiversity; and
- a continuing level of soil development.

Comalco has commissoned a number of studies to ensure that this occurs. One of these is looking at the recolonisation of mine-sites by termites. The project, part of CSIRO's Minesite Rehabilitation Research Program, is led by Dr Alister Spain from the Division of Soils.

Spain is sampling termites at a number of rehabilitated sites including those resown to native forest species and comparatively undisturbed native forest sites. Other comparisons are being made in sites rehabilitated to exotic pasture and other exotic species such as *Pinus caribaea* and *Leucaena leucocephala*.

Apart from the wood-feeding termites that attack houses, there are groups of species that feed on such detritus as fine litter on the ground surface, seeds, or animal dung, Spain says. Another major group of Australian termites feeds on dead grasses, which they cut up into sections and store in nests either beneath the soil surface, or in mounds built at the surface. A number of species also nest up trees.

A section of a broken-open mound exposes the handiwork of *Nasutitermes triodiae*, a common grass-harvesting termite of the Weipa region. The balance of termite species at each site differs according to the length of time an area has been rehabilitated, and between various environments.

Termites are also important in soil development as creators of galleries and underground nests. During construction, soil materials are moved upwards, downwards and laterally through the soil and onto the soil surface. The nests built at the soil surface contain substantial amounts of soil materials (more than 60 tonnes per hectare) and large masses of soil materials are used to form temporary covers over feeding materials.

An interesting technique has been devised for monitoring the termites' activities. It seems that although termites have a range of tastes, many just can't resist the lure of toilet paper! Rolls of toilet paper are used as readily-digestible cellulose baits. They are exposed on the soil surface at various times of the year and the wood-feeding termites attracted to them are collected after 10-week periods. Any mounds present and other termite constructs are also sampled, together with dead woody materials.

Preliminary results of the study, which began early in 1995, demonstrate a rapid development of native termite populations in areas rehabilitated for more than one year. As measured by attacks on the baits, activities were higher in some rehabilitated sites than in certain native forest sites.

Termites were also active in a number of sites rehabilitated to exotic vegetation. However, the balance of species differs with the length of time an area has been rehabilitated and between various environments.

As the study progresses, answers will be sought to many questions concerning the role of termites. Which species are present at which sites? What is their preferred diet? Do different groups of termites become active at various stages of rehabilitation? How do they affect the chemical and physical properties of the soil? Should they be encouraged to return to mine-sites?

When these issues are understood, the scientists will be able to educate managers of rehabilitation projects about the benefits of nature's own restoration agents.

Contact: Dr Alister Spain, CSIRO Davies Laboratory, Private Mail Bag PO Aitkenvale, Qld 4814, (077) 53 8586, fax (077) 53 8600.

A book worth its salt

The swamp sheoak (*Casuarina glauca*), true to its name, occurs naturally on flat, swampy sites and is usually associated with brackish or salty water and high water tables. It tolerates drought and moderate frosts, produces excellent firewood, and can be used in windbreaks, to stabilise soils, and even as a supplementary fodder for sheep.

With attributes such as these, this hardy native of Australia's south-east coast was bound to feature in *Trees for Saltland, a guide to selecting native species for Australia*, a new publication from CSIRO's Division of Forestry. The swamp sheoak is one of 60 species described in the manual which is designed to assist landholders, landcare and community groups, planners, researchers and others to select trees for salt-affected land.

The book is researched and written by Dr Nico Marcar, leader of the CSIRO project Trees for Degraded Land, and team members Debbie Crawford and Peter Leppert, and Tom Jovanovic, with contributions from Drs Robert Floyd and Roger Farrow from the Division of Entomology. The Trees for Degraded Land team has evaluated salt-tolerant trees in field and glasshouse studies in Australia, Pakistan and Thailand during the past 10 years.

Salt-tolerant trees have been evaluated in field and glasshouse studies by the Trees for Degraded Land team at CSIRO's Division of Forestry

About one-third of Australia (29 million hectares) is naturally salt-affected. In addition, there are more than four million hectares of secondary or human-induced saline soils. These may be saline or sodic subsoils (scald) left behind after soil erosion in low rainfall pastoral zones, or the result of raised water tables caused by vegetation clearing (saline seepage) or irrigation mismanagement. There are more than 1.2 million hectares of dryland salinity and 500 000 ha of irrigation land with high saline water tables.

In the past 20 years trees have become part of a biological approach to managing salinity. Salt-tolerant trees can be planted on key 'recharge' (water intake) areas, and on or near 'discharge' (seeps and scalds). Planting trees in these locations can help lower water tables; reduce erosion; provide shade, shelter, and wildlife habitat; decrease stream and river salinity; improve land values; and provide a range of wood and non-wood products.

Most dryland salinity is in the wheat growing and sheep grazing zones of Western Australia and South Australia. Some of the species described in Trees for Saltland are potential commercial producers in these regions. The southern blue gum (*Eucalyptus globulus* subsp. *globulus*) is grown for pulpwood in the higher rainfall areas of WA's wheatbelt, and in drier areas, the blue mallee (*E. polybractea*) is harvested for oil production.

High salt concentrations affect the ability of most plants to extract water from the soil. This is called an osmotic effect, because the plant must obtain soil water through its roots against an osmotic (or salt concentration) gradient. Salt-tolerant tree species have a better ability to exclude salts from their roots than salt-sensitive species. They rely heavily on organic solutes (such as sugars and amino acids derived from photo-synthesis) and inorganic solutes such as potassium, calcium and nitrate to counteract (or adjust to) the induced osmotic stress.

Other species (halophytes), as well as excluding salts at the roots, are better at dealing with salt accumulation in their leaves. They take salts into the vacuoles of leaf cells, or secrete salts onto the leaf surface in special glands and bladders (such as in mangroves and saltbush). Salts on leaf surfaces can then be washed away.

Some of the trees described in the book are also adapted to waterlogged sites. Waterlogging is often associated with saline soils because most of the root zone is already moist from rising water tables or seepage from perched water tables higher up in the landscape and/or infiltration and permeability are low due to sodicity.

Trees for Saltland and a related book *Saltland Pastures in Australia*, produced by the Western Australian Department of Agriculture, also contribute to the goals of the National Program for the Productive Use and Rehabilitation of Salt-affected Land.

Trees for Saltland: a guide to selecting native species for Australia, *costs $19.95 plus postage. Contact the CSIRO Bookshop, PO Box 89, East Melbourne, Victoria 3002, (03) 9418 7217, toll-free 1800 645 051, fax (03) 9419 0459, email: bookshop@csiro.cis.au.*