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The role of ants in minesite restoration in the Kakadu region of Australia's Northern Territory, with particular reference to their use as bioindicators

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Executive summary

The goal of land rehabilitation following mining in environmentally sensitive areas is often ecosystem restoration, rather than simply revegetation. This is the case at Ranger uranium mine (RUM) in the Alligator Rivers Region of Australia's Northern Territory. Effective methods of monitoring ecological restoration are therefore required. Ants have frequently been used as indicators of restoration success following mining in northern Australia, but the extent to which ants actually provide a reliable indication of ecological change has been poorly documented. This study aimed, primarily, to investigate the degree to which ants provide an indication of the general status of ecosystems and, secondarily, to examine the direct role of ants in ecosystem restoration. The desired outcome was the development of procedures for using ants to assess restoration success following mining in the Ranger uranium mine region.

A total of 39 sites were selected to represent the full range of sclerophyll habitats and disturbance histories in the region. They comprised 22 natural (ie relatively undisturbed by human activity) sites, ten disturbed (representing a wide range of human disturbances) sites, and seven sites at various stages of rehabilitation on Ranger's main waste rock dump. All vascular plant species occurring at each site were surveyed during March 1994.

Ants were sampled on three occasions at each site using pitfall traps, recording a total of 162 species from 32 genera. Site species richness was highly correlated with plant species richness ($r = 0.695$ for all plant species; $r = 0.663$ for woody species only). Five measures of ant community composition were analysed, covering the species, genus and functional group levels. Bray-Curtis association matrices based on ant community composition were highly correlated (r ranging from 0.492 to 0.665) with association matrices based on plant species composition.

Data were obtained on the ordinal composition of invertebrate assemblages in the soil, on the ground and on ground vegetation, and on species composition of beetles, grasshoppers and termites. Correlation analyses were performed on site association matrices based on these data and site association matrices based on five measures of ant community composition. There was only a marginal correlation between ant community composition and soil invertebrate assemblages (r ranging from 0.194 to 0.282; only 10 sites sampled), but a good correlation with ground-foraging invertebrates (0.238–0.341; all 39 sites), and an even higher correlation with invertebrates on ground vegetation (0.471–0.675; 31 sites). Ant community composition was correlated with the species composition of all insect groups studied (beetles: 0.398–0.533, 31 sites; grasshoppers: 0.412–0.454, 27 sites; termites: 0.168–0.280, 39 sites).

A litter decomposition experiment was conducted during the 1993/94 Wet season, measuring biomass loss of leaves of *Eucalyptus tetrodonta* and *Acacia auriculiformis*. Eucalyptus leaves decomposed far more rapidly than those of Acacia, but rates of decomposition did not vary markedly across sites. Soil microbial biomass and respiration, on the other hand, did vary markedly across sites, and were correlated with ant species richness. This correlation was particularly high ($r = 0.638$) at disturbed and waste rock sites.

Studies were conducted on the potential influence of ants, through their interactions with seeds, on ecological restoration following disturbance. Elsewhere in Australia, it is common for sites severely disturbed by human activity to be colonised by high densities of harvester ants, resulting in unusually high rates of seed predation. This could have a serious impact on revegetation following disturbance. However, this is unlikely to be a problem in the Ranger

uranium mine region, as disturbance does not appear to lead to increases in either harvester ant populations, or rates of seed harvesting (which, during 1992 and 1993 respectively, averaged 27% and 32% at natural sites, 26% and 28% at disturbed sites, and 6% and 14% at waste rock sites). Disturbance, on the other hand, has a major impact on seed dispersal by ants, primarily through its influence on the distribution and abundance of ant species. On waste rock sites, for example, no seeds were transported further than 50 cm (compared with up to 13 m at other sites). The influence of this on seedling establishment is unknown.

Two major conclusions can be drawn from this study. First, ant communities in the Ranger uranium mine region provide a very good general indication of the state of ecosystems in which they occur. Second, the indicator performance of ants at the functional group level is in most cases comparable, and sometimes superior, to that at the species level. Given that ants need only be identified to genus to be assigned to functional groups, the use of functional groups instead of species is a legitimate, cost-effective measure for rapid assessment.

It is therefore recommended that ants be included in biological monitoring of restoration programs in the region. Ideally, ant communities should be analysed at both species and functional group levels, but the use of functional groups alone would be adequate. A specific sampling protocol is recommended.

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Preface

This is the final report as required under the consultancy agreement between the Environmental Research Institute of the Supervising Scientist (***eriss***) and CSIRO Division of Wildlife and Ecology (the consultant, Principal Investigator, Dr Alan N Andersen).

The *aims* of the consultancy were:

1. to assess the extent to which ants provide an indication of the general status of ecosystems (including those undergoing restoration) in which they occur,
2. to examine the influence of ants on ecosystem restoration dynamics, and
3. hence develop procedures for assessing restoration success, in the Ranger uranium mine region of the Top End of the Northern Territory.

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