PLANT COMMUNITIES OF GREENSTONE HILLS OF THE EASTERN GOLDFIELDS OF WESTERN AUSTRALIA AS ANALOGUES FOR THE REHABILITATION OF ROCKY WASTE DUMPS

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Submitted by

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Frontispiece: Mt. Burges rising above the plain to the northwest of Coolgardie, Western Australia.

I declare that this thesis is my own account of my research and contains as its main content work which has not previously been submitted for a degree at any tertiary educational institution.

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Shane Thomas Samuel Chalwell

Abstract

The vegetation of greenstone hills in the Kalgoorlie area of the Eastern Goldfields region of Western Australia was studied to identify the key environmental influences on community and species distribution. This information was needed to determine if plant communities of the hills could provide analogues for the rehabilitation of waste rock dumps that are produced as a consequence of open cut mining.

The ridges, slopes and flats adjacent to the main slope were examined and the floristic data sorted into communities. Two structurally and floristically distinct alliances were identified, one dominated by eucalypt species and the other by *Acacia quadrimarginea*. The eucalypt woodland displayed a taller upper stratum and few groundlayer species and was the dominant vegetation of the flats at the base of the hills. The acacia community was a low woodland and is the dominant vegetation of the hill slopes. Both communities were dominant at an equal number of sites on the ridges of the hills.

An investigation of the environmental variables found that edaphic, rather than topographic, factors were responsible for the community distribution on the hills. The eucalypt woodland showed a strong affinity to soils derived from calcrete, which had higher levels of electrical conductivity and lower exchangeable sodium percentages than the soils of the acacia low woodland. Under such conditions, the clay fraction of the soil remains in a more flocculated state allowing higher rates of water infiltration and hydraulic conductivity compared to the acacia soils. Soil nutrients were found to have a secondary influence on community distribution and had a greater effect on species distribution within alliances.

A study of the seasonal variation in water content of the soils showed that more moisture is retained in the upper soil horizons in the acacia community than in the eucalypt community during the wetter part of the year, indicating the acacia soils had poorer infiltration properties than the eucalypt soils. The distribution of drought tolerant species such as *A. quadrimarginea* and *Prostanthera incurvata* was found to be correlated to soil moisture content of the dry season whilst no correlation was found for the eucalypts at any time of the year.

Seasonal comparisons of leaf moisture content and xylem pressure potential showed that the eucalypts maintained their total leaf moisture content throughout the year whereas species such as *A. quadrimarginea* and *Allocasuarina campestris* recorded high levels of desiccation of their leaf tissue over the summer. The eucalypts also maintained a more consistent pre-dawn xylem pressure potential throughout the year than either *A. quadrimarginea* or the shrub species *Dodonaea microzyga,* indicating a greater degree of stomatal control and access to a more consistent soil water supply. The eucalypts require access to a greater soil volume than the acacias or shrubs in order to ensure sufficient water supplies for the maintenance of tissue moisture levels throughout the year. In this way, the eucalypts are able to effectively avoid the summer drought, whereas the acacias and shrubs are able to tolerate desiccation of their leaf tissues over this period.

Investigations of the germination requirements and early seedling survival of prominent species from the greenstone hills indicated that fire may be a factor in the regeneration of most hills species. All studied species were either tolerant of or responded positively to the application of dry heat. In relation to seedling establishment on waste dumps,

increasing the soil moisture content of waste dump soils increased the germination rate of most species but did not result in greater seedling survival at the end of the first summer. The provision of microsites which encouraged root development and provided protection for the young seedlings was found to be more important in reducing mortality rates in the first year than increasing the total germination.

The study emphasized the importance of physical soil factors and the soil moisture regime in the distribution of eucalypt and acacia communities on the greenstone hills. A species' response to drought stress strongly influences its ability to compete for soil water on different soil types. The eucalypts studied in this project dominated on soils where there is better recharge of subsoil water reserves which can be accessed over the summer period to maintain tissue water levels. Acacias are tolerant of tissue desiccation and will compete successfully on shallower soils and where hydraulic conductivity is poor.

Although the project was valuable in identifying water relations as the main control on community distribution on the hills, waste dumps are not strictly analogues of intact greenstone hills due to the differences in rock type and profile formation. Electrical conductivity levels are also higher due to extraction processes. However, the environmental relationships of the different species show that the more drought tolerant species such as *Allocasuarina campestris, Acacia quadrimarginea* and understorey species associated with them, may be suitable species to form the basis of vegetation re-instatement on waste dumps in the Kalgoorlie region.

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