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Flora and vegetation of the banded iron formation of the Yilgarn Craton: Robinson Ranges and Mount Gould

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ABSTRACT

A quadrat based study of the flora and vegetation of the Robinson Ranges and Mount Gould, found 170 taxa including 1 weed taxon. Two priority taxa were recorded and two new taxa identified. Fifty quadrats were established to cover the major geographical, geomorphologic and floristic variation across the hills. Data from 49 of these quadrats were used to define seven community types. Differences in communities were strongly correlated with soil chemistry, elevation, amount of exposed bedrock, surficial rock size and slope. Several communities had restricted distributions. None the plant communities of Robinson Range or Mount Gould are currently in the secure conservation estate.

INTRODUCTION

The Robinson Ranges is located in the southern part of the Gascoyne bioregion on the northern edge of the Yilgarn Craton. The ranges extend over 200 km, beginning near the Great Northern Highway, 140 km north of Meekatharra, and extending west to Mount Padbury. The ranges lie in the southern part of the Capricorn Orogen, an early Proterozoic orogenic belt (Gee 1987) and are dominated by banded iron formations forming major resistant ridges (Elias & Williams 1980). They are made up of varied proportions of banded iron formation and hematitic shales (Elias & Williams 1980). The highest unit of the range, east of Mount Fraser, consists of exposed chloritic and hematitic shales (Elias & Williams 1980). Although formed during the same tectonic phase, Jack Hills, 120km south-west, differs in lithology and metamorphic grade (Elias 1982).

Mount Gould is located in the Murchison bioregion, part of the Narryer Terrane of the northern Yilgarn Block (Department of the Environment and Water Resources 2004, Cassidy *et al.* 2006). Mount Gould is dominated by chloritic schists and banded-iron formations (Elias & Williams 1980). Compared to the Robinson Ranges, Mount Gould is more similar to Jack Hills, 30 km south, as both areas contain similar schists, quartz, muscovite, biotite and magnetite (Elias & Williams 1980, Elias 1982).

The climate of the region is arid with mild winters and hot summers and a bimodal rainfall distribution with summer and winter rain. The mean annual rainfall at Peak Hill, 30km east of Mount Fraser, is 237.8 mm. Summer rainfall peaks in January and February and is influenced by cyclonic activity off the Pilbara coast of Western Australia. Cyclones that cross the coast dissipate and develop into rain bearing depressions which may bring rain into the centre of the state. In addition, thunderstorms may develop from convectional activity (Curry *et al.* 1994). Winter rainfall is often the result of cold frontal activity associated with low pressure systems in the south west of Western Australia. These systems often weaken as they move inland and result in isolated showers and strong winds (Curry *et al.* 1994). The highest maximum temperatures occur during summer, with the January as hottest month (mean maximum temperature 37.5 °C). Winters are mild with lowest mean maximum temperatures recorded for July of 18.9 °C. Temperatures rarely fall below 2 °C in winter, with mean minimum of 7.5°C in July.

Previous surveys by Beard (1976) described the Robinson Range occurring as part of the Gascoyne Ranges (Beard 1975), in contrast to Mount Gould and Jack Hills, which are part of the Upper Murchison sub-region. The relief of the southern region of the Gascoyne Ranges is subdued, with smaller and fewer ranges separated by broad flat valleys and plains. Beard (1976) mapped the steepest and stoniest parts of Robinson Ranges as covered with *Acacia aneura*, *A. quadrimarginea*, *Acacia tetragonophylla* over *Eremophila*, *Senna* and *Solanum* spp. This description closely follows the vegetation descriptions by Wilcox and McKinnon (1972) in the inventory of the Gascoyne Catchment. However, Beard (1976) further describes the slopes of the ranges as having denser vegetation and shrubs of *Eremophila latrobei*, *Eremophila exilifolia* and *Dodonaea* spp. while the low stony hills were covered with a mixture of *A. aneura*, *Acacia grasbyi*, *Acacia xiphophylla* and *Acacia victoriae* with *Cassia helmsii*, *Cassia pruinosa* (sic), *Eremophila fraseri*, *Eremophila cuneifolia* and *E. exilifolia*. In contrast to this level of detail, Mount Gould was mapped as *A. aneura* and *A. quadrimarginea* scrub, the same unit as Jack Hills (Beard 1976).

Following the survey work by Beard (1975, 1976), an inventory and rangeland condition survey of the Murchison River Catchment was undertaken by Curry *et al.* (1994). Only the western extent of the Robinson Ranges on Mt Padbury Station (including the highest peaks, Mt. Fraser and Mt. Padbury) were mapped and classified as the Peak Hill land system, originally described by Wilcox and McKinnon (1972). Moreover, Curry *et al.* (1994) differ from Beard and also describe Mount Gould as part of the Peak Hill land system. The land system classification used by Wilcox and McKinnon (1972) follows a catenary sequence of vegetation communities related to topography and geology. In the case of the Peak Hill land system, it is composed of hills and ridges (50%), lower slope and interfluves (40%) and drainage floor and minor channels. The vegetation was described as being dominated by *A. aneura*, *A. tetragonophylla* with scattered *Eremophila*, *Cassia* (sic) and *Solanum* spp.

To date, there have been no targeted surveys of the Robinson Ranges and Mount Gould and the only descriptions have been part of a broader condition or mapping survey (Beard 1975,1976; Curry *et al.* 1994). Previous vegetation surveys of other Banded Iron Formation ranges have shown the presence of rare and endemic taxa and the floristic communities that are unique to and often restricted to the range (Gibson and Lyons 1998a, 1998b; 2001a, 2001b; Gibson 2004a, 2004b; Markey & Dillon 2008a, 2008b; Meissner and Caruso 2008a, 2008b, 2008c). The aim of the present study was to undertake a detailed floristic survey of the Robinson Ranges and Mount Gould and to identify the flora and plant communities that occur on these ironstone ranges.

This study forms part of an on going series of papers documenting the flora and vegetation occurring on Banded Iron Formations across the Yilgarn (Markey and Dillon 2008a, 2008b; Meissner and Caruso 2008a, 2008b, 2008c). Ultimately the data will help elucidate the regional compositional patterning in the vegetation across the Yilgarn banded ironstone ranges and assist in conservation assessments.

METHODS

The methodology employed in this survey follows the standard procedure used in previous vegetation surveys of other ironstone and greenstone ranges in Western Australia (Gibson and Lyons 1998a, 1998b, 2001a, 2001b; Gibson 2004a, 2004b; Markey and Dillon 2008a, 2008b; Meissner and Caruso 2008a, 2008b, 2008c). Fifty 20 x 20 m quadrats were established on the crests, slopes and foot slopes of Robinson Range and Mount Gould in August 2006 (Figure 1). Quadrats were established to cover the broader geographical and geomorphological variation found in the study area. The quadrats were strategically placed in vegetation across the range in a toposequence, from crests and slopes of exposed bedrock and scree, to footlsope and plains composed of colluvial deposits. Each quadrat was permanently marked with four steel fence droppers and their positions determined using a GPS unit. All vascular plants within the quadrat were recorded and collected for later identification at the Western Australian Herbarium.

Data on topographical position, disturbance, abundance, size and shape of coarse fragments on surface, the abundance of rock outcrops (defined as the cover of exposed bedrock), cover of leaf litter and bare ground were recorded following McDonald *et al.* (1990). Additionally, growth form, height and cover were recorded for dominant taxa in each strata (tallest, mid- and lower). The quantitative data were used to describe the plant communities following McDonald *et al.* (1990).

Twenty soil samples were collected from the upper 10 cm of the soil profile within each quadrat. The soil was bulked and the 2 mm fraction extracted using the Mehlich No. 3 procedure (Mehlich 1984). The extracted samples were analysed for B, Ca, Cd, Co, Cu, Fe, K, Mg, Mn, Mo, Na, Ni, P, Pb, S and Zn using an Inductively Coupled Plasma – Atomic Emission Spectrometer (ICP-AES). This procedure is an effective and cost efficient alternative to traditional methods for evaluating soil fertility and has been calibrated for Western Australian soils (Walton and Allen 2004). pH was measured in 0.01M $CaCl_2$ at soil to solution ratio of 1:5. Effective cation exchange capacity (eCEC) was calculated from the sum of exchangeable Ca, Mg, Na and K (Rengasamy & Churchman 1999). Exchangeable Ca, Mg, Na and K were obtained by multiplying the values of Ca, Mg, Na and K obtained from ICP-AES by a standard constant. Organic carbon was measured on soil ground to less than 0.15 mm using Metson's colorimetric modification of the Walkley and Black method 6A1 (Metson 1956; Walkley 1947). It involved wet oxidation by a dichromate-sulfuric acid mixture, which produced enough heat to induce oxidation of the organic carbon (Rayment and Higgenson 1992). Total Nitrogen was measured using the Kjeldahl method 7A2 (Rayment and Higgenson 1992). The nitrogen was measured by automated colorimetry by the nitroprusside/dichloro-S-triazine modification (Blakemore *et al.* 1987) of the Berthelot indophenol reaction reviewed by Searle (1984). Electrical conductivity (EC) was based on a 1:5 soil/deionised water extract and measured by a conductivity meter at 25° C (Rayment and Higgenson 1992).

Quadrats were classified on the basis of similarity in species composition on perennial species only and excluding singletons. This was to facilitate comparison with other analyses of banded ironstone ranges and remove any temporal variations in annuals numbers that may confound comparisons (Gibson and Lyons 1998 a, 1998b, 2001a, 2001b; Gibson 2004a, 2004b; Markey and Dillon 2008a, 2008b; Meissner and Caruso 2008a, 2008b, 2008c). The quadrat and species classifications were undertaken using the Bray - Curtis coefficient followed by Flexible UPGMA (Unweighted pair-group mean average; $\beta = -0.1$; Belbin 1989) clustering. The Bray –

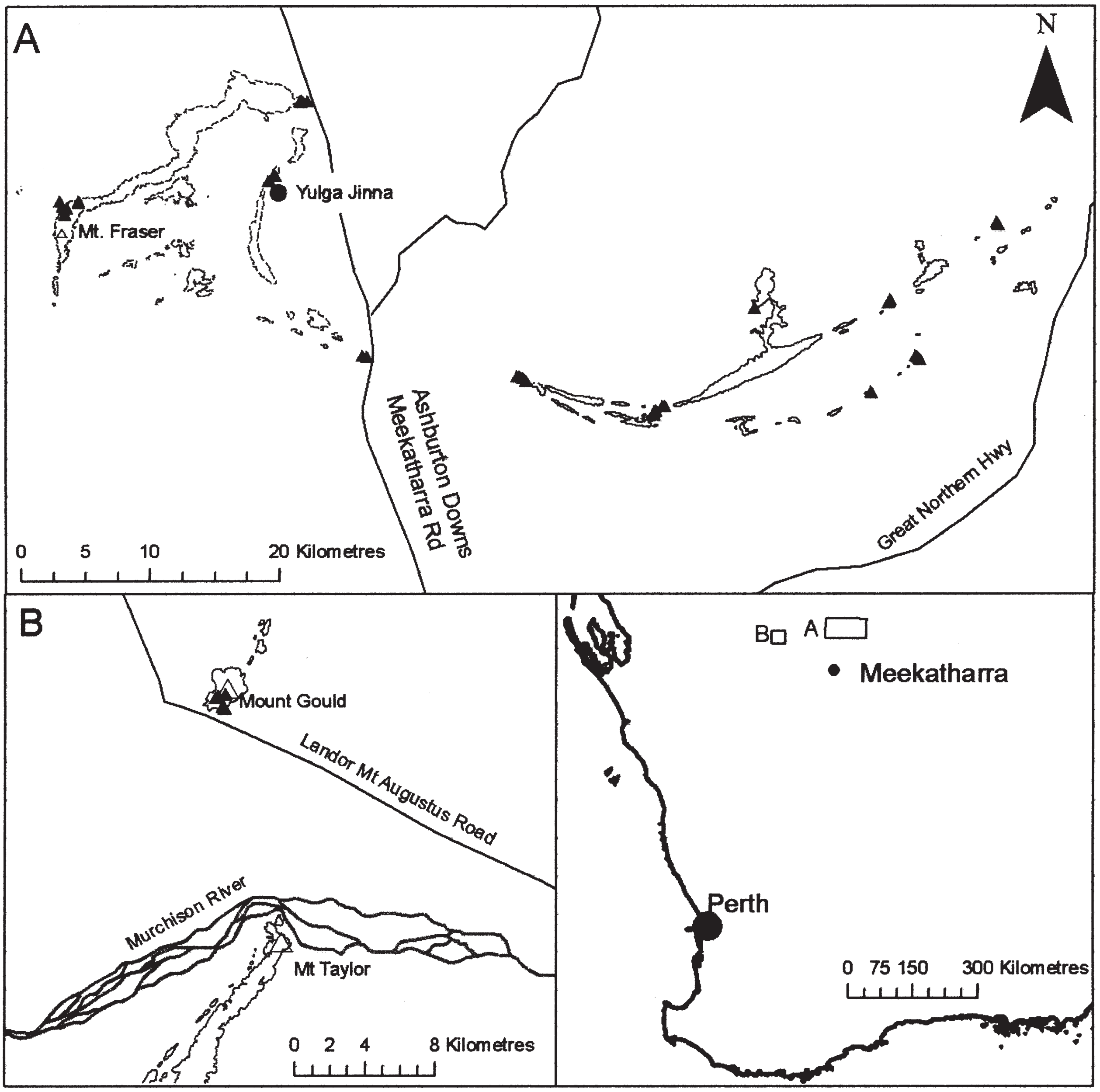

Figure 1. Location of the study area. ***A.*** *Distribution of the 45 quadrats (▲) along Robinson Range. Mount Fraser is the highest Peak (Δ). The 580m (dashed) and 600m contours are shown.* ***B.*** *Distribution of the 5 quadrats (▲) on Mount Gould (Δ). The 420m contour is shown.*

Curtis coefficient is commonly used in ecological studies especially in presence/ absence datasets (Belbin 1989; Clarke *et al.* 2006) while Flexible UPGMA is an effective method of recovering true group structure (Belbin and McDonald 1993). PATN uses a beta value of -0.1 in Flexible UPGMA to dilate and counteract the known underestimation of larger association values (Belbin 1989; Belbin *et al.* 1992). Indicator species and species assemblages characterising each community were determined following Dufréne and Legendre (1997) using INDVAL routine in PC-ORD (McCune and Mefford 1999). Quadrats were ordinated using SSH (semi-strong hybrid multidimensional scaling), a non parametric approach and not based upon the assumptions of linearity, or presume any underlying model of species response gradients. Correlations of environmental variables were determined using PCC (Principal Component Correlation) routine and significance determined by MCAO (Monte Carlo Attributes in Ordination) routine in PATN (Belbin 1989). PCC uses multiple linear regressions of variables in the three dimensional ordination space (Belbin 1989). Statistical relationships between quadrat groups were tested using Kruskal-Wallis non parametric analysis of variance (Siegel 1956), followed by Dunn's Multiple comparison test (Zar 1999).

Nomenclature generally follows Paczkowska and Chapman (2000).

RESULTS

Flora

A total of 170 taxa were recorded from Robinson Range and Mount Gould, represented by 40 families in 81 genera. The best represented families were Poaceae (19 taxa), Asteraceae (15), Malvaceae (13), Mimosaceae (13) and Amaranthaceae (10). The most common genera were *Acacia* (13 taxa), *Eremophila* (9), *Ptilotus* (10), *Senna* (7) and *Sida* (6).

Rare and Priority Flora

Two priority flora were found during the survey.

- *Euphorbia sarcostemmoides* (Euphorbiaceae) is a Priority 1 flora known only in Western Australia from a single location at Mount Augustus, 400 km to the northeast. It is more commonly known from central Australia where it grows on hard, rocky hilltops on skeletal soils (Hassall 1977). It is a succulent leafless shrub growing to 2m with small yellow flowers. It was collected from two sites, on a crest and lower slope, located near the Ashburton Downs-Meekatharra Road.
- *Baeckea* sp. Melita Station (H. Pringle 2738) is a myrtaceous shrub to 2.5m with a characteristic hooked leaf and white flowers. This was found as an isolated shrub growing on Mount Fraser with the nearest known population 200km southeast of Robinson Range.

New Species

Two new species were discovered from the survey of Robinson Range.

- *Pityrodia ipthima* is a shrub to 1.2m with a spike inflorescence of bright purple flowers. It is closely allied to *Pityrodia augustensis*, a declared rare flora growing on Mount Augustus, 400 km north west of the range. It was initially thought to be *P. augustensis*, but upon closer investigation has discolorous leaves, larger, ovate bracts, longer calyx tube, shorter branched hairs on the outer surface of the calyx, and shorter filaments (Shepherd 2007).
- *Indigofera fractiflexa* subsp. Mount Augustus (S. Patrick & A. Crawford SP4734) is a subshrub to 1m, with pink pea flowers. Three specimens had been collected previously from Mount Augustus but were not distinguished as a subspecies. Upon further examination the specimens from Robinson Range differed from the Pilbara collections by possessing a glabrous adaxial leaf surface, mucronate tip, obovate to ovate leaflets, nine leaflets, paired stipules to 2mm and rust red glandular clavate hairs in the leaf axils. *Indigofera fractiflexa* (*sensu stricta*) is found growing on slopes and crests on ironstone in the Hamersley Ranges of the Pilbara while *Indigofera fractiflexa* subsp. Mount Augustus (S. Patrick & A. Crawford SP4734) was found growing in similar positions in the landscape, from the midslopes to crests of Robinson Ranges.

Flora of Taxonomic Interest

Several other taxa collected during the survey are of taxonomic interest. They could not be identified beyond genus, even with sufficient floral and fruiting material. Further taxonomic work and additional collections need to be made to determine their significance and status.

- *Halgania gustafsenii* var. Murchison (R. Meissner & B. Bayliss 743) is a shrub to 50 cm found growing on the slopes of Mount Gould. *Halgania gustafsenii* is a complex of several undescribed varieties with previous collections from Mount Gould placed within *Halgania gustafsenii* var. *gustafsenii* ms. However, these collections differ from collections of *H. gustafsenii* var. *gustafsenii* ms from nearby Jack Hills. The collections from Jack Hills have long silky hairs on the leaves and dense silky hairs on the peduncles, while the leaves and peduncles of the Mount Gould collections were sparsely silky with sessile glands. In addition, the plants appear morphologically different in the field, with much greener rather than silver grey leaves at Mount Gould. Further taxonomic work is needed to resolve the varieties within *Halgania gustafsenii*.
- *Hibiscus* cf. *solanifolius* (R. Meissner & B. Bayliss 923) is a shrub to 1.5m found growing on the crests of Robinson Ranges at two sites. *Hibiscus solanifolius sensu stricta* is found mainly on the Central Ranges of Western Australia, near the South Australian border, 950 km east of Robinson Ranges. However, the collections from Robinson Ranges differed from *H. solanifolius* with fewer epicalyx lobes, the calyx lobes did not exceed the capsule and the capsule had appressed silky hairs rather than tomentose. More collections are required with flowering material to confirm if it is a new taxon.
- *Sida* aff. *atrovirens* (R. Meissner & B. Bayliss 1031) is a small shrub to 20cm collected from Mount Gould. It is the same taxon as specimens collected from Weld Range, an ironstone range 190 km to the south west (Markey & Dillon 2006b). It differs from *Sida atrovirens* by the presence of stellate hairs on the mericarps instead of curled hairs.
- *Sida* aff. *intricata* (R. Meissner & B. Bayliss 1037) is a small prostrate shrub to 10cm and is a single collection from a colluvial outwash on Robinson Range. It differed from *Sida intricata* by the presence of silky hairs on the mericarp.
- *Portulaca* aff. *oleracea* (R. Meissner & B. Bayliss 963) is a succulent annual morphologically similar to *Portulaca oleracea* but differ in seed morphology. The seeds of *P.* aff. *oleracea* have low rounded tubercules in more or less concentric rows and a shiny surface while the seed of *P. oleracea* are tuberculate which are often not visibly arranged in concentric rows and

a dull surface (Jessop 1981). The species was collected from a single colluvial outwash site, in the eastern part of the ranges.

- *Paspalidium* sp. (R. Meissner & B.Bayliss 956) is a single collection of a grass to 20cm found growing on a steep crest of Robinson Range. It had unusual glumes, longer than in other species in the genera. Further collections are required.
- *Solanum* aff. *ashbyae* (R. Meissner & B. Bayliss 1040) a single collection of a small shrub with fruit and no floral material. It differs from *Solanum ashbyae* by having a much reduced calyx around the fruit when compared to other specimens collected in the survey and in the Western Australian Herbarium.

Range Extensions

As a result of the survey, six species were collected that had significant range extensions (> 100 km). *Euphorbia sarcostemmoides* and *Baeckea* sp. Melita Station (H.Pringle 2738) have already been discussed in the previous sections.

- *Halgania odontocarpa* forma *octoforma* is a small herbaceous annual which was collected from a single site on the lower slopes of Mount Fraser. This collection extends its range by approximately 200 km north of the nearest population.
- *Hibbertia arcuata* is an erect shrub to 1.3 m with pungent recurved leaves. It is found primarily in the northern part of Avon Wheatbelt bioregion but there have been several collections further east in the Yalgoo bioregion on banded ironstone. In this survey, it was found in small numbers on the upper slopes and crests of Mount Fraser. These collections extend it's northern range by almost 400 km.
- *Philotheca brucei* subsp. *cinerea* is a shrub to 1.2 m with small pink/white flowers. It is commonly found on breakaways and rocky outcrops in the north Murchison bioregion. Collections in this survey were from the upper slopes and crests of Mount Fraser on rocky ironstone outcrops, 100 km northeast of its nearest population on Mount Gould.
- *Micromyrtus sulphurea* is a myrtaceous shrub to 1.5 m with small yellow flowers. A single collection was made from the upper slopes on rocky outcrops of Mount Fraser, 100 km north of the nearest populations.

Vegetation Communities

A total of 165 taxa were recorded for the 50 quadrats, of which 92 species were perennial taxa. Forty five taxa occurred in more than one quadrat. Final analysis was conducted using perennial species only and excluding singletons. Preliminary analysis showed little difference in community classification when annual species and singletons were removed. One quadrat was removed from the analysis as it was an outlier in the initial analysis, occurring as a disjunct site with several singletons and low perennial numbers.

Seven vegetation communities were delineated from the dendrogram (Figure 2), based upon groupings that made ecological sense. Community 7, a spinifex community occurring on the slopes and crests of Mt. Fraser, was clearly different from the other communities and was the last division in the dendrogram (Figure 2). Community 1 (lower slopes of Robinson Range and Mount Gould) and Community 2 (hummock grassland of *Triodia melvillei* on Mount Gould) were most similar to each other followed by Community 3 (lower slopes and colluvial outwashes of Robinson Range). These were then separated from Communities 4 (community on the slopes and crests of Robinson Range), 5 and 6 (communities occurring on the slightly rocky outcrops (2–10% exposed bedrock) to rocky outcrops (10–20% exposed bedrock) of Robinson Range).

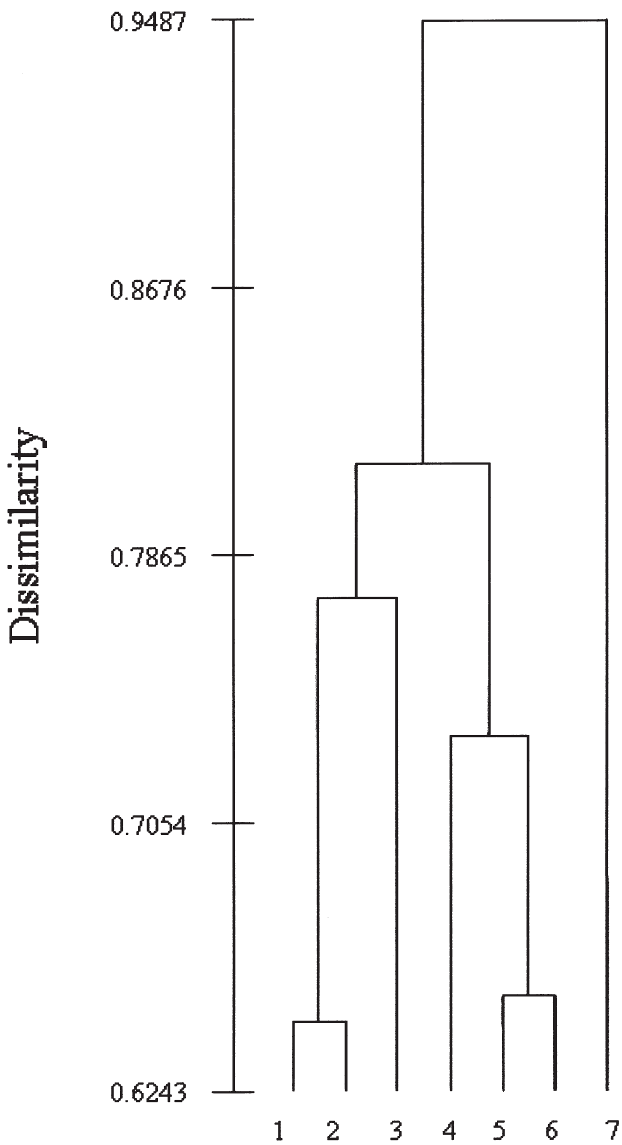

Figure 2. Dendrogram of 7 group level classification of 49 quadrats established at Mount Gould and Robinson Range. Dissimilarity is based upon the Bray-Curtis dissimilarity measure (dilated using β = −0.1).

Community 1 – This community is found on the lower slopes of Robinson Range and Mount Gould. It is described as open to sparse shrublands of *A. aneura* over open to isolated shrublands of *Eremophila* spp. (*Eremophila latrobei* subsp. *latrobei*, *Eremophila jucunda* subsp. *jucunda*, *Eremophila forrestii* subsp. *forrestii*), *Ptilotus obovatus* var. *obovatus* and *Ptilotus polystachyus* over forbland and grassland of *Dysphania rhadinostachya*, *Aristida contorta*, *Eriachne pulchella* and *Goodenia tenuiloba*. It is characterised by Species Group B and D. Indicator species are *Dodonaea petiolaris* and *Tribulus suberosus* (Table 1). It had the lowest species richness of 10.3 taxa per quadrat.

Community 2 – This community was found on the upper slopes and crests of Mount Gould. It is described as isolated shrubland of *A. aneura* or *Grevillea berryana* over sparse to open shrubland of *Philotheca brucei* subsp. *cinerea*, *E. latrobei subsp. latrobei* over hummock grassland of *Triodia melvillei*. It is characterised by taxa from Species Groups B and H with the indicator species *Corchorus crozophorifolius*, *Eriachne mucronata*, *P. brucei subsp. cinerea*, *Sida* sp. *tiny green fruits* (S. van Leeuwen 2260) and *T. melvillei*. Mean species richness was 12 taxa per quadrat.

Community 3 – The community occurs on simple and lower slopes of Robinson range. It is described as sparse shrubland and woodlands of *A. aneura* and *Acacia pruinocarpa* over shrubland of *A. aneura* (juvenile), *A. ramulosa* var. *linophylla*, *Eremophila fraseri*, *Eremophila spectabilis* subsp. *spectabilis* and *Senna glaucifolia* over forbland and grassland of *P. polystachyus*, *E. pulchella* and *Paspalidium basicladum*. It is characterised by Species Group A, B and F. Indicator species are *Hibiscus* aff. *burtonii*, *Senna artemisioides* subsp. *helmsii*, *E. spectabilis subsp. spectabilis*, *A. aneura* var. *aneura/intermedia* morphotype, *A. tetragonophylla* and *Senna* sp. Meekatharra (E. Bailey 1–26). Mean species richness was 11 taxa per quadrat.

Community 4 – This community was found on the slopes and crests of banded ironstone on Robinson Range. It is described as open to sparse shrubland of *A. aneura* over open to isolated shrubland of *Aluta maisonneuvei* subsp. *auriculata*, *Eremophila* spp. (*Eremophila punctata*, *E. exilifolia*, *E. jucunda subsp. jucunda*, *E. spectabilis subsp. spectabilis* and *E. forrestii subsp. forrestii*) over forbland and grassland of *Eriachne pulchella*, *P. basicladum*, *P. polystachyus* and *Sida* sp. *Golden calyces glabrous* (H.N. Foote 32). Characterised by Species Groups A and B (Table 1). Indicator species were *E. jucunda subsp. jucunda* and *E. punctata*. It had a mean species richness of 14.1 taxa per quadrat.

Community 5 – The community is located on crests and slopes with slightly rocky (2–10% cover) to very rocky (20 – 50% cover) outcrops on Robinson Range. It is described as open to sparse shrubland of *A. aneura*, *Acacia citrinoviridis*, *Corymbia ferriticola* subsp. *ferriticola* over *Eremophila* spp. (*E. latrobei subsp. latrobei*, *E. exilifolia*, *E. punctata*, *E. jucunda subsp. jucunda*, *Eremophila pendulina* and *E. forrestii subsp. forrestii*), *P. obovatus var. obovatus*, *S. chrysocalyx*, *Ptilotus schwartzii* over grasslands of *P. basicladum* and *Eriachne pulchella*. It is characterised by Species Groups B and C (Table 1). Indicator species are *P. schwartzii*, *C. ferriticola subsp. ferriticola* and *Dodonaea pachyneura*. Mean species richness was 13.7 taxa per quadrat.

Community 6 – This community is found on very rocky to slightly rocky crests and mislopes of banded ironstone on the Robinson Range. It is described as open to sparse shrubland of *A. aneura*, *A. citrinoviridis* over open to sparse shrubland of *Eremophila* spp. (*E. latrobei subsp. latrobei*, *E. exilifolia* and *E. jucunda subsp. jucunda*), *S. glaucifolia* and *Sida* sp. *Golden calyces glabrous* (H.N. Foote 32) over grassland of *E. pulchella* and *P. basicladum*. It is characterised by Species Group A and B (Table 1). Indicator species are *P. schwartzii*, *Indigofera fractiflexa* subsp. Mt. Augustus (S. Patrick & A. Crawford SP4734), *E. jucunda subsp. jucunda*, *Senna glutinosa* subsp. *pruinosa* and *E. exilifolia*. Mean species richness was 10.2 taxa per quadrat.

Community 7 – The community is restricted to the upper slopes and crest of Mount Fraser and described as sparse to open shrubland of *A. aneura* and *A. citrinoviridis* over sparse to open shrubland of *P. brucei subsp. cinerea*, *Eremophila pendulina*, *Prostanthera ferricola*, *Pityrodia iphthima* over shrubland and hummock grassland of *T. melvillei*, *Amphipogon sericeus* and *P. obovatus var. obovatus*. Indicator species are *P. schwartzii*, *E. pendulina*, *Hibbertia arcuata*, *A. sericeus*, *P. ferricola*, *Psydrax suaveolens*, *P. brucei subsp. cinerea* and *T. melvillei* (Table 1). It had a mean species richness of 11.3 taxa per quadrat.

Environmental Parameters

Four elements in the soil chemistry data (B, Cd, Mo and Na) were either invariant or had more than half the data below the limits of detection and were not used in subsequent analyses. An analysis of soil chemistry showed pH, eCEC, organic C, total N, and all the metal irons showed significant differences in concentration between the soils of the different community types (Table 2). Post hoc tests failed to discriminate differences between individual community types for Organic C, Cu and Mn.

The most acid soils occurred at Community 7 (pH 3.9) which were significantly more acidic than soils at Communities 1, 2 and 3. The soils at Community 7 and Community 1 had the highest values of total N and these were significantly higher than those of Community 4. Community type 4 had soils with the lowest values for P, K, Mg and the trace elements Ca, Co, Fe, Ni and Zn but it recorded the highest values for S. Community 1 and 2 had significantly higher macronutrients than Community 4 with Community 5 also recording significantly higher P than Community 4 (Table 2). Community 6 also recorded significantly lower K values than Community 2. For the micronutrients Ca was significantly higher in Communities 1, 2 and 3 compared with Community 4 as was eCEC. Fe was highest in Communities 5 and 7 and significantly greater than Communities 3 and 4.

Despite these differences there was considerable overlap in soil chemistry for all elements with the soils of half the communities not being significantly different from either the high or low values. Communities 5, 6 and 7 generally occurred on soils with these intermediate fertilities with the exceptions outlined above (Table 2).

Four of the six physical site parameters were also significantly different between communities. Community 7 occurred at higher elevations on Mount Fraser and was significantly different to Communities 1, 2, 3 and 4. The maximum surficial rock (coarse fragment) size was significantly lower at Community 3 than Communities 1, 5 and 7. Rock outcrop abundance was significantly higher at Community 5 than Community 1, 3 and 4. Slope was significantly steeper (>20 degrees) at quadrats in Community 2 compared to Community 3 (< 4 degrees). As with the soils data the average site parameters of the intermediate community types was not significantly different from groups with either the lowest or highest values (Table 3).

The three-dimensional ordination (stress = 0.2070) showed similar patterns as found in the univariate analysis and gave reasonable separation of most groups in three dimensions (Figure 3). Exceptions included one of the quadrats of Community 2 that was well separated form the other two quadrats, as was one of the quadrats from Community 6. The best fit vectors showed Community 7 most strongly correlated with increasing rock abundance and increasing altitude. Community 1 and 2 were most strongly correlated with increasing micronutrients and to lesser degree increasing slope. In contrast, Communities 3 and 5 occupied an intermediate position along most vectors and were best separated by coarse fragment size

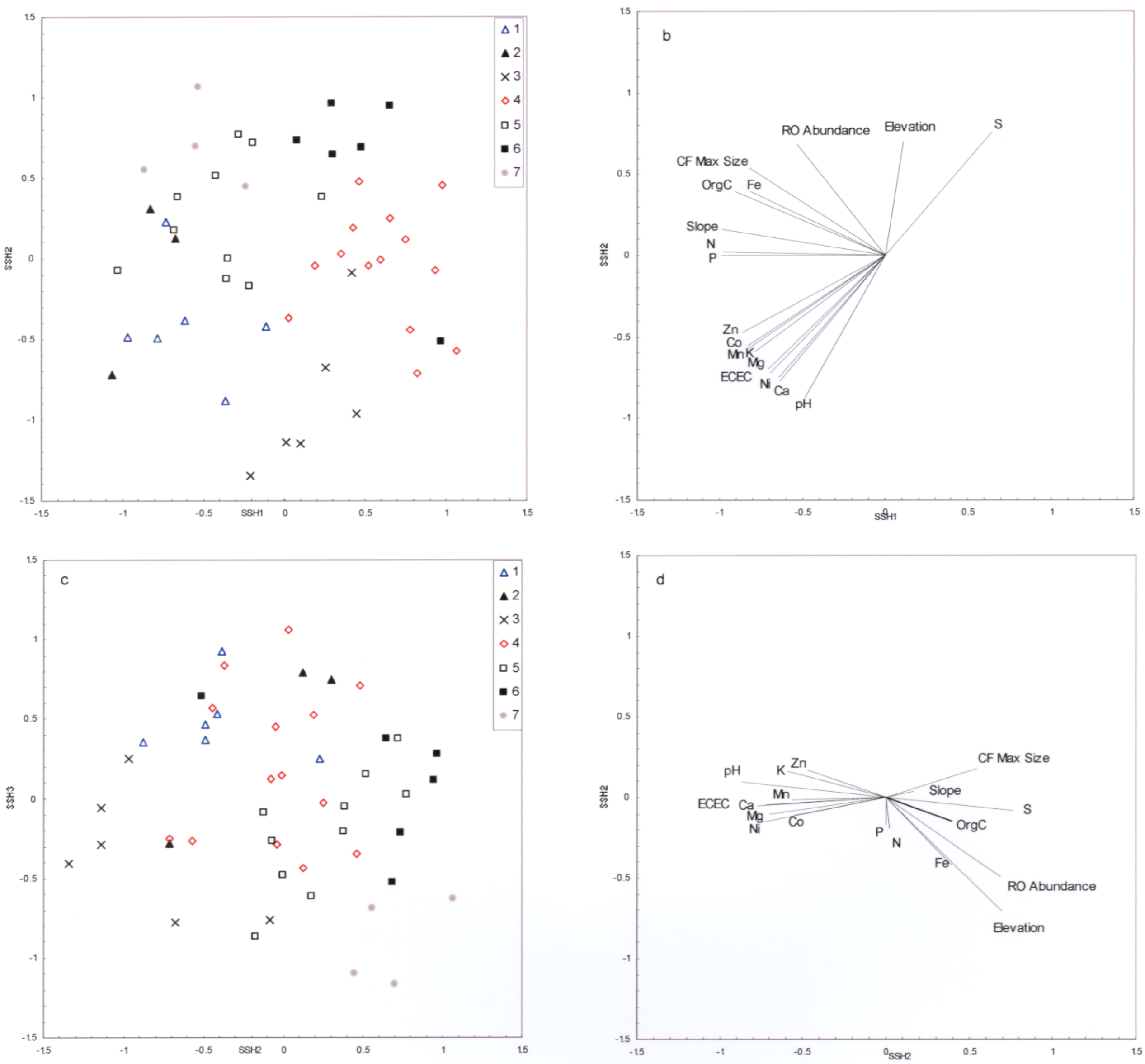

Figure 3. Three dimensional ordination showing only axis 1, 2 and 3 of the 49 quadrats established on the Robinson Range and Mount Gould and represented by community type (a & c). Lines represent the strength and direction of the best fit linear correlated variables (b & d).

and rock outcrop abundance. Community 4 and 6 were highly correlated with the lower end of most of the macro & micro nutrients, with the exception of S.

DISCUSSION

The total number of flora recorded from Robinson Range and Mount Gould was slightly lower than at Jack Hills, a nearby ironstone range (Meissner & Caruso 2006 a). The numbers of perennials at both ranges were similar, with 89 perennials at Jack Hills and 97 recorded from Robinson Range and Mount Gould. The ranges were both dominated by acacias, eremophilas and Malvaceae species, characteristic of the area (Curry *et al.* 1994).

Approximately 44% of the flora recorded were annuals, similar to the situation found at Jack Hills (c. 50% annuals). However, the composition of annual species was different, with the annuals recorded at Jack Hills dominated by Asteraceae, and Robinson Range and Mount Gould dominated by Poaceae. This can be explained by bimodal rainfall in the Meekatharra area resulting in different annual communities, grasses predominating following summer rainfall, and Asteraceae dominating the annuals following winter rain (Mott 1972). High rainfall in the summer preceding the Robinson Ranges survey resulted in a large number of grasses germinating and hence a higher representation in the flora. In contrast, when the Jack Hills were surveyed in 2005 a higher winter rainfall was recorded resulting in higher numbers of Asteraceae and other forbs.

Two new taxa were found as a result of the survey of the Robinson Ranges. The new species, *Pityrodia iphthima* is closely allied to *P. augustensis*, a declared rare flora, found only on Mount Augustus, a sandstone monolith, 400 km north in the Gascoyne bioregion. Additionally, *Indigofera fractiflexa* subsp. Mt Augustus (S. Patrick & A. Crawford SP4734), which is found across the Robinson Ranges, and also occurs on Mount Augustus was identified as distinct for the first time. The disjunction in the ranges of these two taxa between Mount Augustus and Robinson Range is a possible result of fragmentation and range contraction in response to climatic oscillations in the late Tertiary – Quaternary (Hopper 1979).

Pityrodia iphthima is restricted to higher elevations and may be a relict species while *Indigofera fractiflexa* subsp. Mount Augustus occurs on the lower elevations of Robinson Ranges and Mount Augustus. Additional surveys between Mount Augustus and Robinson Ranges are needed to fully determine the distribution of this taxon.

Preliminary comparison of the perennial communities on Robinson Ranges and Mount Gould and those found on Jack Hills (Meissner & Caruso 2006a) showed that they are significantly different in terms of species composition (ANOSIM Global $R = 0.406$, $P < 0.01$, Clarke and Warwick 2001), despite their geographical proximity (c. 100km). An example of this rapid compositional change is shown by the restricted spinifex communities found on all three ranges. Each range has a spinifex community dominated by *T. melvillei* but it occurs with different suites of perennial species and different indicator species in each of the three areas (Meissner & Caruso 2008b). The unique species present in the Mount Gould community were *C. crozophorifolius* and *Cymbopogon ambiguus;* at the Robinson Ranges the community was dominated by *Hibbertia arcuata*, *Amphipogon sericeus*; and at Jack Hills were *Halgania gustafsenii*, *E. jucunda subsp. jucunda, E. exilifolia, Hibiscus sturtii* var. *sturtii* and *Acacia* sp. Jack Hills (R. Meissner & Y. Caruso 4) found. This contrasts with Mattiske Consulting Pty Ltd (2005), who recognised variants of spinifex communities on Jack Hills occurring on Mount Gould, but not on the Robinson Ranges. Interestingly the same community (Community 1) occurs on the lower slope of Mt Gould and Robinson Ranges (near Mt Fraser). This pattern of more widespread lower slope and flats communities and restricted upland communities has been previously reported from the ironstone ranges in the Mt Jackson – Windarling area (Mattiske Consulting Pty Ltd, 2001).

While the upland spinifex communities on the Robinson Ranges (Community 7) and Mt Gould (Community 2) were found in a similar landscape position the soil chemistry was very different. The Robinson Range community occurring on more acid soils which tended to be lower in most macro and micro nutrients than those of Mt Gould. The compositional differences in the perennial communities across Mt Gould and the Robinson Ranges were consistent with differences in landscape position, slope, rockiness of sites (both outcrop and surficial) and the majority of the soil chemistry variables investigated from the top 10 cm of soil.

Communities 1 and 3 occurred at lower elevation and had little to no exposed bedrock and smaller surficial rocks, their soils also showed high levels of calcium, a feature common in the soils on the lower slopes of goldfield ranges. Interestingly the soils of Community 2 (upper slopes) also showed elevated calcium concentrations, perhaps related to local geology.

Communities 4, 5 and 6 were all *A. aneura* shrublands over *Eremophila* spp. and were the most common communities found across the Robinson Range. They occurred on the slopes and crests of banded iron formations. Community 5 occurred on rockier sites which tended to be on steeper slopes than Community 4, with Community 6 occupying in intermediate positions. All three communities occurred on poor acid soils. There were few significant differences in nutrient concentrations (exceptions being P and Fe) but Community 4 was consistently found on the poorest soils.

The quadrat excluded from the final analysis was located on a colluvial outwash with surficial ironstone, approximately 3 km from the main range, and may illustrate a gradual compositional shift as a function of distance from the range. This quadrat is closely allied to Community 3, which occurs on the lower slopes and colluvial sites closer to the range. It was separated by the presence of several species that only occurred at the site and as a consequence shared a lower number of perennial species with Community 3.

The vegetation patterns here are generally consistent with but more detailed than those described by Curry *et al.* (1994). Our Communities 1, 3, 4, 5, and 6 would fall within their *A. aneura, A. tetragonophylla* shrubland over *Eremophila, Cassia* and *Solanum* in the Peak Hill land system. Our Communities 2 and 7 have not previously been described.

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Table 1

Sorted two-way table of quadrats established on Robinson Range showing species by community type. Taxa shaded grey within a community are indicator species identified by INDVAL > 18 (Dufrene and Legendre 1997) at the 7 group level.

	Community 1	2	3	4	5	6	7
Group A							
Abutilon cryptopetalum			* *		*		
Abutilon oxycarpum subsp. *prostratum*	*	*	* * *				
Thysanotus manglesianus			*		*		
Acacia pruinocarpa			* * *	*		*	
Senna glutinosa subsp. *pruinosa*			*			* * * (shaded)	
Eremophila forrestii subsp. *forrestii*	*		* * *	* * *		*	
Hibiscus aff. burtonii	*		* * * * * (shaded)	* * * *	* * *	*	*
Senna artemisioides subsp. *helmsii*	*		* * * * * (shaded)	* *			
Eremophila spectabilis subsp. *spectabilis*			* * * * (shaded)	* * * * *	*		
Solanum lachnophyllum				* * * * * *		*	
Group B							
Acacia aneura var. *microcarpa*	* * * * * *	* * *	* * * * * *	* * * * * * * * * * * * * * *	* * * * * * * * *	* * * * * *	* * *
Sida chrysocalyx	* * * * *	* *	* * * * *	* * * * * * * * * * * * * *	* * * * * * * * *	* * * * * *	* * * *
Eremophila latrobei subsp. *latrobei*	* * * * * *	* * *	* * *	* * * * * * * * * *	* * * * * * * *	* * * *	
Ptilotus schwartzii var. *schwartzii*	*		*	* * * * * * * * * *	* * * * * * * * * (shaded)	* * * * * * (shaded)	* * * * (shaded)
Ptilotus obovatus var. *obovatus*	* * * * * *	* * *	* * * * *	* * * *	* * * * * * * * *	* *	* * *
Solanum ashybii/lasiopetalum complex	* * * * *	*	* * * *	* * * * * * * *	* * * *	*	
Acacia citrinoviridis				* * * * * *	* * * *	* * *	* * *
Indigofera fraxtiflexa subsp. Mount Augustus (S	*		*	* * * * *	* * * *	* * * * * (shaded)	
Eremophila jucunda subsp. *jucunda*	* *		* *	* * * * * * * * * * (shaded)	* *	* * * * * * (shaded)	
Senna glaucifolia complex			* * *	* * * * * * * * * *	*	*	
Eremophila punctata			* *	* * * * * * * * * (shaded)	*		
Grevillea berryana		* *	* *	* * * * * * * * * * * *	* * * *	*	
Monachather paradoxus	* * *	* *	* * *	* * * * * * * * * * * *	* * *		
Group C							
Acacia aneura var. *aneura/intermedia*			* * * * (shaded)	*	* * * * *		*
Eremophila pendulina					* * * *		* * * (shaded)
Corymbia ferriticola subsp. *ferriticola*	*			*	* * * * * * * * (shaded)	* *	*
Dodonaea pachyneura		*			* * * * * * * (shaded)		
Hibiscus cf. solanifolius					* *		
Stenanthemum petraeum					* *		
Acacia aneura var. *argentea x A. minyura*			*		*		*
Cheilanthes brownii					* *		
Cheilanthes sieberi subsp. *sieberi*	*		*	*	* *		
Hibiscus gardneri				*	*		
Group D							
Dodonaea petiolaris	* * * * (shaded)				*	*	*
Tribulus suberosus	* * * * (shaded)				*		
Marsdenia australis	*				* *	* * *	
Eremophila galeata	*		* *				
Harnieria kempeana subsp. *muelleri*	*				*		
Group E							
Acacia thoma				* *	* *		
Aluta maisonneuvei subsp. *auriculata*				* * *			
Eragrostis eriopoda	*	*	*	*	* * *	*	
Psydrax rigidula				*	*		
Hibiscus sturtii var. *truncatus*	*			*			
Euphorbia sarcostemmoides				* *			
Group F							
Acacia minyura			* *	*		*	
Acacia tetragonophylla			* * (shaded)				
Senna sp. Meekatharra (E. Bailey 1-26)			* * (shaded)				
Senna stricta	*		*				
Acacia ramulosa var. *linophylla*			*	*			
Sida sp. *unisexual* (N.H. Speck 574)			*		*		
Group G							
Acacia grasbyi			*	* * * *			* *
Hibbertia arcuata							* * (shaded)
Amphipogon sericeus							* * (shaded)
Prostanthera ferricola							* * * (shaded)
Psydrax suaveolens					*		* * (shaded)
Group H							
Corchorus crozophorifolius		* * (shaded)					
Eriachne mucronata	* *	* * * (shaded)			* *		*
Philotheca brucei subsp. *cinerea*		* * * (shaded)					* * * * (shaded)
Triodia melvillei		* * * (shaded)			*		* * * * (shaded)
Cymbopogon ambiguus	*	*					
Sida atrovirens complex	*	* * * (shaded)			*		
Eremophila exilifolia						* * * (shaded)	
Eremophila glutinosa		*				*	

Table 2

Plant community mean values for soil chemistry parameters (measured mg/kg except eCEC, pH, Total N, Org C and EC). Differences between ranked values tested using Kruskall – Wallis non parametric analysis of variance. Standard error in parentheses. a,b denote significant difference between groups by post hoc test (P < 0.05). (P = probability, n = number of quadrats, ns = not significant).

	Community Type							
	1	2	3	4	5	6	7	P
pH	4.4 (0.2)^{a}	4.6 (0.2)^{a}	4.5 (0.1)^{a}	4.1 (0.0)^{ab}	4.1 (0.1)^{ab}	4.1 (0.0)^{ab}	3.9 (0.0)^{b}	0.0004
EC	1.7 (0.2)	2.3 (0.3)	1.3 (0.2)	1.6 (0.1)	2.0 (0.5)	1.7 (0.2)	2.5 (0.5)	0.1777
Total N	0.051 (0.004)^{a}	0.047 (0.0)^{ab}	0.041 (0.003)^{ab}	0.038 (0.001)^{b}	0.050 (0.0)^{ab}	0.040 (0.002)^{ab}	0.055 (0.002)^{a}	0.0003
P	15.2 (2.3)^{a}	17.3 (2.4)^{a}	9.0 (3.1)^{ab}	5.4 (0.3)^{b}	19.9 (4.3)^{a}	7.2 (1.0)^{ab}	15.0 (3.0)^{ab}	0.0000
K	110.5 (17.6)^{ac}	126.7 (14.5)^{a}	90.0 (9.4)^{abc}	67.7 (2.8)^{b}	78.7 (7.4)^{abc}	62.0 (5.8) ^{bc}	80.8 (2.9)^{abc}	0.0011
OrgC^{NS}	0.60 (0.05)	0.55 (0.04)	0.46 (0.04)	0.48 (0.02)	0.57 (0.03)	0.49 (0.04)	0.67 (0.04)	0.0238
Mg	37.7 (9.1)^{a}	56.3 (13.9)^{a}	43.7 (13.5)^{a}	14.7 (1.1)^{b}	25.1 (3.0)^{ab}	20.2 (2.7)^{ab}	20.5 (0.6)^{ab}	0.0001
eCEC	1.35 (0.3)^{a}	1.57 (0.2)^{a}	1.37 (0.2)^{a}	0.60 (0.0)^{b}	0.90 (0.1)^{ab}	0.75 (0.1)^{ab}	0.75 (0.1)^{ab}	0.0005
Ca	154.3 (39.6)^{a}	160.0 (23.1)^{a}	158.5 (27.0)^{a}	63.7 (4.3)^{b}	99.2 (17.3)^{ab}	81.8 (13.1)^{ab}	74.0 (6.4)^{ab}	0.0006
Co	0.45 (0.2)^{ab}	0.86 (0.3)^{a}	0.43 (0.2)^{ab}	0.06 (0.0)^{b}	0.36 (0.1)^{ab}	0.14 (0.0)^{ab}	0.03 (0.0)^{ab}	0.0011
Cu ^{NS}	0.77 (0.03)	0.53 (0.03)	0.72 (0.04)	0.75 (0.02)	0.78 (0.05)	0.62 (0.03)	0.65 (0.03)	0.0081
Fe	36.7 (3.6)^{ab}	43.7 (3.3)^{ab}	28.3 (2.1)^{a}	27.6 (1.2)^{a}	52.8 (6.4)^{b}	32.2 (2.9)^{ab}	60.0 (2.0)^{b}	0.0000
Mn ^{NS}	36.7(9.1)	43.7 (13.1)	26.2 (7.4)	11.3 (1.4)	28.0 (8.7)	12.7 (2.5)	7.5 (2.0)	0.0017
Ni	0.2 (0.08)^{a}	0.3 (0.10)^{ab}	0.3 (0.20)^{ab}	0.1 (0.01)^{b}	0.2 (0.03)^{ab}	0.1 (0.01)^{ab}	0.1 (0.0)^{ab}	0.0032
S	6.0 (1.3)^{a}	5.3 (0.7)^{ab}	6.2 (1.1)^{a}	10.9 (0.6)^{b}	8.2 (0.8)^{ab}	9.8 (0.8)^{ab}	10.0 (2.1)^{ab}	0.0019
Zn	1.3 (0.29)^{a}	1.1 (0.09)^{a}	0.7 (0.08)^{ab}	0.4 (0.03)^{b}	0.7 (0.13)^{ab}	0.5 (0.03)^{ab}	0.6 (0.03)^{ab}	0.0003
n=	6	3	6	15	9	6	4	

Table 3

Plant community mean values for physical site parameters; elevation (m above sea level), rock outcrop (RO) abundance (0 – no bedrock exposed to 5 – rockland), slope (degrees), maximum size of coarse fragments (1 – fine gravely to 7 large boulders), runoff (0 – no runoff to 5 – very rapid), coarse fragment (CF) abundance (0 – no coarse fragments to 6 very abundant coarse fragments). Differences between ranks tested using Kruskall –Wallis non-parametric analysis of variance. Standard error in parentheses. a, b and c represent significant differences between community types at P < 0.05 (n = number of quadrats, P = probability, ns = not significant).

	Community Type							
	1	2	3	4	5	6	7	P
Elevation (m)	525.7 (32.4)^{a}	526.3 (25.7)^{a}	559.2 (5.7)^{a}	575.7 (5.4)^{a}	599.2 (7.3)^{ab}	599.2 (7.4)^{ab}	698.5 (26.0)^{b}	0.0001
Coarse Fragment Size	5.3 (0.3)^{a}	5.7 (0.3)^{ab}	3.2 (0.2)^{b}	3.6 (0.2)^{ab}	5.3 (0.2)^{a}	4.5 (0.3)^{ab}	5.5 (0.3)^{a}	0.0000
Rock outcrop abundance	0.7 (0.7)^{a}	0.7 (0.3)^{ab}	0.2 (0.2)^{a}	0.4 (0.1)^{a}	2.9 (0.4)^{b}	1.5 (0.7)^{ab}	2.8 (0.8)^{ab}	0.0002
Slope	10.0 (2.8)^{ab}	20.33 (2.2)^{b}	3.8 (1.1)^{ab}	3.7 (0.5)^{a}	12.6 (2.8)^{ab}	7.5 (1.1)^{ab}	9.5 (3.9)^{ab}	0.0057
Runoff	2.0 (0.6)	3.0 (0.0)	1.2 (0.4)	1.5 (0.2)	2.1 (0.4)	1.0 (0.4)	1.5 (0.6)	0.0717
CF Abundance	4.5 (0.2)	4.3 (0.3)	4.2 (0.3)	4.3 (0.1)	4.2 (0.1)	4.8 (0.3)	4.8 (0.3)	0.3865
n=	6	3	6	15	9	6	4	

APPENDIX

Flora list for Robinson Range, including all taxa from the sampled quadrats and adjacent areas. Nomenclature follows Paczkowska and Chapman (2000), * indicates introduced taxon. Vouchers for each taxon were lodged at Western Australian Herbarium (PERTH).

Acanthaceae
Harnieria kempeana subsp. *muelleri*
Adiantaceae
Cheilanthes brownii
Cheilanthes sieberi subsp. *sieberi*
Aizoaceae
Trianthema glossostigma
Amaranthaceae
Ptilotus aervoides
Ptilotus chamaecladus
Ptilotus exaltatus var. *exaltatus*
Ptilotus gaudichaudii var. *gaudichaudii*
Ptilotus helipteroides var. *helipteroides*
Ptilotus obovatus var. *obovatus*
Ptilotus polystachyus var. *polystachyus*
Ptilotus roei
Ptilotus rotundifolius
Ptilotus schwartzii var. *schwartzii*
Anthericaceae
Thysanotus manglesianus
Apiaceae
Trachymene ornata
Trachymene pilbarensis
Asclepiadaceae
Marsdenia australis
Sarcostemma viminale subsp. *australe*
Asteraceae
Brachyscome ciliocarpa
Calotis hispidula
Calotis multicaulis
Helipterum craspedioides
Olearia eremaea
Olearia plucheacea
Pterocaulon sphacelatum
Rhodanthe battii
Rhodanthe charsleyae
Rhodanthe chlorocephala
Rhodanthe citrina
Rhodanthe maryonii
Rhodanthe pollackii
Streptoglossa liatroides
Taplinia saxatilis
Boraginaceae
Halgania gustafsenii var. Murchison (R. Meissner & B. Bayliss 743)
Heliotropium heteranthum
Heliotropium inexplicitum
Trichodesma zeylanicum
Brassicaceae
Lepidium oxytrichum
Lepidium pedicellosum
Stenopetalum anfractum
Stenopetalum filifolium
Caesalpiniaceae
Senna artemisioides ssp x *helmsii* x *glaucifolia* x *oligophylla*
Senna artemisioides subsp. *helmsii*
Senna cf. *glutinosa* subsp. x *luerssenii*
Senna glaucifolia
Senna glutinosa subsp. *pruinosa*
Senna sp. Meekatharra (E. Bailey 1–26)
Senna stricta
Chenopodiaceae
Dysphania melanocarpa
Dysphania saxitilis
Dysphania kalpari
Dysphania rhadinostachya subsp. *inflata*
Dysphania rhadinostachya subsp. *rhadinostachya*
Maireana convexa
Rhagodia eremaea
Convolvulaceae
Evolvulus alsinoides var. *villosicalyx*
Cuscutaceae
**Cuscuta epithymum*
Cyperaceae
Bulbostylis barbata
Dilleniaceae
Hibbertia arcuata
Euphorbiaceae
Euphorbia australis
Euphorbia boophthona
Euphorbia drummondii subsp. *drummondii*
Euphorbia sarcostemmoides P1
Phyllanthus erwinii
Geraniaceae
Erodium cygnorum
Goodeniaceae
Brunonia australis
Goodenia aff. *triodiophila* (R. Meissner & B. Bayliss 894)
Goodenia macroplectra
Goodenia pinnatifida
Goodenia tenuiloba
Goodenia triodiophila
Goodenia wilunensis
Haloragaceae
Haloragis odontocarpa forma *octoforma*
Haloragis odontocarpa forma *pterocarpa*
Haloragis odontocarpa forma *rugosa*
Haloragis trigonocarpa
Lamiaceae
Pityrodia iphthima
Prostanthera ferricola
Lobeliaceae
Lobelia heterophylla
Loranthaceae
Amyema hilliana
Malvaceae
Abutilon cryptopetalum
Abutilon fraseri
Abutilon oxycarpum subsp. *prostratum*
Hibiscus aff. *burtonii* (R. Meissner & B. Bayliss 997)
Hibiscus cf. *solanifolius* (R. Meissner & B. Bayliss 923)

Hibiscus gardneri
Hibiscus sturtii var. *truncatus*
Sida aff. *atrovirens* (R. Meissner & B. Bayliss 1031)
Sida sp. tiny green fruits (S. van Leeuwen 2260)
Sida sp. Golden calyces glabrous (H.N. Foote 32)
Sida sp. Excedentifolia (J.L. Elgan 1925)
Sida aff. *intricata* (R. Meissner & B. Bayliss 1037)
Sida ectogama

Mimosaceae
Acacia aneura var. *aneura*
Acacia aneura var. *argentea* (short phyllode variant)
Acacia aneura var. *argentea x A. minyura*
Acacia aneura var. *microcarpa*
Acacia citrinoviridis
Acacia marramamba
Acacia marramamba
Acacia pruinocarpa
Acacia ramulosa var. *linophylla*
Acacia rhodophloia
Acacia sclerosperma subsp. *sclerosperma*
Acacia sp. Juliflorae-flat, Eremaean region
Acacia tetragonophylla
Acacia thoma

Myoporaceae
Eremophila exilifolia
Eremophila forrestii subsp. *forrestii*
Eremophila galeata
Eremophila glutinosa
Eremophila jucunda subsp. *jucunda*
Eremophila latrobei subsp. *latrobei*
Eremophila pendulina
Eremophila punctata
Eremophila spectabilis subsp. *spectabilis*

Myrtaceae
Aluta maisonneuvei subsp. *auriculata*
Baeckea sp. Melita Station (H. Pringle 2738) P1
Corymbia ferriticola subsp. *ferriticola*
Micromyrtus sulphurea
Thryptomene decussata

Papilionaceae
Glycine canescens
Indigofera fractiflexa subsp. Mount Augustus (S. Patrick & A. Crawford SP4734)
Swainsona affinis
Swainsona kingii

Poaceae
Amphipogon sericeus
Aristida contorta
Cymbopogon ambiguus
Digitaria brownii
Enneapogon caerulescens var. *caerulescens*
Eragrostis cumingii
Eragrostis eriopoda
Eragrostis pergracilis
Eriachne aristidea
Eriachne mucronata
Eriachne pulchella
Eriachne pulchella subsp. *dominii*
Monachather paradoxus
Neurachne minor
Paspalidium basicladum
Paspalidium sp. (R. Meissner & B. Bayliss 956)
Thyridolepis mitchelliana
Triodia melvillei
Tripogon loliiformis

Polygalaceae
Polygala isingii

Portulacaceae
Calandrinia eremaea
Calandrinia monosperma
Calandrinia ptychosperma
Calandrinia schistorhiza
Portulaca aff. *oleracea* (R. Meissner & B. Bayliss 963)
Portulaca oleracea

Proteaceae
Grevillea berryana
Hakea lorea

Rhamnaceae
Stenanthemum petraeum

Rubiaceae
Psydrax latifolia
Psydrax rigidula
Psydrax suaveolens
Synaptantha tillaeacea var. *tillaeacea*

Rutaceae
Philotheca brucei subsp. *cinerea*

Santalaceae
Santalum lanceolatum

Sapindaceae
Dodonaea pachyneura
Dodonaea petiolaris

Solanaceae
Nicotiana rosulata subsp. *rosulata*
Solanum aff. *ashbyae* (R. Meissner & B. Bayliss 1040)
Solanum ashbyae
Solanum ellipticum
Solanum lachnophyllum
Solanum lasiophyllum

Tiliaceae
Corchorus crozophorifolius
Zygophyllaceae
Tribulus adelacanthus
Tribulus suberosus