

VEGETATION PATTERNS ASSOCIATED WITH A LARGE ROCK PLATE IN THE MEEHAN RANGE, TASMANIA

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(with two tables, one plate and three text-figures)

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Rock outcrops provide unusual environmental conditions, often being the habitats of disjunct populations or rare species. A large rock plate on Mt Direction, within the Meehan Range, southeastern Tasmania, supports an open-heath of unusual floristic composition, and contains the only known population of *Ozothamnus reflexifolius* Leeson & Rozefelds. Four floristic communities occur on and around the plate, forming a sequence from the open-heath on the plate itself to tall woodland with a dense understorey of small trees where rock and bare ground cover are low. Patterns of moisture availability, related to soil depth, aspect, slope and topographic position seem to best explain the floristic, structural and species richness patterns in the area.

Key Words: rock outcrop, skeletal soils, *Ozothamnus reflexifolius*, Tasmania.

INTRODUCTION

Rock plates and the skeletal soils that surround them provide an extreme habitat for vascular plant species within any region (e.g., Kruckerberg & Rabinowitz 1985, Baskin & Baskin 1988, Mishio 1992, Medail & Verlaque 1997, Porembski & Barthlott 2000, Poot & Lambers 2003). Complex patterns of shedding and accumulation of moisture in response to variations in topography and soil depth can induce high local heterogeneity in the vegetation, which often contains disjunct populations of common species, and rare local endemics (Prober & Austin 1990, Prober 1992, Coates 1996, Coates *et al.* 1999, Maisels *et al.* 2000, Wolf *et al.* 2000, Schonswetter *et al.* 2003). While shallow or absent soils induce moisture stress, they also provide a barrier to fire, allowing rare fire-sensitive species to survive in fire-prone landscapes (Coates 1996, Coates *et al.* 1999, Clarke 2002, Leeson & Kirkpatrick 2004). The vegetation of the rock plates of Tasmania has been classified by Gilfedder *et al.* (1997). However, one of the most biologically interesting rock plates in Tasmania, the sole location of the shrub species, *Ozothamnus reflexifolius* Leeson & Rozefelds, was not sampled in that study.

The present paper provides a description of the vegetation of this rock plate and directly adjacent areas, and relates variation in species composition to environmental variables.

THE STUDY AREA

The study area, located in southeastern Tasmania is centred on an unusually large dolerite rock plate (fig. 1). It is approximately 2 ha in area and is divided by an occasional winter creek. Slopes within the study area vary from gentle to 60°. Altitude varies from 200 to 340 m above sea level and aspect ranges from northwesterly through to southwesterly.

Rainfall is less than 600 mm per annum and is generally distributed evenly throughout the year. Annual potential evaporation is approximately 1250 mm. Application of the environmental lapse rate for Mt Wellington (Nunez & Colhoun 1986) indicates that the mean daily maximum

temperature of the warmest month is approximately 18°C, while the mean daily minimum temperature of the coolest month is approximately 2.2°C.

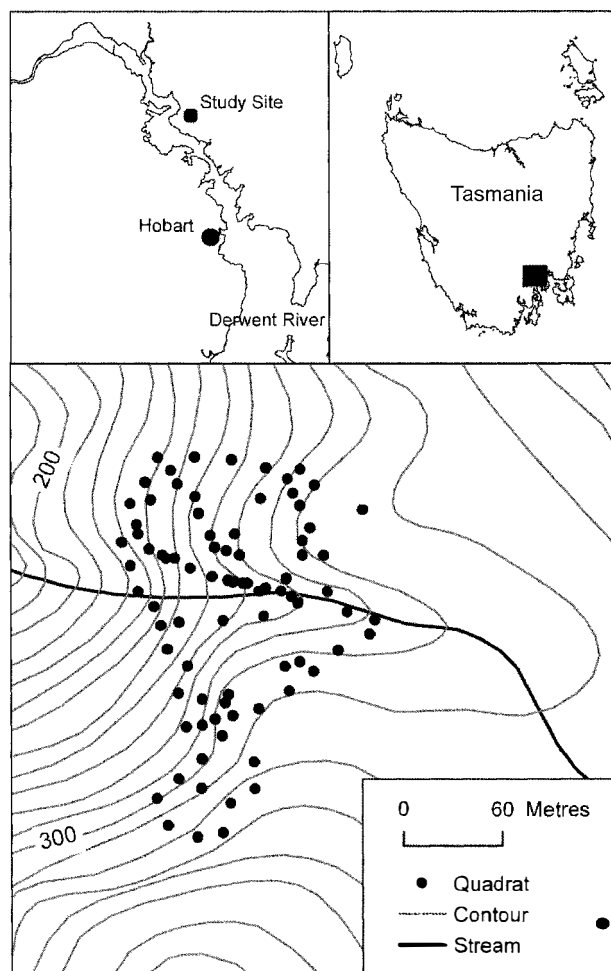


FIG. 1— Location map, and topography and quadrat locations at the study area.

Soils occurring on the surface of the rock plate are shallow, stony clay-loams containing relatively high levels of organic matter. A gradational change into a shallow duplex clay-loam over a thin reddish-brown clay horizon occurs away from the rock plate. In contrast, these soils contain very little organic matter. Deeper duplex red-brown clay-loam soils are found most distant from the rock plate. The pH of all soils is typically within the range 5.5–6.0.

METHODS

Eighty-three 5 x 5 m quadrats were placed within the study area (fig. 1). Quadrat sampling size was determined by utilising the techniques described by Wiegert (1962). All vascular plant species present within quadrats were recorded and their percentage cover estimated by the one observer within the following Braun-Blanquet cover classes: 1 = 0–0.5%, 2 = 0.5–5%, 3 = 5–25%, 4 = 25–50%, 5 = 50–75%, 6 = >75%. Bare ground, rock and litter were also scored within each quadrat and assigned a relevant cover score. Geocoordinates for all quadrats were recorded during September 2001 with a Garmin GPS12 receiver. Altitude, slope and aspect for each quadrat were also recorded.

All data were entered into the ecological community database, DECODA (Minchin 1994) and an initial sorting of presence-absence data for all 83 quadrats was performed by the polythetic divisive classificatory program, TWINSPAN (Hill 1979). The resulting table was resorted and communities discriminated based on co-occurrence of species.

Global non-metric multidimensional scaling was used to perform an ordination of all 83 quadrats using a Bray-Curtis (1957) dissimilarity matrix (fig. 2). Ten starting configurations were used in two dimensions, using a maximum of 100 repetitions. A stress ratio stopping value of 0.99 and a minimum stress stopping value of 0.01 was applied. Depending on the data structure, ANOVA, the Kruskal-Wallis H test or Chi-squared were used to test the significance of variation in environmental and vegetation variables between groups. Results were taken to be significant if $P < 0.05$. Multiple regression or generalised linear modelling (GLM) were used to develop explanations of variation in the ordination axis scores and species richness.

Nomenclature for all species follows Buchanan (1999).

RESULTS

Four communities were discriminated from the sorted table. Community 1 is characterised by the presence of *Ozothamnus reflexifolius* and a relatively high frequency of *Acianthus caudatus* R.Br., *Allocasuarina verticillata* Labill., *Austrostipa rudis* (Sprengel) S.W.L. Jacobs & J. Everett, *Carex breviculmis* R.Br., *Epacris acuminata* Benth., *Poa rodwayi* Vickery and *Schoenus apogon* Roemer & Schultes. Other species present in this community included *Acacia mearnsii* De Wild., *Astroloma humifusum* (Cav.) R.Br., *Austrodanthonia caespitosa* (Gaudich.) H.P. Linder, *Cheilanthes austrotenuifolia* Quirk & Chambers, *Correa reflexa* (Labill.) Vent., *Dodonaea viscosa* Jacq., *Hibbertia riparia* (R.Br. ex DC.) Hoogl., *Lepidosperma gunnii* Boeck., *Lomandra longifolia* Labill., *Ozothamnus scutellifolius* Hook.f., *Pelargonium inodorum* Willd., *Plantago varia* R.Br., *Themeda*

triandra Forskal and *Thysanotus patersonii* R.Br. (table 1). The quadrats in this community largely fell within the open-heath on the rock plate (pl. 1) and have greater mean species richness than all other communities (table 2).

Community 2 has a high frequency of *Ozothamnus reflexifolius*, *Allocasuarina verticillata*, *Astroloma humifusum*, *Dodonaea viscosa*, *Lepidosperma gunnii* and *Poa rodwayi*. Additional species recorded are similar to community 1 except for the absence of *Epacris acuminata* and *Pelargonium inodorum*. Species present in this community but absent in community 1 included *Bossiaea prostrata* R.Br., *Bursaria spinosa* Cav., *Eucalyptus globulus* Labill., *Oxalis perennans* Haw. and *Pimelea nivea* Labill. (table 1). The quadrats in this community largely occurred in *Allocasuarina verticillata* low open-forest (pl. 1). The community has lower mean species richness than community 1 and higher mean species richness than community 4 (table 2).

Community 3 had high frequencies of *Allocasuarina verticillata*, *Astroloma humifusum*, *Dodonaea viscosa*, *Lomandra longifolia* and *Poa rodwayi*. These species co-occur in communities 2 and 3 in similar proportions. However, species absent from community 3 but present in communities 1 and 2 include *Ozothamnus reflexifolius*, *Austrodanthonia caespitosa*, *Carex breviculmis*, *Hibbertia riparia*, *Schoenus apogon*, *Themeda triandra* and *Thysanotus patersonii*. Species present here but absent from the first two communities include *Acacia melanoxylon* R.Br. in W.T. Aiton, *Allocasuarina verticillata*, *Asplenium flabellifolium* Cav., *Bedfordia linearis* (Labill.) DC., *Eucalyptus pulchella* Desf. and *Pimelea humilis* R.Br. (table 1). The quadrats in community 3 occur in vegetation in which large emergent *Eucalyptus globulus* occur above a smaller tree layer consisting of *Acacia mearnsii*, *Acacia melanoxylon*, *Allocasuarina verticillata*, *Eucalyptus pulchella*, *Eucalyptus viminalis* and *Exocarpos cupressiformis* (pl. 1). This community has lower mean species richness than community 1 (table 2).

Community 4 is similar to the other three communities in having a high frequency of *Allocasuarina verticillata*, *Astroloma humifusum* and *Lomandra longifolia*. Overall, species composition of this community is similar to community 3, except for the presence of *Acaena novae-zelandiae* Kirk and *Austrodanthonia caespitosa* and the absence of *Acacia verticillata*, *Acacia melanoxylon*, *Eucalyptus pulchella* and *Pimelea nivea* (table 1). The quadrats in this community largely fall within *A. verticillata* woodland (pl. 1). The community has lower mean species richness than communities 1 and 2.

The four communities occupy largely distinct sections of ordination space (fig. 3), with all communities being statistically distinct on axis 1, and community 3 being distinct from all other communities on axis 2 (table 2).

The environmental variable that most strongly differentiated the communities as a whole was rock cover (table 2). The scores on ordination axis 1 were also most strongly differentiated by this variable (simplified so that classes 4, 5 and 6 of rock cover were merged, GLM, $P < 0.001$). Aspect was significant as a covariate ($P < 0.05$) in the rock cover GLM model for axis 1. A model with the same explanatory components was obtained for mean species richness, which covaried with the ordination score on axis 1 (table 2). Axis 2 of the ordination was very weakly explained by a regression model consisting of altitude and slope (mds2 = 1.44 - 0.0131 Slope - 0.00229 Altitude, $P < 0.05$, R-Sq = 8.9%).

TABLE 1
Percentage frequency of taxa in communities

Species	Community			
	1	2	3	4
<i>Acianthus caudatus</i>	91.67	3.23	18.75	16.67
<i>Austrostipa rudis</i>	83.33	25.81	6.25	4.17
<i>Epacris acuminata</i>	75	-	12.5	4.17
<i>Carex breviculmis</i>	66.67	19.35	-	-
<i>Schoenus apogon</i>	66.67	16.13	-	-
<i>Lepidosperma gunnii</i>	58.33	54.84	18.75	41.67
<i>Themeda triandra</i>	50	12.9	-	-
<i>Cheilanthes austrotenuifolia</i>	50	25.81	18.75	37.5
<i>Austrodanthonia caespitosa</i>	33.33	19.35	-	4.17
<i>Hibbertia riparia</i>	33.33	3.23	-	-
<i>Thysanotus patersonii</i>	25	6.45	-	-
<i>Plantago varia</i>	25	3.23	12.5	4.17
<i>Pelargonium inodorum</i>	8.33	-	-	-
<i>Ozothamnus scutellifolius</i>	8.33	6.45	6.25	8.33
<i>Ozothamnus reflexifolius</i>	100	100	-	-
<i>Pimelea nivea</i>	-	48.39	6.25	-
<i>Bossiaea prostrata</i>	-	3.23	-	-
<i>Poa rodwayi</i>	91.67	100	100	4.17
<i>Dodonaea viscosa</i>	16.67	64.52	87.5	41.67
<i>Lomandra longifolia</i>	33.33	41.94	81.25	66.67
<i>Bursaria spinosa</i>	-	38.71	50	20.83
<i>Eucalyptus pulchella</i>	-	-	37.5	-
<i>Pimelea humilis</i>	-	-	37.5	20.83
<i>Correa reflexa</i>	25	22.58	31.25	8.33
<i>Eucalyptus globulus</i>	-	6.45	25	12.5
<i>Asplenium flabellifolium</i>	-	-	18.75	4.17
<i>Acacia verticillata</i>	-	-	12.5	-
<i>Acacia melanoxydon</i>	-	-	6.25	-
<i>Bedfordia linearis</i>	-	-	6.25	4.17
<i>Allocasuarina verticillata</i>	75	90.32	81.25	95.83
<i>Astroloma humifusum</i>	41.67	58.06	62.5	66.67
<i>Oxalis perennans</i>	-	3.23	37.5	45.83
<i>Acacia mearnsii</i>	8.33	25.81	12.5	41.67
<i>Acaena novae-zelandiae</i>	-	-	-	4.17

Figures in bold are the highest percentage frequencies for taxa.

TABLE 2
Characteristics of communities

	Community				p
	1	2	3	4	
Mean mds 1	1.63A	1.34B	0.85C	0.36D	0.000 (ANOVA)
Mean mds 2	0.48A	0.66A	1.04B	0.57A	0.000 (ANOVA)
Mean species richness	10.67A	8.00B	7.88BC	6.50C	0.000 (ANOVA)
Bare ground > 25% cover (%)	50	67	31	29	0.018 (Chi ²)
Rock > 5% cover (%)	83	58	6	0	0.000 (Chi ²)
Mean elevation (m)	242	260	285	300	0.036 (KW)
Mean slope (°)	17.08A	10.90B	8.75B	11.88AB	0.014 (ANOVA)
Mean aspect (°)	257A	288B	262A	292B	0.007 (ANOVA)

ANOVA = Analysis of variance, KW = Kruskal-Wallis H-test. Values with any letter the same in a row are statistically identical at $p > 0.05$

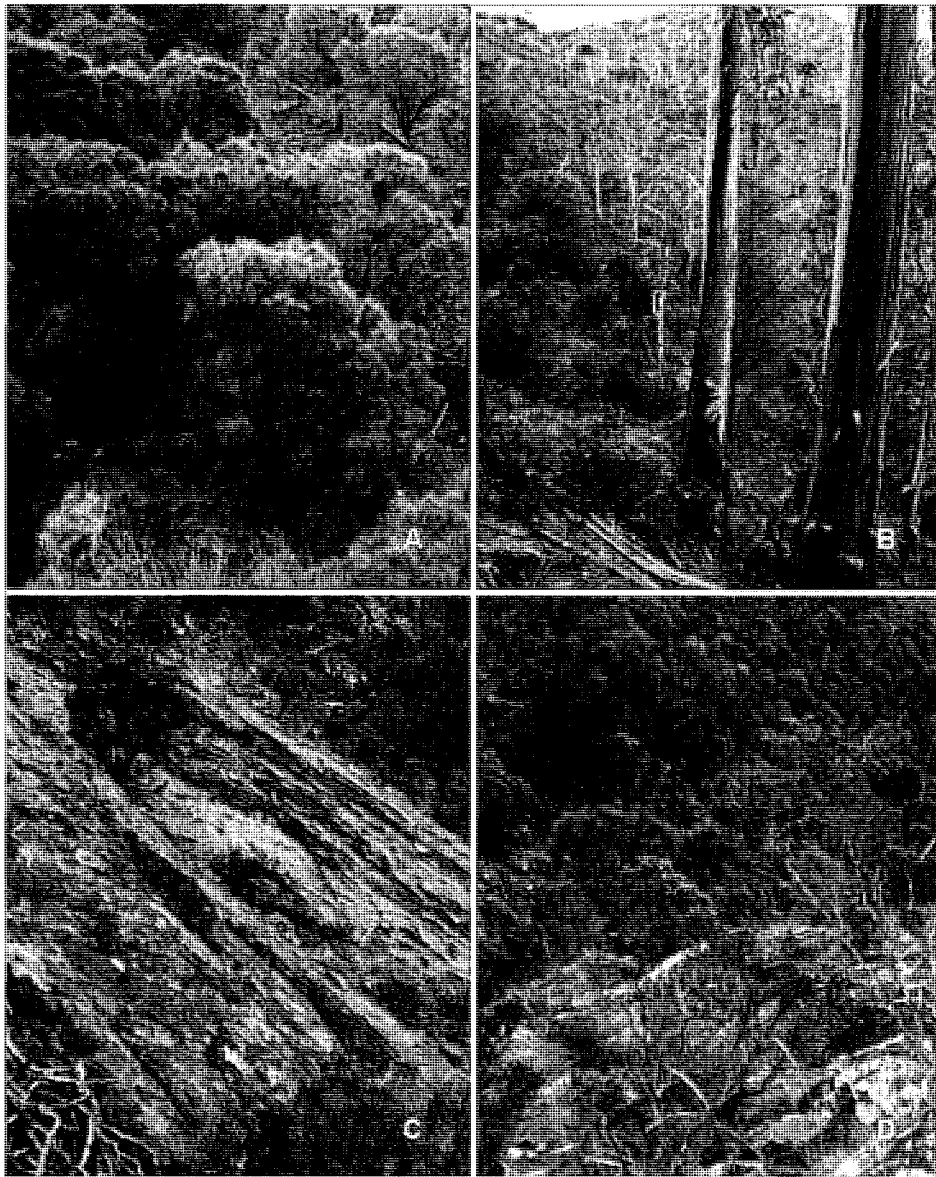


PLATE 1

Typical views of vegetation types at the study area: (A) = *Allocasuarina verticillata* woodland; (B) = *Eucalyptus globulus* tall woodland; (C) = rock face vegetation; (D) = open-heath.

DISCUSSION

Relative degrees of availability of soil moisture seem most consistent with the variation in the vegetation of the study area, with the major axis of floristic variation, and variation in species richness, being strongly related to rock cover and bare ground. This corresponds with a structural change from sparse heath on almost solid rock to tall eucalypt woodland over a dense second stratum of trees where rock cover is negligible. Because soil tends to accumulate more on gentle slopes than on steep slopes, it is not surprising that the rock plate heath is on steeper slopes than most of the other structural communities. The role of aspect in influencing floristic variation is less clear.

Community 1, which occurs in the rockiest situations, has a west-south-west mean aspect, as does the more mesic community 3, while communities 2 and 4 have west-north-west aspects. Given that the strongest and driest winds are northwesterly in southeastern Tasmania, and that insolation

is greater on the more northerly slopes, there seems likely to be a moderation of droughtiness related to more southerly aspects. Topographic position is also important for moisture relationships, with the most mesic communities being at the base of the large rock plate.

The rock plate provides the core of the habitat of *Ozothamnus reflexifolius*, only known from this site (Leeson & Rozefelds 2003, Leeson & Kirkpatrick 2004), which even apart from the presence of this species, supports an unusual heath assemblage, not described by Kirkpatrick & Harris (1999) in their statewide conspectus of heath communities, nor by Gilfedder *et al.* (1997) in their classification of Tasmanian rock plate communities. The rock plate with the most similar vegetation to the one described here is on the Lake Leake Road on the seaward slope of the Eastern Tiers, in woodland dominated by *E. pulchella*. This had a Bray-Curtis similarity of only 35% (Leeson and Kirkpatrick 2004). The Mt Direction rock plate is therefore of extremely high conservation significance.

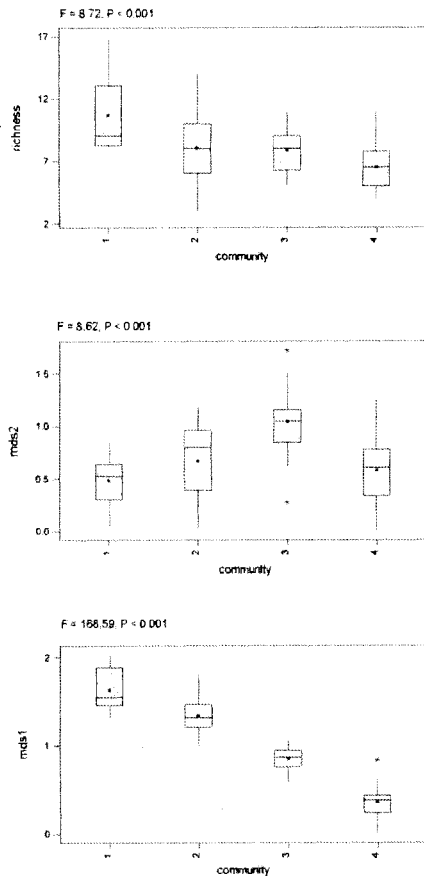


FIG. 2 — Box plots of: *mds* axis 1 score by community; *mds* axis 2 score by community; species richness by community. The boxes enclose the 25–75 percentiles, the lines show the ranges and the dots represent the means.

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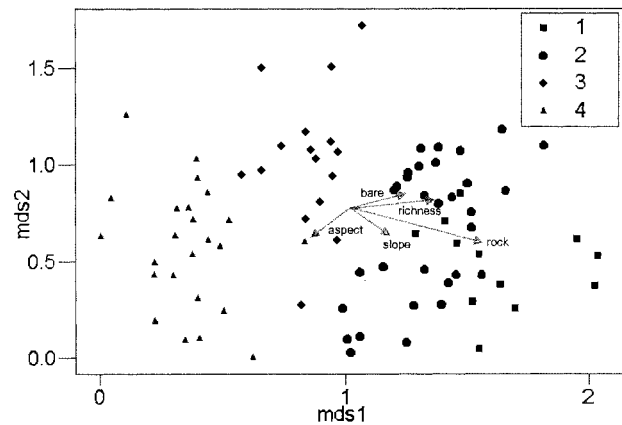


FIG. 4 — Significant vectors in two-dimensional ordination space, showing the distribution of the four communities.

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