Austrodanthonia spp. in grazed native pastures on the Monaro tableland, NSW

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Abstract
Panicles of *Austrodanthonia* spp. (Wallaby grass) were collected on two contrasting native grassland sites on the Monaro tableland of New South Wales in an attempt to understand species distribution in relation to soil factors. Ten species were found at a site on a coarse-grained granite soil near Berridale and six on a site on basalt near Bungarby, with *A. racemosa* being the most common species at both sites. Some associations with soil chemical data were found at the Berridale site, but there were fewer associations at Bungarby. Soil factors associated with clay content and exchangeable cations appeared to be more important than other chemical factors. Results are discussed in relation to data from other studies, and the difficulty of establishing associations is acknowledged.

Key Words
Species, grassland, soil chemistry, disturbance

Introduction
Austrodanthonia (formerly *Danthonia*) in New South Wales is a genus of 18 species of native grasses which are highly valued in grazed temperate pastures (Garden *et al.* 2001). These species are common on the Monaro region of New South Wales (NSW), an elevated area extending from Canberra and Queanbeyan in the north to the Victorian border in the south, bounded in the east by the Kybean Range and in the west by the Snowy Mountains (Benson 1994). In this area, climatic and other ecological factors have resulted in extensive open grassland, where little pasture sowing and fertiliser application has been carried out relative to other tableland areas. Since most graziers in the region have to rely on these native grassland areas for wool and livestock production, the contribution of *Austrodanthonia* species to pasture production is critical because of their known drought tolerance and generally higher feed quality than many other native grasses (Waters *et al.* 2009). *Austrodanthonia* species have different attributes and adaptations to climate and soil type, allowing them to fill many different ecological niches (Flora of Australia 2005). The aim of this study was to identify the species of *Austrodanthonia* that were present in representative native grasslands of the Monaro region, in an attempt to understand their distribution in relation to soil factors.

Methods
Two grazed, native grassland sites were selected on the Monaro tableland, NSW as part of a larger study on the effects of varying soil fertility and grazing on biodiversity of native grasslands. The two sites (Table 1) were on contrasting soil types, one a soil derived from granite near Berridale (36° 24′ 25′′S, 148° 51′ 23′′E) and the other on a soil derived from basalt near Bungarby (36° 37′ 40′′S, 149° 02′ 30′′E). Both sites had been grazed by sheep for over 100 years without the addition of fertiliser or sown species, although there were small amounts of naturalised clovers (*Trifolium* spp.) present. The vegetation at each site was dominated by native perennial grasses, with the main species being *Austrostipa scabra, Austrodanthonia* spp. and *Enneapogon nigricans* at Berridale and *Poa sieberiana, Austrodanthonia* spp. and *Austrostipa bigeniculata* at Bungarby. As part of the grazing experiment, each site had nine 5 ha fenced plots. For this study, three collectors each harvested 20 ripe panicles of *Austrodanthonia* in January 2005 along random transects in each plot, making a total of 60 panicles per plot (540 panicles per site). Sampling occurred at 20 m intervals along each transect, with the nearest panicle to the toe of a boot at that point being collected. Panicles were placed intact into paper bags and stored under dry condition for later identification in a laboratory using a binocular microscope and the latest botanical key (Flora of Australia 2005).

Soil samples (0-10 cm depth) were collected in each plot at both sites in January 2005 by bulking soil cores taken at 20 m intervals along random transects in each plot. Samples were analysed for pH ($CaCl_2$), organic carbon, Colwell phosphorus, sulphur, cations (K, Ca, Mg, Na, Al, Total CEC), electrical conductivity and

phosphorus buffer index (PBI). Soil and species data were analysed by regression using Genstat v11 to test relationships between proportions of species found in each plot and soil characteristics associated with plots.

Table 1. Characteristics of collection sites on the Monaro tableland of NSW (means with SDs).

	Altitude (m)	Mean annual rainfall (mm)[A]	Soil parent material	Soil pH ($CaCl_2$)	Colwell Soil P (mg/kg)	Phosphorus Buffer Index	Exch. Mg (meq/100g)
Berridale	935-965	527 (131)	Granite	5.1 (0.23)	18 (4.4)	26 (5.2)	0.95 (0.28)
Bungarby	945-965	599 (146)	Basalt	5.2 (0.13)	47 (13.7)	202 (13.2)	6.9 (1.9)

[A]From the Silo database, 1889-2012 (Jeffrey *et al.* 2001).

Results and Discussion

The proportions of *Austrodanthonia* species identified in the native grasslands at each site are shown in Figure 1. Ten species were identified at the Berridale site. *A. racemosa* was the most common species, comprising 65.6% of the total species found. Other species recorded (in declining order of occurrence) were *A. eriantha, A. tenuior, A. laevis, A. fulva, A. caespitosa, A. penicillata, A. pilosa, A. setacea* and *A. richardsonii*. Fewer species (6) were found at the Bungarby site. *A. racemosa* was again the most common species, comprising 71.5% of the total species found. Other species recorded were *A. tenuior, A. caespitosa, A. fulva, A. eriantha* and *A. laevis*.

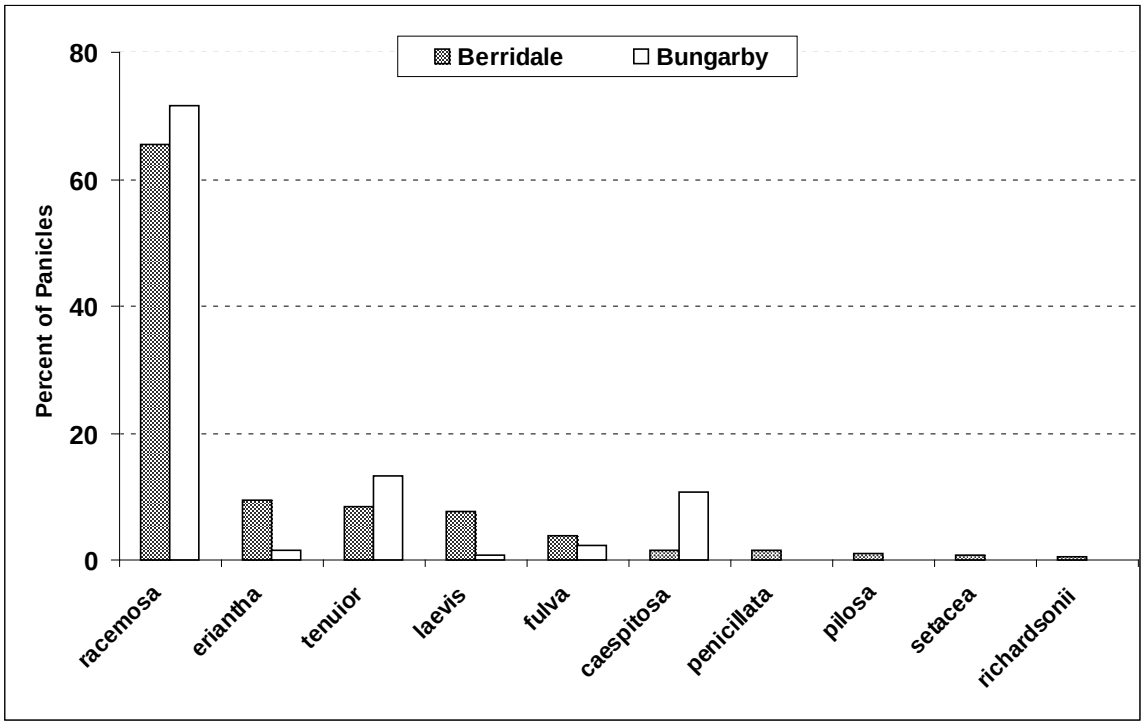

Figure 1. Proportions of *Austrodanthonia* species identified at native grasslands at sites at Berridale and Bungarby, NSW. Data presented as means over 9 plots at each site.

Data from this study confirmed the finding of Garden and Dowling (unpublished) in an earlier survey, that the most common *Austrodanthonia* species found on the Monaro tableland is *A. racemosa*. This species is widespread throughout south-eastern Australia, and is reputed to be common in disturbed sites (Flora of Australia 2005). The results showed that despite contrasting soil types and rainfall at the two sites, the proportions of species were generally similar. The main differences were for *A. eriantha* and *A. laevis* (higher at Berridale) and *A. tenuior* and *A. caespitosa* (higher at Bungarby), and the absence of *A. penicillata, A. pilosa, A. setacea* and *A. richardsonii* at Bungarby.

Flora of NSW (2005) made comment that *A. eriantha* is often the most dominant species on the Southern Tablelands of NSW, but this is not supported by the findings of this study. Dowling *et al.* (1996) suggest that *A. eriantha* is more commonly found in areas of low soil pH, which applies to many areas of the Southern Tablelands of NSW, but excludes most areas of the Monaro region. As in this study, *A. racemosa* was consistently much more common than *A. eriantha* in the work of Dowling *et al.* (1996) and Garden and Dowling (unpublished; mean 60 *vs* 32% over the Central, Southern and Monaro tablelands combined; 70 *vs* 15% Monaro only).

In native grasslands on the tablelands of NSW, it is extremely rare to find a pure stand of a single species and, commonly, species are intermixed or dominating in particular small-scale ecological niches (Garden and Dowling (unpublished). The way these sites were sampled (many samples over an extended transect) would tend to result in more, rather than fewer species although, clearly, *A. racemosa* was a dominant species at both sites. The findings of this study suggest that *A. tenuior* is found at higher altitude (950 m) than that suggested by Flora of Australia (2005) of 5-750 m. *A. setacea* was recorded at the Berridale site (altitude ~950 m) which is higher than the suggested range for this species of 0-650 m (Flora of Australia 2005). This was also the case for *A. fulva* which was recorded at both sites, yet is described by Flora of Australia (2005) as found at an altitudinal range of 30-500m.

Analysis of differences between plots revealed that at Berridale the proportion of *A. racemosa* tended to decline from plots 1-9 (plots generally arranged in a linear pattern), while the proportion of *A. fulva* was considerably higher in plots 8 and 9 compared to other plots (next highest in plot 7). Regression analyses showed there were some significant relationships and trends between species dominance and soil properties at Berridale. The presence of *A. racemosa* decreased with increasing PBI (P=0.032), increased with increasing Ca:Mg ratio (P=0.003) and decreased with increasing Mg (P=0.033). The presence of *A. fulva* increased with increasing soil Mg (P<0.001). Thus, there appears to be a consistent pattern of *A. fulva* being more prevalent at higher soil Mg, and *A. racemosa* less prevalent. However, whether these are causal effects or due to some other factor is unknown. Plots 8 and 9 had the highest PBI and Mg values, possibly reflecting higher clay content due to natural landscape variability.

There were also some significant relationships between proportions of other species and soil factors. *A. eriantha* declined with increasing soil phosphorus (P=0.031). *A. laevis* declined with increasing Ca:Mg ratio (P=0.027) and organic carbon (P=0.038). *A. tenuior* increased with increasing soil potassium (P=0.01) and PBI (P=0.039). *A. caespitosa* decreased with increasing electrical conductivity (P=0.036).

At Bungarby, there were fewer significant relationships or trends. Similar to the Berridale site, there was a trend for *A. racemosa* to decrease with increasing PBI (P=0.056). The PBI at this site was much higher than at Berridale, but the relative range (180-220) was again fairly narrow. The proportion of *A. tenuior* increased with increasing PBI (P=0.008). *A. caespitosa* declined with increasing Ca (P=0.025) and Total CEC (P=0.027). At this site there was no apparent linear relationship between proportions of species and plot number or between location of plots and soil chemical data, except that plots 2 and 3 had the highest PBI, and plots 1, 2, 3 and 9 had the highest soil Ca and total CEC. This is perhaps not surprising, as at this site the plots were not arranged in a linear pattern as they were at Berridale.

Apart from PBI, there appeared to be little consistency in the results obtained at both sites. PBI is a reflection of how easy or difficult it is to alter soil P with added fertiliser P (Moody 2007). However, increasing PBI generally reflects a higher clay content and presence of higher valency cations such as Al, Ca and Mg. Species which showed some sensitivity to some of these factors were *A. racemosa*, *A. tenuior*, *A. fulva*, *A. laevis* and *A. caespitosa*.

There is very little published information on the effects of climatic and edaphic factors on species of *Austrodanthonia*. However, Waters *et al.* (2009) studied the effects of a number of factors on the distribution of 5 species of *Austrodanthonia* in central western NSW. While direct comparisons are difficult due to the different soils and environment and the range of species found, some comments can be made. Waters *et al.* (2009) suggest that *A. eriantha* is associated with relatively low fertility soils, confirming the observations of Garden and Dowling (unpublished). The data from our study is in some agreement with this, as there was a higher proportion of *A. eriantha* at lower soil P at the Berridale site. Waters *et al.* (2009) also found that *A. fulva* was associated with high total CEC values. Although we did not show such a relationship, in our study there was a higher proportion of *A. fulva* at higher soil Mg, a cation frequently associated with higher total CEC.

Waters *et al.* (2009) made the observation that *A. caespitosa* has some affinity with highly disturbed sites. While disturbance was not part of our study, using data wider than the present study, we could perhaps make the same observation in our environment for *A. racemosa*, as this species is found in a wide range of environments, and is frequently common in many previously cultivated, sown, fertilised and grazed pastures

throughout the tablelands of NSW. Perhaps the differing conclusions here are due to differences in species dominance. In the environment studied by Waters *et al.* (2009), *A. caespitosa* is the most common species found, and may therefore be highly adaptable, whereas on the tablelands of NSW, *A. racemosa* appears to occupy a similar position.

Conclusions

Several species of *Austrodanthonia* were found at the two sites studied, with *A. racemosa* being by far the most common at both sites. The data from this study and that of Waters *et al.* (2009) show that it is no easy matter to show relationships between presence of individual *Austrodanthonia* species and edaphic, environmental and management factors. To some extent this is due to the great difficulty in field identification of species in this genus, requiring identification to be made at a location distant from the sites at which factors can be observed and measured. The other main problem, alluded to by Waters *et al.* (2009), is that there is no clear guidance as to the scale at which the various factors are operating. For example, to fully understand the influence of soil factors on individual species it may be necessary to sample intensively around individual plants, as micro-variations in these factors may be important. While our data reveal some possible associations, it is clear that much work remains to be done to adequately define the distribution of *Austrodanthonia* species and the factors which control it. However, we suggest that this could be rewarding, given the value of these species in grazed pastures throughout southeast Australia.

Note: It has recently been suggested that species presently in the genus *Austrodanthonia* may in future be included in *Rytidosperma* (Humphreys *et al.* 2010). This is likely to require some changes to species names.

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