PROCEEDINGS OF THE AUSTRALIAN RANGELAND SOCIETY BIENNIAL CONFERENCE
Official publication of The Australian Rangeland Society

Copyright and Photocopying

Form of Reference

The reference for this article should be in this general form;

Author family name, initials (year). Title. *In*: Proceedings of the nth Australian Rangeland Society Biennial Conference. Pages. (Australian Rangeland Society: Australia).

For example:

Anderson, L., van Klinken, R. D., and Shepherd, D. (2008). Aerially surveying Mesquite *(Prosopis* spp.) in the Pilbara. *In*: 'A Climate of Change in the Rangelands. Proceedings of the 15th Australian Rangeland Society Biennial Conference'. (Ed. D. Orr) 4 pages. (Australian Rangeland Society: Australia).

Disclaimer

The Australian Rangeland Society and Editors cannot be held responsible for errors or any consequences arising from the use of information obtained in this article or in the Proceedings of the Australian Rangeland Society Biennial Conferences. The views and opinions expressed do not necessarily reflect those of the Australian Rangeland Society and Editors, neither does the publication of advertisements constitute any endorsement by the Australian Rangeland Society and Editors of the products advertised.

The Australian Rangeland Society

AN INTRODUCTION TO THE GYPSOPHILOUS VEGETATION OF SEMI ARID AND ARID SOUTHEASTERN AUSTRALIA

M.J. O'Keefe, M.E. Westbrooke and S.K. Florentine

Centre for Environmental Management, University of Ballarat, PO Box 663, Ballarat VIC 3353

ABSTRACT

The growth of plants in soils rich in gypsum has received little attention. Research is being undertaken to investigate the degree to which there is a characteristic suite of species specifically associated with these soils and the nature of their adaptation to cope with high levels of sulphur and other problems. Many areas with high gypsum content have been subject to high levels of disturbance from open-cut mining. In this paper, some preliminary findings in relation to species occurrence is presented along with lists of species identified as potential gypsophiles. A program is outlined to investigate how plants are adapted to cope with gypsophilous soils.

INTRODUCTION

The vegetation associated with outcrops of gypsum in arid and semi-arid regions of Australia has received little attention. Plants associated with gypsum are referred to as gypsophiles, while gypsophily refers to the ability of a plant to tolerate gypsum. There appears to be some overlap between gypsophilous and saline flora. Significant deposits of gypsum (hydrated calcium sulphate) occur in Victoria, South Australia, Western Australia, Northern Territory, Queensland and New South Wales, where mean annual rainfall is less than 400 mm. Many otherwise widespread species are not recorded on gypsum soils, which have been classified as floristically poor. This suggests that gypsum has an adverse effect on most plant species. What this effect is, and how some plants have become adapted, form the basis of this research. To understand gypsophily, both the benefits and disadvantages of the gypsum substrate must be investigated. This research is important to enable the appropriate management of vulnerable or threatened taxa that have a known association with gypsum, and to guide the appropriate rehabilitation of gypsum mines following suspension of operations. Fleshy Minuria (*Kippistia suaedifolia*), family Asteraceae, provides an ideal opportunity to investigate the ecology of gypsophiles in Australia. An apparently obligate gypsophile, *K. suaedifolia* is endangered in NSW and considered vulnerable in Victoria. However, preliminary studies have revealed a population of almost 100,000 plants on exposed gypsum at an abandoned mine in the Raak Plain, northwest Victoria and close to a million plants at another abandoned mine near Ivanhoe, western NSW. This latter site is one of only three known occurrences of the species in NSW. Two key questions are being investigated:

- Is there a suite of plant species regularly associated with gypsum?
- How are plants adapted to cope with gypsophilous soils?

As an example of an apparently obligate gypsophile, the ecology of *K. suaedifolia* will be investigated in natural and disturbed environments.

SPECIES ASSOCIATED WITH GYPSOPHILOUS SITES

Method

In a preliminary investigation, disturbed sites associated with gypsum open cut mines around Ivanhoe

and relatively undisturbed sites in and around the Scotia Discharge Complex in western NSW were investigated (Fig 1.). The latter sites have been subject to some elevated grazing pressure but no mining activity. At the Scotia site, a population of *K. suaedifolia* had been discovered during previous vegetation surveys (Westbrooke *et al.* 1998). At each site all species occurring were recorded and their life-form noted. This list of species was compared to data on possible gypsophiles from Parsons (1976), David Symon (SA Herbarium, *pers. comm.*, 2003) and Neville Walsh (Melbourne Royal Botanic Gardens, *pers. comm.*, 2003).

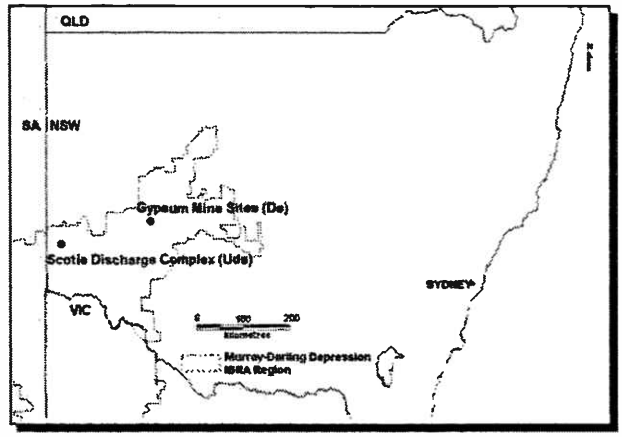

Figure 1. Location of NSW study sites included in this paper

RESULTS

Data from Parsons (1976) together with unpublished data from Symon (SA Herbarium, *pers. comm.*, 2003) and Walsh (Melbourne Royal Botanic Gardens, *pers. comm.*, 2003) provided a list of 40 species associated with gypsum sites in southeast Australia. Only seven of these have been recorded during this study so far, however a further 66 gypsum associated species were found. Eight new populations of *K suaedifolia* were discovered within the undisturbed sites at the Scotia Discharge Complex. No further records of *K. suaedifolia* were discovered at the disturbed sites.

Table 1. Preliminary list of South Eastern Australian gypsophiles 2003

Species	Source (2003)	This study	Preliminary list of SE gypsophiles	Source (2003)	This study
Poaceae			**Chenopodiaceae cont.**		
Austrostipa geoffreyi	DS	?	*Maireana appressa*	NW	
Austrostipa nulla nulla	DS,NW	?	*Maireana fimbriolata*	RP	
Poa fax	NW		*Maireana oppositifolia*	NW	
Azioacceae			*Osteocarpum acropterum*	NW	✓
Dysphania simulans	NW		*Sclerolaena symoniana*	DS	
Asteraceae			**Fabaceae**		
Brachyscome ciliocarpa	NW		*Swainsona minutiflora*	DS	
Brachyscome exilis	NW		*Swainsona phacoides*	NW	
Elachanthus glaber	NW		*Swainsona purpurea*	NW	
Elachanthus pusillus	NW		**Frankeniaceae**		
Eriochlamys behrii	NW		*Frankenia foliosa*	NW	✓
Haegiela tatei	NW		*Frankenia sessilis*	DS	
Kippistia suaedifolia	DS, NW,RP	✓	**Goodeniaceae**		
Minuria gardneri	DS		*Goodenia cenfracta*	DS	
Minuria multiseta	DS		*Goodenia gypsicola*	DS	
Othonna gypsicola	DS		*Scaevola collaris*	RP.	
Trichanthodium baracchianum	NW		**Malvaceae**		
Trichanthodium skirrophorum	NW		*Lawrencia helmsii*	DS, RP	

Boraginaceae			*Radyera farragei*	NW	
Embadium johnstonii	DS		**Myrtaceae**		
Brassicaceae			*Calytrix gypsophila*	DS	
Hymenolobus procumbens	NW		**Solanaceae**		
Campanulaceae			*Nicotiana burbidgeae*	DS	
Isotoma scapigera	DS		**Nicotiana glauca*	RP.	✓
Chenopodiaceae			*Nicotiana truncata*	DS	
Atriplex papillata	NW		**Zygophyllaceae**		
Halosarcia flabelliformis	NW		*Zygophyllum aurantiacum*	NW,RP	✓
Halosarcia halocnemoides	NW	✓	*Zygophyllum compressum*	NW,RP	
Halosarcia indica	NW	✓			

A total of 73 species from 28 families were identified during this survey (Table 2). The highest representation was from the Chenopodiacae and Asteraceae with 20 and 12 species respectively. Of the 73 species, 46 were found at the disturbed sites while 36 species were recorded in the undisturbed sites. The twelve exotic species from the mine sites reflect the high level of disturbance. Many of these exotic species are regarded as generalists, coping with a wide range of substrates. No exotic species were recorded from the Scotia sites. Only seven species were common between the sites, *Kippistia suaedifolia, Atriplex sp.2, Maireana pyramidata, Salsola kali, Sclerolaena muricata S. patenticuspis* and *Zygophyllum aurantiacum.* The majority of species were perennial with the exotic species influencing the number of annuals at the disturbed sites. Overall there were three trees, 27 perennial shrubs, six perennial low shrubs, 16 perennial forbs, one perennial vine, 20 annual forbs and three annual/biennial forbs.

Table 2. Comparison of species presence in Disturbed (Ds) and Undisturbed (Uds) gypsum sites 2003/04

Species	Life-form	Ds	Uds	Species	Life-form	Ds	Uds
Monocots				*Osteocarpum acropterum*	Pl	✓	
Liliaceae				*Rhagodia spinescens*	PS		✓
**Asphodelus fistulosus*	PF	✓		**Salsola kali*	A/B S	✓	✓
Poaceae				*Sclerolaena bicornis*	PS	✓	
Austrostipa sp.1	PF	✓		*Sclerolaena muricata*	PS	✓	✓
Austrostipa sp.2	AF		✓	*Sclerolaena parviflora*	PS		✓
Avena sp.	AF	✓		*Sclerolaena patenticuspis*	Pl	✓	✓
Bromus sp.	AF	✓		*Sclerolaena* sp.1.	Pl	✓	
Eragrostis sp.1. *(dielsii?)*	PF?	✓		**Convulvulaceae**			
Triodia scariosa	PF		✓	*Convolvulus erubescens*	PF	✓	
Dicots				**Cucurbitaceae**			
Asteraceae				**Citrullus colocynthis*	PV	✓	
Gnephosis tenuissima	AF		✓	**Euphorbiaceae**			
Brachyscome ciliaris	PF		✓	*Euphorbia drummondii*	F	✓	
Brachyscome sp.1.	AF?	✓		**Frankeniaceae**			
**Carthamus lanatus*	AF	✓		*Frankenia foliosa*	PS		✓
Centipeda cunninghamii	PF	✓		**Gentianaceae**			
**Chondrilla juncea*	AF	✓		*Centaurium tenuiflorum*	F	✓	
Kippistia suaedifolia	Pl	✓	✓	**Goodeniaceae**			
Olearia muelleri	PS		✓	*Goodenia cycloptera*	PF	✓	
Olearia pimeleoides	PS		✓	**Lamiaceae**			
Podolepis capillaris	AF		✓	**Marrubium vulgare*	PF	✓	
Pseudognaphalium luteo-album	AF	✓		**Salvia verbenaca*	PF	✓	
**Xanthium spinosum*	AF	✓		*Teucrium racemosum*	PF	✓	
Aizoaceae				*Westringia rigida*	PS		✓
Disphyma crassifolium subsp. clavellatum	PF		✓	**Malvaceae**			
Boraginaceae				*Sida* sp.	PS	✓	
**Echium plantagineum*	AF	✓		**Mimosaceae**			
**Heliotropium europaeum*	AF	✓		*Acacia burkittii*	PS		✓
Brassicaceae				**Myoporaceae**			
**Carrichtera annua*	AF	✓		*Eremophila glabra*	PS		✓
Menkea australis	F		✓	*Eremophila scoparia*	PS		✓
Sisymbrium sp.1	A/B	✓		*Eremophila sturtii*	PS		✓
Caesalpiniaceae				*Myoporum platycarpum*	T		✓
Senna artemisioides subsp. filifolia	PS		✓	**Myrtaceae**			
Campanulaceae				*Eucalyptus populnea*	T	✓	
Wahlenbergia communis	PF	✓		*Eucalyptus gracilis*	T		✓
Caryophyllaceae				**Nyctaginaceae**			

Species	Life-form	Ds	Uds	Species	Life-form	Ds	Uds
Spergularia rubra	A/BF		✓	*Boerhavia diffusa*	PF	✓	
Chenopodiaceae				**Proteaceae**			
Atriplex sp.1.	PS	✓		*Hakea leucoptera*	PS		✓
Atriplex sp.2.	PS	✓	✓	**Sapindaceae**			
Atriplex vesicaria	PS		✓	*Dodonaea viscosa* subsp. *angustissima*	PS		✓
Dissocarpus paradoxus	Pl	✓		**Scrophulariaceae**			
Enchylaena tomentosa	PS	✓		*Stemodia florulenta*	PF	✓	
Halosarcia halocnemoides	Pl		✓	**Solanaceae**			
subsp. halocnemoides				**Nicotiana glauca*	PS	✓	
Halosarcia helmsii	PS		✓	**Thymelaeaceae**			
Halosarcia indica	PS		✓	*Pimelea trichostachya*	F	✓	
Maireana brevifolia	PS	✓		**Zygophyllaceae**			
Maireana pentatropis	PF		✓	*Zygophyllum aurantiacum*	PS	✓	✓
Maireana pyramidata	PS	✓	✓	*Zygophyllum eremaeum*	PS/S		✓

*=exotic species, P=perennial, A=annual, F=forb, S=shrub, l=low shrub, T=tree, B=biennial, V=vine

DISCUSSION

The differences between previous records (Table 1) and the species recorded at this stage of the study (Table 2) highlight the paucity of study to date. Further investigations will enable the separation of species into obligate and facultative gypsophiles. The exotic species recorded, perhaps with the exception of *Nicotiana glauca* (Solanaceae), should be considered generalists. Both seasonal and regional differences will account for some discrepancy between the two lists but this should be negated as further sites are surveyed in NSW, NW Victoria and SA over a range of seasons. Species composition varied not only between the disturbed and undisturbed sites but also between natural populations occurring in different areas within the Scotia Discharge area. The composition of these sites reflect, to some degree, the surrounding communities and suggests that species are able to successfully migrate from their 'comfort zone' to the harsher gypsum environment. It is also likely that some perennial species with an extensive root system actually 'avoid' the gypsum. The influence of the location of gypsum in the soil profile, the purity and type of gypsum deposit on species composition will be investigated during the course of this research. This may help explain why *K. suaedifolia* is abundant at two of the mine sites surveyed but not located at others, which mining reports suggest are of 'poorer' gypsum content. This situation was replicated at the undisturbed situations in the Scotia Discharge Complex area, where *K. suaedifolia* grew abundantly on some gypsum islands, was absent from neighbouring gypsum islands, but was present on gypsum deposits some 20 km away.

ADAPTATION OF PLANTS TO GYPSOPHILOUS SOILS

The ecology of *K. suaedifolia* will form a major component of this study, including its reproductive ecology, ability to grow on other soils and establishment and growth characteristics. Seed has been collected from *K. suaedifolia* over the past two years and will be used along with that from other gypsophiles in seed germination trials. These trials will investigate the growth of key species in different purity levels of gypsum. Seed production, longevity, dispersal, germination and time to flowering will be studied in conjunction with anatomical and physiological adaptations. The soil seed bank will also be investigated at each site to determine: (i) seasonal differences in species composition, (ii) the presence of species that are unable to germinate or establish due to the gypsum substrate and (iii) the seed store of *K. suaedifolia.* The path of sulphur within *K. suaedifolia* and *Z. aurantiacum* will be traced using a scanning electronic microscope.

ACKNOWLEDGEMENTS

We greatly thank David Symon, SA Herbarium, John Pickard, Macquarie University, Peter Milthorpe, NSW DLWC Conodobolin, Bob Parsons, La Trobe University, Roy Kennedy, Ivanhoe, Paul Jaskiernak and Karen for their valued assistance. Financial support for this research was provided by

the Commonwealth Government Australia.

REFERENCES

Mattiske Consulting (1995). *Review of Botanical Values on a Range of Gypsum Dunes in the Wheatbelt of Western Australia.* Department of Conservation and Land Management, Western Australia.

Parsons, R.F. (1976). Gypsophily in plants - a review. *American Midland Naturalist* 96: 1-20.

Westbrooke, M.E, Miller, J.D. and Kerr, M.K.C. (1998). The vegetation of the Scotia 1: 100 000 map sheet, western New South Wales. *Cunninghamia* 5: 665-678.