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Lists of gypsophilous plants from southern Australia

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Abstract

An annotated list is provided of plants that appear to be gypsophilous. About 14 species may be considered obligate gypsophiles: *Asteridia archeri*, *Austrostipa geoffreyi*, *Austrostipa nulla nulla*, *Calytrix gypsophila*, *Embadium johnstonii*, *Goodenia gypsicola*, *Kippistia suaedifolia*, *Lawrencia helmsii*, *Melaleuca nanophylla*, *Minuria gardneri*, *Minuria multiseta*, *Nicotiana burbidgeae*, *Nicotiana truncata*, *Senecio gypsicola*. A further 233 species are facultative gypsophiles, being clearly tolerant of high concentrations of gypsum but much more widely spread. Fifty-six species of naturalised plants were recorded from gypsum deposits in South Australia in field surveys by the author; all species would be considered facultative gypsophiles.

Introduction

Gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$), a calcium dihydrate, occurs widely in drier southern and interior Australia. It may be present in three main forms: as kopi, a white floury powder (gypsite); seed gypsum (crystalline gypsarenite), a porous granular state; or rock gypsum (selenite), in larger aggregates. The latter may form rock-like masses or occur at times as glass-like plates. *Kopi* is an Aboriginal word for a mourning cap made of gypsum and was used by the Aborigines near the junction of the Darling and Murray rivers (Curr 1886–87).

Accounts of gypsum in South Australia may be found in Jack (1921) and in Western Australia in De la Hunty & Low (1958) and Jones (1993). Many localities are itemized and chemical analyses given but in neither of these are there any botanic details.

A substantial account of gypsum in New South Wales is given by Wynn (1965). This showed that gypsum is found in many localities in the Western Division and with few exceptions in areas with less than 375 mm (15 inches) average annual rainfall. The only plant species mentioned is *Nicotiana glauca* (tree tobacco) with the comment “Although not specific for the mineral... the plant grows profusely on many deposits ...”.

An extensive account of gypsum deposits of Western Australia is provided by Jones (1993). These are mainly in the southern portion of the State and quite numerous. However, no plants are mentioned in this report. Considering the particularly interesting flora of southern Western Australia there is scope to investigate gypsophily in this area.

An account of gypsum deposits in Victoria was published by Thomas (1947). The deposits are principally in the north-west of the State but again no plants are mentioned.

The largest deposit in Australia is at Lake McDonnell on western Eyre Peninsula, 60 km west of Thevenard, South Australia (Forbes 1960a, 1960b; Anon. 2000). This extensive deposit averages 3.87 m thick and much of it is greater than 95% pure gypsum. Impurities are calcium carbonate and some sodium chloride.

Further accounts of gypsum in South Australia may be found in a popular account of the Arckaringa hills area, Deichman (1986) and King (1951) on Cooke Plains, and King (1952) on the Craigie Plains deposits.

Gypsum commonly occurs as dunes to the lee sides of salt lakes. In many cases this is on the east or south east side of the lakes. Many gypsum dunes taper down to the saline lake systems at their base making the separation of salt tolerant and gypsophilic species difficult. A great many herbarium labels lack any critical distinction between these two categories. The mere sighting of samphires prompts a response that the area must be saline. The summit of the dunes may be more or less pure gypsum or with thin leaf mould when well vegetated and the lower slopes often have thin to deep layers of loam covering the gypsum. A number of small annual herbs live in the shallow mould above the gypsum and it is difficult to know whether these are truly gypsophilous or merely tolerant.

The face of the mining cut through the dune at Cooke Plains, South Australia shows mallee roots descending almost vertically through 4 m of gypsum. The herbaceous perennial *Microseris scapigera* may have its tubers completely developed in floury white kopi. The roots of some *Austrostipa* clearly penetrate gypsum to considerable depths, and shrubs at such sites (e.g., *Atriplex*, *Maireana*, *Rhagodia*, *Lawrencia*) clearly have their permanent root systems well into the gypsum whatever the surface veneer may consist of.

Parsons (1976) published a review of gypsophily in plants. This dealt largely with the ability of plants to metabolise the sulphur in gypsum. It contained references to principal gypsum deposits elsewhere in the world and included some species lists. Only five Australian species were listed, all of which are included in the present lists.

Chippendale (1963) describes some of the gypsophilous plants and the ecological succession on the margin of Lake Amadeus. A list of plant species is given in the ecological gradient from the edge of the saline lake surface to the edge of the gypseous sands. From the saline margin to the edge of the gypseous sands they included *Plagianthus* (now *Lawrenzia*) *glomeratus*, *Pachycornia* (= *Sclerostegia*) *tenuus*, *Frankenia cordata*, *Arthrocnemum halocnemoides*, *Bassia* (= *Maireana*) *leuhmannii*, *Bassia* (= *Sclerolaena*) *birchii*, *Zygophyllum compressum*, *Atriplex vesicaria*, *Chenopodium nitrariaceum*, *Hakea leucoptera*, *Melaleuca glomerata* and *Eremophila macdonnellii*. However the ecological gradient was steep and the analysis complicated by blown red sand.

The only account that provides a near comprehensive listing of gypsophilous plants for a region in Australia that I have located is one by Mattiske Consulting (1995–96) for the Department of Conservation and Land Management, Perth, which examined the “botanical values on a range of gypsum dunes in the wheat belt of Western Australia”. The report includes a large list of plants collected, many of which are gypsum tolerant, and does include about 30 species “present mostly at high gypsum sites”. These have been incorporated into this report.

O’Keefe (2003) in an article on gypsophily in Victoria, makes a plea for more knowledge of gypsophiles in Australia. The author records three classes of gypsophily:

- Obligate gypsophiles
- Facultative or non-differential gypsophiles
- Halophytic gypsophiles

Very few plant species are named.

Indigenous gypsophilous plants in southern Australia: evidence from plant collections and literature

Methods

Data from herbarium collections and the literature have been assembled to provide a list of gypsophilous plants, contained in the Appendix to this paper.

The list of actual and suspected gypsophiles contained in the Appendix are based substantially on herbarium label data and on recent collections by R. Bates, F. Badman and the author. It also incorporates data from the few published accounts available: Chippendale (1963), Mattiske (1995–96) and O’Keefe (2003), together with label data from the State Herbarium of South Australia (AD), the Herbarium of the Northern Territory (DNA, NT) and the Western Australia Herbarium (PERTH).

Occurrences relate to South Australia unless otherwise stated.

Nomenclature follows the *Census of South Australian Vascular Plants* (Barker et al. 2005).

The original intention of the following lists was to provide one of truly gypsophilous plants substantially confined to gypseous soils and a second list of gypsum tolerant species. Because of a lack of critical collecting details, this was more difficult than expected. In addition, a much greater number of species was rapidly found whose habitats extended widely beyond recognised gypsum fields.

More often than not label data is inadequate and in most cases notes made by the collector cannot be checked. Where a single label record of gypsum has been found commonsense assessments have been made. The term “likely sites” is used repeatedly in the text where a number of collections come from possible sites but do not actually mention gypsum.

May I plead for more careful and more detailed collecting notes on the soils on which your worthy specimens grow.

Results

From the specimen and literature survey, just 14 species are likely to fall into O’Keefe’s (2003) category of “obligate gypsophiles”:

- Asteridia archeri* – Compositae
- Austrostipa geoffreyi* – Gramineae
- Austrostipa nulla nulla* – Gramineae
- Calytrix gypsophila* – Myrtaceae
- Embadium johnstonii* – Boraginaceae
- Goodenia gypsicola* – Goodeniaceae
- Kippistia suaedifolia* – Compositae
- Lawrenzia helmsii* – Malvaceae
- Melaleuca nanophylla* – Myrtaceae
- Minuria gardneri* – Compositae
- Minuria multisetata* – Compositae
- Nicotiana burbridgeae* – Solanaceae
- Nicotiana truncata* – Solanaceae
- Senecio gypsicola* – Compositae

The other 233 species seem best considered as facultative gypsophiles.

A survey of weeds at South Australian gypseous sites

Methods

Between 2000 and 2006 nine gypseous sites in South Australia were surveyed by the author for occurrences of naturalised plants. Sites visited were:

- Lake Macdonnell, Eyre Peninsula
- Streaky Bay, Eyre Peninsula
- Yaninee, Eyre Peninsula
- Kopi, Eyre Peninsula
- Marion Lake, Yorke Peninsula
- Lake Fowler, York Peninsula
- Craigie Plain, Murray Lands
- Cooke Plains, South East
- Lake Gillies, Eyre Peninsula

The species located are listed in Table 1.

Table 1. Collections of naturalised plants obtained by the author from the nine sites in South Australia (*recorded in N.S.W by Wynn 1965)

Species	Lake Mac. donnell, EP	Streaky Bay, EP	Yaninee, EP	Kopi, EP	Lake Gillies, EP	Marion Lake, YP	Lake Fowler, YP	Craigie Plain, Murray Lands	Cooke Plain, SE
<i>Aira caryophyllea</i>	+	.	.	.
<i>Anagallis arvensis</i>	+	+	+	.	.
<i>Arenaria leptoclados</i>	+
<i>Asphodelus fistulosus</i>	+	.	.	+	.	+	+	.	.
<i>Avellinia michelii</i>	+	.	.	.
<i>Avena barbata</i>	+	+	+	.	.	+	+	.	.
<i>Brachypodium distachyon</i>	+	.	.
<i>Bromus diandrus</i>	.	+	.	.	.	+	+	.	.
<i>Bromus rubens</i>	+	.	+	+	.
<i>Bupleurum semicompositum</i>	+	+	.	.	.	+	.	.	+
<i>Cakile maritima</i>	+	.	.
<i>Carduus tenuiflorus</i>	+	.	.
<i>Carrichtera annua</i>	+	.	.	+	.
<i>Centaurea melitensis</i>	+	+	.	.	.	+	.	.	.
<i>Cerastium semidecandrum</i>	+
<i>Erodium cicutarium</i>	+
<i>Euphorbia paralias</i>	+	.	.	.
<i>Euphorbia terracina</i>	+	.	.	.
<i>Fumaria muralis</i>	+	.	.
<i>Galium murale</i>	.	.	.	+	.	+	.	.	.
<i>Hedypnois rhagodioloides</i>	+
<i>Hordeum glaucum</i>	+	+	.
<i>Hypochoeris glabra</i>	+	.	+	.
<i>Lagurus ovatus</i>	+	+	.	.
<i>Limonium campanyonis</i>	+	+	+	.	.
<i>Linum strictum</i>	+	.	.	.
<i>Lolium rigidum</i>	.	.	+	+	.	+	+	.	.
<i>Lycium ferocissimum</i>	+	+	.	+
<i>Malva dendromorpha</i>	+	.	.	.
<i>Medicago minima</i>	+	.
<i>Medicago polymorpha</i>	+	+	.	.
<i>Melilotus indica</i>	.	+	.	.	.	+	+	.	.
<i>Mesembryanthemum crystallinum</i>	.	.	.	+	.	.	+	.	.
<i>Mesembryanthemum. nodiflorum</i>	.	+	+	.	.	.	+	.	.
<i>Minuartia mediterranea</i>	.	+	+	.	.
<i>Moraea setifolia</i>	.	+	+	+	+
<i>Nicotiana glauca*</i>	+	.	.	.	+	.	+	.	+
<i>Oxalis pes caprae</i>	+	.	.
<i>Parapholis incurva</i>	.	+	+	.	.	+	.	.	.
<i>Plantago coronopus</i>	+	.	.	.
<i>Polypogon tenellus</i>	+	.	.	.
<i>Reichardia tingitana</i>	+	+	+	.
<i>Reseda lutea</i>	+	+	.	.
<i>Rostraria cristata</i>	.	.	.	+	.	+	.	.	.
<i>Rostraria pumila</i>	+	+	+
<i>Schismus barbatus</i>	.	+	+
<i>Silene nocturna</i>	.	+	+
<i>Sisymbrium erysimoides</i>	+	.
<i>Sonchus oleraceus</i>	+	+	+	.	.
<i>Sonchus tenerrimus</i>	.	.	+	+	.
<i>Spergularia diandra</i>	.	+	+
<i>Spergularia marina</i>	+	.	.
<i>Trifolium compestre</i>	+	.	.
<i>Vulpia fasciculata</i>	+	.	.
<i>Vulpia myuros</i>	.	+	.	.	.	+	.	.	.

All data is supported by voucher collections deposited in the State Herbarium of South Australia (AD).

Results

The survey of naturalised gypsophiles indicates that plants collected are weedy, mostly annual plants. Using O'Keefe's (2003) classification of gypsophiles, there is no evidence that any of them are obligate gypsophiles. Like many successful weeds they are tolerant of varied ecologies and especially of disturbance.

Discussion

The relative paucity amongst the indigenous flora of obligate gypsophiles may reflect the relatively recent onset of aridity in southern Australia. Recency of origins similarly explains the lack of obligate gypsophiles in the gypseous weed flora of South Australia. and the lower numbers compared with indigenous species.

This paucity is also paralleled in the poor development of succulence in the same geographical area compared with the rich succulent floras of arid areas in southern Africa or southern North America. In Australia stem succulence has developed in 2–3 species of *Euphorbia* (Euphorbiaceae) and in *Sarcostemma* (Asclepiadaceae) and leaf succulence in Aizoaceae, Chenopodiaceae, Crassulaceae, Portulacaceae and Zygophyllaceae.

In contrast, sclerophylly is widely developed throughout the area. It has origins dating back to the early Tertiary (Barlow 1981). Leaf xeromorphy in plants on gypsum in North America was studied and published in Shields (1951).

Neither succulence nor sclerophylly seem noticeably developed on any of the gypsum sites visited.

APPENDIX.

Plant collections and literature records signifying definite or likely gypseous occurrence of plant species

Herbarium specimens cited, by collector and their unique collection number, are from South Australia unless otherwise stated

Aizoaceae

Carpobrotus modestus, on deep flourey gypsum at Kopi: Symon 16403.

C. rossii, on deep gypsum at Lake Macdonnell (Symon 16356) and Marion Lake (Symon 16582).

Disphyma crassifolium subsp. *clavellatum*, at Lake Gillies (Symon 16003), Streaky Bay (Symon 16431), Lake Macdonnell (Symon 16381), Lake Fowler (Symon 16665).

Gunniopsis is widespread through southern drier areas. This genus has species tolerant of gypsum but no true obligate gypsophiles.

G. kockii, some likely sites but none mention gypsum.

G. papillata, with many collections, Bates 18814, Ising 1955, Robinson 2706, Symon 9114, 9345, collected on gypsum.

G. quadrifida, many collections with Canty 2340 and Crocker 41 on gypsum.

G. rubra, recorded on gypsum in W.Aust. by Matiske (1995).

G. septifraga, many collections, including Bates 23615

and Symon 12347 on gypsum and some likely sites.

G. tenuifolia, many collections and likely sites; only Bates 17309 mentions gypsum.

G. zygophylloides, many collections. Murfet 721 records gypsum.

Tetragona implexicoma, on deep gypsum at Lake Macdonnell (Symon 16344) and Lake Fowler (Symon 16641).

Amaranthaceae

Amaranthus mitchellii, many collections, but few record gypsum: Symon 15659, Bates 50534.

Hemichroa diandra, recorded on gypsum in W. Aust. by Matiske (1995), in S. Aust. on gypsum by DEH 430-589.

Ptilotus is a large genus with many species and few records of tolerance.

P. barkeri, Bates 18781 & 19795 record gypsum, while 5 others are from likely sites.

P. nobilis, many collections and some likely sites but only Symon 15700 records gypsum.

P. parvifolius, includes some likely sites in S. Aust. but only Nordenstam & Anderberg 961 record gypsum.

Apocynaceae

Alyxia buxifolia, Cleland AD97213128, Symon 16562, 17272.

Boraginaceae

Embadium johnstonii, a small rare annual, there are likely sites and Bates 50579, 59367, Davies 693, 694, 695, 696 all record gypsum.

Heliotropium curassavicum; there are many collections at AD mostly from fresh or saline muds with few likely sites. Only Conrick 1790 and Latz 14070 from N.T. mention gypsum.

Omphalolappula concava, recorded on gypsum in W. Aust. Matiske (1995).

Campanulaceae

Isotoma scapigera, recorded on likely sites in southern Yorke Peninsula by Green (1993) and on gypsum by Symon 16359, 16589, 16606, 16689.

Casuarinaceae

Casuarina obsea, reported on gypsum in W. Aust. (Short 2000).

C. pauper, DEH BS94-4292 on gypsum.

Chenopodiaceae

This large family is particularly well developed in the drier areas of southern Australia. Species occur on almost all land forms and are frequently found on saline areas.

Atriplex vesicaria, recorded on gypsum in W. Aust. by Matiske (1995), in S. Aust. by Symon 15989, 19994, 16022, 16271, DEH 430-585, and in N.T. by Chippendale 6397.

Atriplex holocarpa, seasonally abundant on gypseous soils of the Moon Plain, north of Coober Pedy: Bates 59335, 59346.

Atriplex spongiosa, seasonally abundant on gypseous soils on the Moon Plain, north of Coober Pedy: Bates 59266, 59273, 59336, 59348, 59237.

Atriplex stipitata, Symon 16721.

Enchylaena tomentosa, an extremely widely spread shrublet by no means confined to gypsum, Symon 16404, 16535, 16719.

Einadia nutans, also a widely spread shrublet with very few records on gypsum, Latz 15464 in N.T.

Halosarcia calyptata, Chippendale 6377 on gypsum in N.T.

H. halocnemoides, Latz 15562 in N.T. on gypsum.
H. pruinosa, Chippendale 6376 in N.T. on gypsum.
Maireana, like *Atriplex*, a large genus with many species from many sites.
M. appressa, Symon 9347 in S. Aust., Latz 14068, in N.T. on gypsum
M. erioclada, widespread but also found on gypsum Symon 16307, 16354, 16444.
M. luehmannii, Chippendale 6378 in N.T. on gypsum
M. oppositifolia, recorded on gypsum W. Aust. by Mattiske (1995) and in S. Aust. by Symon 16019, 16286, 16331, 16430.
M. pentatropis, on kopi at Kopi, Symon 16412.
M. schistocarpa, Latz 15925 in N.T. on gypsum
M. trichoptera, Symon 16530 on gypsum.
Malacocera gracilis There is a high proportion of gypsum records in the relatively few specimens at AD: Bates 28603, Briggs 535, 1415, Chinnock 1695, 2105, 4326, 16905.
Monolepis spathulata, recorded in millions on the Moon Plain, Bates 59255, indicating a likely species.
Osteocarpum pentapterum, Henshall 560 on gypsum in N.T.
O. saluginosum, only Latz 15582 in N.T. on gypsum.
Rhagodia crassifolium, recorded on gypsum in W. Aust. by Mattiske (1995), and in S. Aust. by Symon 15981, 15992, 16409, 16439, 16572, 16632.
R. preissii, Symon 16278 on gypsum.
R. spinescens, Symon 15982 on gypsum.
Scleroblitum atriplicifolium, this species is frequently found on likely sites but few record gypsum: Davies 715.
Sclerolaena. A large genus of over 60 species widely spread throughout drier Australia but excluding Tasmania. Many species come from saline areas including likely sites. All the following record gypsum.
S. blackiana, Davies 701, Bates 59500.
S. brevifolia, Symon 15987, 16396, 16538.
S. clelandii, Bates 46969, Symon 12553, 12599 in S. Aust., Albrecht 7185, 7192 in N.T.
S. constricta, Bates 17285, 51029, Lothian 2087, Smyth 260, Symon 13205.
S. decurrens, Robinson 846 in S. Aust., Latz 15591 in N.T.
S. deserticola, Bates 14720, Symon 12548, 12607.
S. diacantha (see also *S. uniflora* with which it may be confused), Symon 15993, 16273, 16279, 16306 in S. Aust., Latz 15848 in N.T.
S. fimbriolata, Symon 9935.
S. intricata, Latz 15351 in N.T.
S. parviflora, Latz 15746 in N.T.
S. symoniana, likely sites and Symon 12531, 12594, DEH 430-59a.
S. tatei, Badman 4286, Bates 19248, Barker 232.
S. uniflora, Symon 16402, 16414.
Sclerostegia moniliformis, recorded on gypsum in W. Aust. by Mattiske (1995).
S. tenuis, Albrecht 7173 in N.T., on gypsum.
Threlkeldia diffusa, a widely distributed undershrub but common on gypsum: Symon 15986, 16021, 16413, 16618, 16644.

Compositae

This very large family includes species found in almost any habitable environment. With the Chenopodiaceae it includes a large number of gypsum tolerant species as well as some true gypsophiles.
Angianthus preissianus, often on sub-saline area; two collections on gypsum: Symon 16587, 16625.
A. uniflorus, Short 4220 on gypsum in W. Aust.
Asteridea archeri, reported by Short (2000) on gypsum

mound in W. Aust.
A. chaetopoda is recorded on gypsum in W. Aust. by Mattiske (1995) and Short (2000).
Brachyscome ciliaris, a widespread species with several varieties and numerous collections.
 —var. *ciliaris* was recorded on gypsum in W. Aust. by Mattiske (1995) and in S. Aust. by Symon 16516, 16702.
 —var. *lanuginosa*, also widespread and has been recorded on gypsum in S. Aust. by Symon 15698, 16195 and in N.T. by Latz 15847.
B. eriogona, a single record: Bates 51032.
Calocephalus sonderi, a single collection on deep gypsum, Lake Macdonnell: Symon 16369.
Calotis hispidula, widespread small herbs and many collections with few likely sites: Symon 16198, 16524.
Centipeda thespidioides, in N.T.: Latz 15890.
Chondropyxis halophila: there are few collections at AD with some likely sites. Kuchel 1566, Symon 16380 record gypsum.
Eclipta alatocarpa, a rare plant in S. Aust. with few collections at AD with some likely sites. Symon 15668 records gypsum.
Erymophyllum glossanthus is recorded on gypsum in W. Aust. by Mattiske (1995).
Flaveria australasica, Symon 16573 records gypsum. This genus has been recorded as gypsophilous in Mexico (Johnson 1941).
Gnephosis drummondii, recorded on gypsum in W. Aust. by Mattiske (1995).
Haegiella tatei, recorded on gypsum in W. Aust. by Mattiske (1995).
Helichrysum leucopsidium, collected on deep gypsum at Lake Macdonnell: Symon 16339.
Kippistia suaedifolia, a true gypsophile, with virtually all collections found on gypsum even on relatively isolated sites as at Lake Fowler. In S. Aust. Badman 3794, Bates 28587, Crocker s.n. Keane s.n. Knight 135, Kuchel 1563, Lay 513, Purdie 2846, Reid 174, Symon 3758, 12375, 12587, 14511, 15240, 16352, Woolmer 3, all record gypsum. In W. Aust. Eichler 21259, Short 4221, in N.T. Latz 15680, 14075, in N.S.W. Pickard 2872, 2975, in Vict. Corrick 7418 record gypsum. In addition there are many likely sites amongst the collections. See Lander (1980a) for a recent account.
Leiocarpa tomentosa, Latz 15588 in N.T.
Microseris lanceolata, there are many collections at AD and few come from likely sites, Symon 16023 was collected in gypsum flour at Cooke Plains.
Millotia major, recorded on gypsum in W. Aust. by Mattiske (1995) and in S. Aust. in Symon 16591A.
Minuria annua, occurs on likely sites. Bates 50346, 59250, Symon 9118, 9288 record gypsum. See Lander (1980b) for a recent account.
M. cunninghamii, in N.T., Latz 15929.
Minuria gardneri, all the few collections record gypsum: Symon 16011 from S. Aust., Eichler 21261, Lander s.n., Short 4222 from W. Aust.
Minuria multiseta, a probable gypsophile; Donner 7407, Symon 12557, Williams 9573, 10557, 10694 in S. Aust., Albrecht 8805, Latz 4113, 5724 in N.T.: all record gypsum.
Olearia axillaris, in deep gypsum: Symon 16341 and 16599.
Pleuropappus phyllocalymmeus, Bates 59852, and likely sites particularly in southern Yorke Peninsula.
Podotheca angustifolia, on gypsum: Symon 16574.
Pogonolepis muelleriana. Many collections and some likely sites. Bates 51265, Robinson 3409, Spooner 12301, Symon 16295, 16498 record gypsum.
Pseudognaphalium luteoalbum, many collections but only

- a single record, *Symon 16605*, on gypsum.
Pycnosorus pleiocephalus, *DEH 430-587*.
Senecio lanibracteus, I. Thomps., many collections, a single record on gypsum: *Symon 16204*.
Senecio gypsicola, this relatively newly described species is confined to gypseous sites in the Coober Pedy–Oodnadatta–Arckaringa triangle. All collections record gypsum: *Bates 19816*, *Symon 15664*, *15699*, *16161*, *16196*. It is surprising that this relatively distinctive annual was not collected by Ising despite his many collections in that area. This probably reflects the intermittent occurrence of short lived species in this arid area (cf. *Nicotiana truncata*).
Senecio spanomerus, *Symon 15990*, *16362*, *16580*, *16648*, all on gypsum.
Sonchus oleraceus, extremely widespread herb, on deep gypsum (*Symon 16197*, *16366*, *16551*, *16647*, *16704*).
Streptoglossa adscendens, many collections; few likely sites only, e.g. *Bates 51080*.
Trichanthodium skirrophorum, many collections; few likely sites only, e.g. *Bates 51022*.
Vittadinia australasica, *Symon 16550*, *16705* on gypsum.
V. eremaea, *Latz 15542*, *15580* from N.T., on gypsum.
V. gracilis, *Symon 16528*, *16708* on gypsum.

Convolvulaceae

- Convolvulus recurvatus*, common on deeply cracking gypseous soils, e.g. *Bates 59520*, *Symon 16203*, *15680*, on the Moon Plain, north of Coober Pedy.
Wilsonia backhousei, collected on gypsum at Marion Lake, *Symon 16622*.

Cruciferae

- A large family with many mainly annual species in arid Australia.
Arabidella nasturtium, some likely sites. *Bates 59225*, *59263*, *Symon 9113* record gypsum.
A. glaucescens, many likely sites. *Badman 1026*, *Davies 711*, *Lothian 2077* all record gypsum.
Arabidella procumbens, in thousands on gypsum (*Bates 59233*).
Carinavalva glauca, an uncommon plant and comes from likely sites but no record of gypsum.
Lepidium strongylopyllum, an uncommon plant and comes from likely sites but no record of gypsum.
Lepidium phlebopetalum, a widespread herb. *Davies 706*, *714*, *Smyth 254* record gypsum.
Lepidium sagittulatum, seasonal on gypseous washes of the Moon Plain, north of Coober Pedy (*Bates 59234*).
Menkea australis, a single record *Bates 59284* on gypsum.
Phlegmatospermum cochlearinum, a widespread species; *Bates 59265*, *Davies 710*, *Symon 15666*, *16185* record gypsum.
Stenopetalum decipiens, recorded on gypsum in N.T. by *Latz 15452*, *15585*.

Droseraceae

- Drosera macrantha*, recorded on gypsum in W. Aust. by *Mattiske (1995)*.

Dysphaniaceae

- Dysphania*. The several species of small herbs are frequently collected on gypseous sites. All species and collections listed are recorded on gypsum.
D. kalpari, *Michael 328*.
D. plantaginella, *Badman 473*, *752*, *Bates 17369*, *Crisp 827*.
D. platycarpa, *Latz 14158*, *46908*, in N.T.
D. simulans, numerous records: *Badman 813*, *Bates 28579*, *Robinson 2707*, *Smyth 255*, *Symon 12346*, *14510*,

Williams 7487 in S. Aust., *Albrecht 7191*, *Henshall 2117*, *Latz 04057*, *14162*, *14073* in N.T., *Symon 9941* in W. Aust.

- D. sphaerosperma*, *Albrecht 7188*, *8797*, *Henshall 728*, *7800*, *Richardson 8*, *Latz 15446* in N.T.

Epacridaceae

- Acrotliche patula*, on deep gypsum at Lake Macdonnell (*Symon 16365*) and at Marion Lake (*Symon 16560*).
Constephium drummondii, recorded on gypsum in W. Aust. by *Mattiske (1995)*.
Leucopogon affn. *insularis*, recorded on gypsum in W. Aust. by *Mattiske (1995)*.
Leucopogon parviflorus, *Symon 16585* on gypsum.
Syphelia hainesii, reported on gypsum in W. Aust. (*Short 2000*).

Euphorbiaceae

- A large cosmopolitan family from many habitats. Species are known from the gypsophilous flora of Mexico (*Johnston (1941)*, *Waterfall 1946*).
Euphorbia australis, widespread mostly on stoney slopes. Only *Symon 15253* and *Vonow 2345* record gypsum.

Frankeniaceae

- Frankenia* is a large and difficult genus that is common on many saline sites. Discrimination between saline and gypseous is often inadequate.
F. cinerea/punctata was recorded on gypsum in W. Aust. by *Mattiske (1995)* and in N.T. *Chippendale 6382*.
Frankenia cordata, *Chippendale 6396* on gypsum in N.T.
F. foliosa, *Bates 46968* on gypsum.
F. sessilis, *Symon 16346*, *16374*, *16469*, *16679*, on deep gypsum.
F. pauciflora, *Symon 16440*, on gypseous sand.

Geraniaceae

- Erodium carolinianum*, *Symon 15244* on gypsum.

Goodeniaceae

- This widespread and substantially Australian family is dominated by two genera *Goodenia* and *Scaevola* both of which contain tolerant species and one gypsophile.
Goodenia anfracta, a rare species cryptically coloured. Of the few collections at AD, *Symon 9349*, *13188*, *13206A*, *14512* all record gypsum.
G. fascicularis, a widespread herbaceous perennial from many sites. A woolly or cottony form has been repeatedly collected from the Moon Plain area: *Bates 51029*, *Symon 15663*, *15677*, *15688*, *16207*, indicating a likely gypseous species.
G. gypsicola, *Alcock 8289*, *Symon 12605*, *White AD99931164* in S. Aust., *Chinnock 8586*, *Leeuwen 3006*, *Nicolle 2660*, *2671* in W. Aust., all collections come from gypseous sites. This species is probably a true gypsophile.
G. lobata, a rare species with few collections at AD; *Bates 50919* reports gypsum.
G. pusilliflora, a widespread ephemeral with few likely sites; only *Bates 28632* reports gypsum.
G. varia, a widely spread sub-coastal species common on gypsum: *Symon 16355*, *16586*.
Scaevola, a widely distributed genus of at least 70 species in Australia.
S. collaris, a small shrub common on saline and subsaline sites. Many collections at AD of which *Symon 12544*, *12590*, *13189* in S. Aust., *Albrecht 7174*, *Latz 15583* in N.T. all record gypsum; also recorded on gypsum in W. Aust. by *Mattiske (1995)*.
S. crassifolia, collected on deep gypsum by *Symon 16349*, *16603*.

- S. parvibarbata*, a widespread small shrub with few likely sites. *Bates 50919, 50984* in S. Aust., *Latz 14060* in N.T. record gypsum.
- S. spinescens*, a tough, long-lived, intricate shrub; only *Chippendale 6380* in N.T. mentions gypsum.

Gramineae

This large family occurs in almost all ecological sites. A large number of species are tolerant of some gypsum and it is possible that some *Austrostipa* are true gypsophiles.

- Austrostipa drummondii*, recorded on gypsum in W. Aust. by *Mattiske (1995)* and in S. Aust. *Symon 16645, 16678*.
- A. elegantissima*, a widespread species with a single record *Symon 16642*.
- A. exilis*, several records *Symon 9550, 15845, 16592, 16635*.
- A. flavescens*, a single record *Symon 16688*.
- A. geoffreyi*, the type *Jacobs 7030* was described from gypsaceous islands at Lake King, W. Aust.
- A. nitida*, several records *Crocker s.n. Camp 44-45, DEH 430-588; Latz 15548* in N.T.
- A. nodosa*, *Symon 16710* on gypsum.
- A. nulla-nulla*, a relatively uncommon species. The type description states "apparently restricted to gypsaceous rises". All our few collections record gypsum: *Bates 20758, Brown 402, 408, Symon 3728, 16649, 16670, 16677, DEH 430-583*. This species may be a true gypsophile.
- A. puberula*, a single record *Symon 16532* on gypsum.
- A. scabra* ssp *falcate*, a widespread species and subspecies, with *Symon 15845, 16716* recording gypsum.
- A. stipoides*, a coastal species with a single record *Symon 16584* on gypsum.
- A. trichophylla*, a widespread species, with only *Bates 17053, Symon 16532, 16717* recording gypsum.
- A. vickeryana*, a rare species in S. Aust. Only *Barratt s.n.* records gypsum.
- Cynodon dactylon*, a single record on gypsum: *Latz 15538* in N.T.
- Dactyloctenium radulans*, widespread with numerous collections; a single record on gypsum: *Symon 16194*.
- Danthonia caespitosa*, very widely spread, but only three good records *Symon 16533, 16553, 16701* on gypsum.
- Enneapogon**. This genus is related to *Pappophorum* which includes gypsophilous species in southern U.S.A.
- E. cylindricus*, although mostly found on calcareous sites, *Symon 15249* and *Vonow 234* record gypsum.
- Eragrostis**, a large and varied genus with many collections.
- E. dielsii*, with numerous collections and some likely sites; *Bates 59289, Symon 16183, 16184* in S. Aust., *Latz 15579* in N.T. record gypsum.
- E. falcata*, numerous collections and likely sites; *Bates 9567, Robinson 805, Symon 12534, 13135, 13190*, record gypsum.
- E. pergracilis*, has been collected from a number of likely sites and *Symon 12582, 12583, 14372* record gypsum.
- Eriachne helmsii*, a single record *Latz 15539* in N.T. on gypsum.
- Eriochloa australiensis*, a single record *Symon 16199* on gypsum.
- Panicum laevinode*, commonly found on the deep cracking clays in the gibber plain washes and certainly in a number of likely sites. *Badman 5132, Bates 50576, 50577, Martin AD99226012, AD99226018; Symon 16191, 16200* record gypsum.
- Polypogon tenellus*, *Bates 26048* on gypsum.
- Setaria basioclada*, a single record *Albrecht 7187* in N.T.

on gypsum.

- Triodia pungens*, a single record *Latz 15549* in N.T. on gypsum.

Haloragaceae

- Haloragis aspera*, frequently found on the gypsum-influenced soils of the washes and creeklines in the Moon Plain area north of Coober Pedy, *Symon 16193*.
- H. odontocarpa*, a single record, *Bates 59513*, from likely sites in the same area as above.

Juncaginaceae

Plants of aquatic, marshy or seasonally wet sites. The small annual species include some that are tolerant of gypseous soils.

- Triglochin centrocarpum*, *Bates 59708, 59812* on gypsum
- T. mucronatum*, *Bates 59810* on gypsum .
- T. trichophorum*, *Bates 59777, 59822* on gypsum.

Labiatae

Teucrium racemosum. This perennial rhizomatous herb occurs on the deep cracking soils of low lying seasonally wet areas; some of these are strongly influenced by gypsum as on the Moon Plain, north of Coober Pedy. *Bates 51096, Symon 15676, 16188, 16529* suggest gypsum.

Leguminosae

Acacia is a huge genus of about 1000 species in Australia, they occur in nearly all habitats and, although a number of species have been collected on gypsum, there is no suggestion that any of them are true gypsophiles.

- A. aneura* var. *conifera*, recorded on gypsum by *Latz 15584*.
- A. anceps*, on deep gypsum: *Symon 16334*.
- A. argyrophylla*, on deep gypsum: *Symon 16657*.
- A. calcicola*, recorded on gypsum: *Cleland AD95802150*.
- A. cibaria*, recorded by *Latz 15537* in N.T. on gypsum.
- A. cupularis*, on gypsum: *Symon 16659*.
- A. kempeana*. *Chippendale 6388* in N.T. records gypsum.
- A. longifolia*, on gypsum: *Symon 16602*.
- A. nematophylla*, on gypsum: *Symon 16555*.
- A. prainii*, on gypsum *Symon 12571*.
- A. tetragonophylla*, recorded by *Chippendale 6387* and *Latz 15447* in N.T. on gypsum.
- A. victoriae*, recorded by *Latz 15543* in N.T. on gypsum.
- Cullen australasicum*, *Latz 14153* in N.T. on gypsum.
- Eutaxia microphylla*, *Symon 17274*, on deep gypsum.
- Swainsona** is a genus of 80–90 species widespread in arid Australia and absent from the monsoonal and tropical north.
- S. campylantha*: amongst the numerous collections at AD only *Bates 51030* and *Symon 16205* record gypsum.
- S. cyclocarpa*, few collections at AD but *Latz 15561* in N.T. is from a likely site.
- S. fuscoviridis*: *Bates 50042* describes this as 'Salt Lake Swainsona' and records it on gypsum at the edge of Lake Harris, Eyre Peninsula.
- S. microphylla*: no gypsum recorded on the numerous collections at AD. However, *Albrecht & Latz 8806* record it on gypsum in the N.T.
- S. minutiflora*, a rare and small *Swainsona* responding to rains. *Bates 59268* records thousands of small plants on gypsum.
- S. purpurea*, widespread with numerous collections at AD. There are some likely sites: *Bates 59269*, and *Symon 12591, 16202* report gypsum.
- S. unifoliata*, few collections at AD, *Albrecht 7193, Latz 15678, Maconochie 8808* in N.T. and *Symon 12439, 12762* in S.Aust. record gypsum.

Trigonella suavissima Lindl, an abundant and widespread herb with many collections at AD. Only *Latz 14162* in N.T., *Symon 15247, 16189* in S. Aust. record gypsum.
Templetonia retusa, in deep gypsum at two sites: *Symon 16350, 16558*.

Lythraceae

Lythrum wilsonii, *Latz 14163* in N.T. on gypsum.

Malvaceae

Hibiscus trionum: only *Symon 15674, 15683* record gypsum.

Lawrenzia, a small genus of a dozen species frequently found in depressions with heavy soils, often subsaline and some with gypseous derivations.

L. glomerata, gypsum occurs repeatedly in the substrate of this species, but many collections come from sites with no indication of gypsum. However, *Badman 3795, Bates 19321, Purdie 2798, Symon 12379, 12537, 12584, 16323, 16336, 16621* in S. Aust., *Chippendale 6375, Latz 15564, 15681* in N.T., in W. Aust. (Short 2000), all record gypsum. Several species occur in this complex, varying in their soil preferences, only some gypseous (W. Barker pers.comm., September 2006).

L. helmsii, a striking plant not common. As virtually all collections available to me mention gypsum, it may be a true gypsophile: *Conrick 933, Melville 4011, Symon 5460*, all in W. Aust.

L. squamata, a widespread shrub, mostly found on heavy subsaline soils; the following record gypsum: *Lander 1165, Latz 5946, Smith 790* in W. Aust.; *Latz 15563* in N.T.; *Canty 2356, Bates 19826, 19915, Latz 15846, Mollemans 1784, Purdie 2782, 2848, Symon 15563, 16006, 16335, 16337, 16433, 16612, Vonow 2178, Williams 7488* in S. Aust.

L. viridi-grisea, *Latz 18067* in N.T. and likely sites.

Sida is a large and widespread genus with few records of tolerance to gypsum.

S. ammophila, *Latz 15811* in N.T. on gypsum.

S. everistiana, *Latz 14055* in N.T. on gypsum.

S. intricate, *Latz 15850* in N.T. on gypsum.

Myoporaceae

Eremophila glabra ssp. *glabra*, *Maconochie 1807* in N.T. on gypsum.

E. neglecta, *Henshall 3293* in S. Aust., on gypsum.

Myrtaceae

A large family that may dominate the botanical landscape in Australia. *Eucalyptus* is a very large genus and is widely distributed, *Melaleuca* is smaller but equally widespread. Both contain tolerant and possible gypsophile species.

Calytrix gypsophila, has been collected from many likely sites and is probably a true gypsophile. All the following record gypsum: *Bates 20768, Lay 89, 199, Mollemans 670, 706, 756, 1750, 18877-1880 inc, Symon 12535, 14751, DEH 430-586*.

Calytrix tetragona Labill, on deep gypsum: *Symon 16347, 16554*.

Darwinia salina, one of the many species in which the distinction between salt and gypsum tolerance is not clear. Many collections are from saline sites, but *Bates 3292, Croft 11, Symon 16000* all record gypsum.

Eucalyptus. A very large genus with over 500 species in Australia found in almost all habitats. A number of species are tolerant of gypsum and there may be a single gypsophile.

E. 'anceps' was recorded on gypsum in W.Aust. by Mattiske (1995).

E. brachycalyx, on deep gypsum *Symon 15997, 16016, 16287*.

E. diversifolia, mostly on limestone but *Symon 16616* on deep gypsum.

E. eremicola, mostly on sand but *Forde 482* in N.T. records gypsum

E. gracilis, a widely dispersed species; it has been collected on deep gypsum, e.g. *Symon 15979, 16015, 16633*.

E. gypsophila, named because of its common occurrence on gypseous dunes around salt lakes. Of the many collections at AD and despite many likely sites, only the following mention gypsum: *Lay 525, Mollemans 809, 869*.

E. intertexta, a widely distributed species with some disjunct populations. *Latz 15436* in N.T. records gypsum.

E. leptophylla, widespread across southern Australia, but only *Symon 16293* records gypsum.

E. mannensis, mostly growing on sand, but *Forde 122, Latz 15463* in N.T., *DEH BS94-4296* in S. Aust. record gypsum.

E. oleosa, a widespread and variable species mostly on limestone, but only *Symon 16539* records gypsum.

E. oxymitra, mostly on dunes and sand plains; only *Latz 15453* in N.T. records gypsum.

E. quadrans, recorded on gypsum in W. Aust. by Mattiske (1995).

E. socialis, like *E. oleosa*, a widely spread species on a variety of soils. Only *Hill & Stanberg 3198, Symon 15980, 16540* record gypsum.

Leptospermum. Most species grow in moderate to high rainfall areas. Few extend to the drier areas.

L. coriaceum, the only relevant record is on gypseous sand: *Symon 16267*.

Melaleuca. A large genus extending throughout Australia. Several species certainly tolerant of gypsum and one possible gypsophile.

M. gibbosa, mostly found in sub-swampy sites, with only *Symon 16611* on deep gypsum.

M. halmaturorum, a species found in swamps and depressions, often saline, but has been collected from gypseous sands by *Symon 16304, 16315, 16443, 16556*.

M. hamulosa, recorded on gypsum in Western Australia by Mattiske (1995).

M. lanceolata, widely distributed often on limestone, but noted on deep gypsum by *Symon 16634*.

M. nanophylla, found on some likely sites. *Cornwall 463, Forde 480* record gypsum.

M. pauperiflora, usually found about seasonal swamps and depressions with fresh rather than salt water. AD collections contain no mention of gypsum except *Symon 15988, 16393* on deep gypsum dune and *Symon 16305* on deep kopi flour.

Orchidaceae

Microtis unifolia, collected on deep gypsum by *Symon 16576*.

Thelymitra macrophyllan, recorded on gypsum in W. Aust. by Mattiske (1995).

Pittosporaceae

Billardiera cymosa, collected on deep gypsum: *Symon 16332*.

B. lehmanniana, recorded on gypsum in W. Aust. by Mattiske (1995).

Plantaginaceae

Plantago cunninghamii, two records, "in millions" *Bates 59226, 59262* on gypsum.

Polygalaceae

Comesperma volubile, common on deep gypsum: *Symon 16330*.

C. viscidulum, a rare plant in S. Aust., collected on gypsum: *Symon 14759*.

Potamogetonaceae

Ruppia maritima, *Latz 14087* in N.T., in gypseous water.

Proteaceae

Hakea francisiana, *Lay 85*, the only species of this large family recorded on gypsum so far.

Santalaceae

Exocarpos aphyllus, *Symon 17273*, in likely sites.

Santalum spicatum, *Latz 15545* in N.T.: two trees on edge of gypsum depression.

Solanaceae

Duboisia hopwoodii, recorded on gypsum by *Latz 15468* in N.T.

Lycium australe, this shrub has been collected on deep gypsum several times, e.g. *Symon 15984, 16457, 17270*.

Nicotiana. A medium-sized genus distributed over much of Australia but is less common in the high rainfall and tropical regions. Only few species have reliable records on gypsum.

N. burbridgeae, not common, in the general area of Dalhousie Springs. A number of likely sites. *Robinson 2708* and *Symon 9294, 14456* record gypsum.

N. occidentalis subsp. *obliqua*, *Albrecht 8809* in N.T., on gypsum.

N. truncata, a recently described species confined to the Coober Pedy – Oodnadatta area, particularly in shallow washes on soils strongly influenced by gypsum. It may be a true gypsophile. *Symon 15665, 15671, 16208, 16233* all record gypsum.

N. velutina, a widespread species; it was reliably collected on gypsum in the far north west of S. Aust. by *Symon 12332, 12560, 12570*.

Solanum. This huge genus with almost 100 species in Australia is found in almost all sites except alpine and aquatic areas. Several species are gypsum-tolerant and one is a possible gypsophile. All the following are from S. Aust.

S. coactiliferum, a widespread species with a single record on gypsum: *Symon 16002*.

S. esuriale, a similarly widespread species with a single record on gypsum: *Symon 15672*.

S. hystrix, with a single record on deep gypsum: *Symon 16363*.

S. lacunarium, several records from the gypseous soils: *Symon 15669, 16186*.

S. oligacanthum, several records from the gypseous soils: *Symon 15658, 15694*.

S. symonii, found on likely sites and on gypsum (*Burford 96, Kuchel 1565*), on crystalline gypsum (*Symon 9548*), and on deep gypsum (*Symon 16367, 16597*).

Umbelliferae

Daucus glochidiatus is a widespread variable annual with many collections and some likely sites: *Bates 51267, 59251, Symon 15691, 16031, 16034, 16548, 16573*, from N.T. *Latz 15387*, all mention gypsum.

Hydrocotyle, a large genus of small plants, a number growing in wet, saline or gypseous sites.

H. hexaptera is recorded on gypsum in W. Aust. by *Mattiske (1995)*.

H. medicaginoidea: this small herb is often found in saline areas and some likely sites. It is one of those plants that occur in leaf litter and thin loams covering gypsum and the extent to which its roots penetrate gypsum may at times be debatable. The following mention gypsum: *Bates 51268, 59827, Kuchel 1567, Symon 16031, 16035, 16361, 16457, 16623*.

Trachymene cyanopetala, once collected on gypseous sand: *Symon 16291*.

Trachymene glaucifolia, mostly found on sand or in rocks but there are some likely sites in addition to *Bates 51026* and *Symon 15667, 15689* that record gypsum.

Trachymene ornata, one record on gypsum: *Symon 16266*.

Trachymene pilosa, two records on gypsum: *Symon 16294, 16570*.

Zygophyllaceae

Nitraria billardieri, a widespread shrub often found in sub-saline areas. It has been repeatedly collected on gypsum and is obviously tolerant. The following are all from deep gypsum: *Symon 16333, 15995-6, 16536, 16601*.

Zygophyllum. This genus is well developed in the drier areas. Many species are tolerant of both alkaline, saline and gypseous soils and are repeatedly collected on gypsum.

Z. aurantiacum subsp. *aurantiacum*. In S.Aust. *Purdie 1119* records gypsum, while the following record deep gypsum: *Symon 15983, 16393, 16537, 16638, 16700, DEH 430-584*. Recorded on gypsum in W.Aust. by *Mattiske (1995)* and in N.T. by *Albrecht 7189, 8807* and *Richardson 9*.

Z. aurantiacum subsp. *simplicifolium*, on deep gypsum: *Symon 16351, 16377, 16411*.

Z. ammophilum, *Symon 16296* on gypsum.

Z. billardieri, *Symon 16445* on gypsum.

Z. compressum, *Latz 14098* in N.T., *Bates 9563, 28586, 32314, Chinnock 2102, Symon 16338, DEH BS94-4405* in S. Aust. all record gypsum.

Z. crassissimum, *Albrecht 7190* in N.T., and *Bates 19924, 51040* in S. Aust. report gypsum.

Z. hybridum, *Bates 50483* reports gypsum.

Z. humillimum, *Bates 50399, 59223* reports gypsum.

Z. ovatum, on deep gypsum *Symon 15991*.

Z. kochii, the collections *Bates 59224, 59362* record gypsum.

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