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Flora and vegetation of Burnerbinmah Station: a study of the plant communities in the Mulga shrublands of the Murchison Region, Western Australia

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SUMMARY

A study was undertaken of the flora and plant communities of Burnerbinmah Station in the Murchison Region of Western Australia. The station lies at the head of the Mongers Lake drainage system, with associated calcrete valley fills and platforms, alluvial plains, sandplains, granite exposures and breakaways.

Thirty- four quadrats were used to define nine community types that were correlated with soil types and topography. A total vascular flora of 551 species was recorded from the station, of which 494 were native and 57 were introduced. *Acacia* is represented by 32 species, Mulga (*A. aneura*) being dominant in many communities. Nine taxa listed on the Department of Conservation and Land Management's priority flora list were found on the station.

INTRODUCTION

Burnerbinmah Station was purchased by the Department of Conservation and Land Management in 1995, when the pastoral lease was transferred to the Department.

The Station covers about 59 908 hectares and is situated approximately 70 km south-west of Mount Magnet and 270 km due east of Geraldton in Western Australia. It lies within in the Shire of Yalgoo between Yalgoo, Mount Magnet and Paynes Find. This is within the Murchison Region, part of the Eremaean Botanical Province (Beard 1990), and lies on the boundary between the Yalgoo and Murchison Bioregions (Thackway and Cresswell 1995). It has an arid climate of unpredictable summer and winter rainfall but is close to the eastern margin of the South-western Botanical Province (Fig. 1).

Based on figures recorded at Yalgoo (c. 70 km to the north-west), the average annual rainfall is about 250-280 mm (Beard 1976). At Burnerbinmah the mean annual rainfall between 1980 and 1994 was 251 mm. In February 1995, cyclonic storms brought heavy rain to the area and the annual rainfall for Burnerbinmah in that year was 451 mm (Brand 1999).

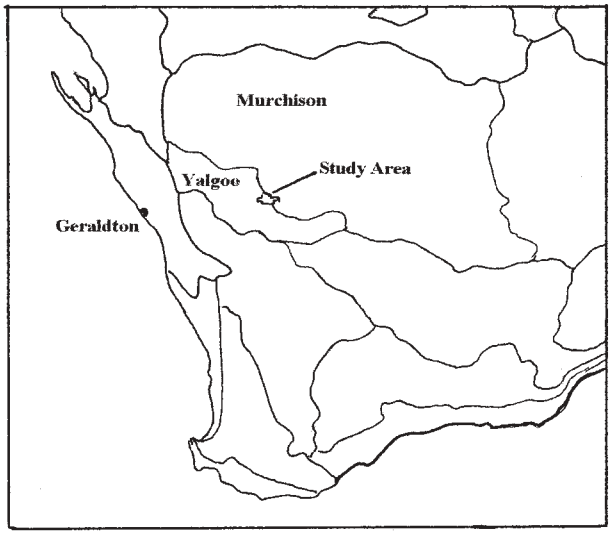

Figure 1. Location of the study area and its position within the Austin Bioregion.

HISTORY

The pastoral lease was taken up in 1878, and with seven adjoining leases make the lease as it is today. About 1884 a mud brick home was built at the head of Mongers Lake and is incorporated in the present day homestead. The Station was grazed, mainly with sheep, and some cattle and horses, from the 1890s until de-stocked in 1995.

A few plant collections were made by R.A.Saffrey in 1969, when some specimens were taken as vouchers for *Arid Shrubland Plants of Western Australia*, 2nd edn (Mitchell & Wilcox 1994). J.S.Beard made some collections in 1973 during fieldwork for the vegetation survey of the region (Beard 1976). A.L.Payne and A.M.E.Van Vreeswyk made further collections in 1993 during fieldwork for the inventory and condition survey of the Sandstone-Yalgoo-Paynes Find area (Payne *et al.* 1998). Voucher specimens for regeneration monitoring trials of Sandalwood (*Santalum spicatum*) have been taken by J.E.Brand since 1996, as part of ongoing work on Sandalwood at Burnerbinmah (Brand 1999; Patrick *et al.* 1997/8).

GEOLOGY

Mongers Lake runs southwards through the station, roughly bisecting it. Calcrete is deposited along the northern section of this drainage line and along another on the south-western corner of the station. Surrounding the lake are alluvial deposits of sand and clay deposited in drainage channels and on floodplains. The land rises from the lake floor at 300 m to 378 m on the eastern side and 358 m on the western side. Alluvial and colluvial deposits of transported clay, sand and lithic fragments occur mainly on the western side. Yellow sandplain is found throughout the station, with some red colluvial sand on plateau remnants. There are also smaller areas of residual deposits, sand, clay and duricrust and deposits of laterite on top of breakaways. Granitoid rocks also provide relief. There are large outcrops of adamellite to granodiorite rocks, particularly on the south-western side, and smaller outcrops of adamellite and granite throughout (Baxter *et al.* 1983).

VEGETATION AND LANDFORMS

There have been few detailed botanical studies of specific areas in the Murchison Region. Davies (1970) published a list of c. 200 taxa for Mileura Station which is situated c. 250 km north of Burnerbinmah. The terrain there is flat with some laterite breakaway scarps and granite tors. The vegetation is less diverse, mainly Mulga (*Acacia aneura*) shrubland, with some saltbush on floodplains but with no spinifex sandplains.

Eighty taxa were listed in an annotated list of the angiosperms of Lakeside Station (Kenneally 1968) which lies 120 km north of Burnerbinmah, with a similar annual rainfall. The vegetation is predominantly Mulga, with a larger range of species on breakaways.

The vegetation on Burnerbinmah Station is mainly representative of the arid zone flora but it is close to the eastern limit of the South-West Botanical Province. The vegetation of the Murchison Region is predominantly Mulga low woodland on plains, reduced to scrub on hills (Beard 1990). Low woodlands of Mulga, often rich in ephemerals, dominate the vegetation of the Murchison Bioregion, and the Yalgoo Bioregion has open woodlands and scrub of Mulga, *Callitris-Eucalyptus salubris* and bowgada (*Acacia ramulosa* var. *linophylla*) (Thackway and Cresswell 1995).

The predominance of the Mulga association through the station is reflected by a rich assemblage of *Acacia* species, at 32 taxa the largest number for any genus recorded there.

The vegetation map for the Murchison (Beard 1976) shows that the station lies across a rainfall boundary, approximately the 250 mm isohyet. Beard recorded Mulga woodland predominating on the drier eastern side and mixed *Acacia* scrub with scattered Mulga on the western side. This major division is also reflected in the area being the south-western edge of the distribution of most species of *Triodia*.

Eight land types are represented with a total of twelve component land systems (Payne *et al.* 1998) (Table 1). The upper reaches of the Mongers Lake wetland complex form a broad valley. Other landforms include breakaways, granite hills and exposures, salt lakes and calcareous plain. One gorge has permanent freshwater and there are areas of sandplain. A wide range of plant communities results from this diversity, including Mulga low woodlands in the broad valleys and, less commonly, mallee woodlands. *Acacia* shrubland occurs on shallow soils associated with granite exposures. Spinifex sandplain on the eastern side of the station is replaced by mixed spinifex and sedgelands on the red sandplains of the western side. There are freshwater and saline wetlands. Open Mulga with bluebush (*Maireana* spp) and saltbush (*Atriplex* spp) and also bluebush, saltbush and samphire (*Halosarcia*) shrublands are associated with the salt lakes.

WILDLIFE MANAGEMENT PROGRAMS FOR RARE AND POORLY KNOWN FLORA

The work was undertaken as part of a wildlife management program for rare and priority (poorly known) flora in the Department of Conservation and Land Management (CALM) Geraldton District.

The district runs inland nearly 600 km, and thirty seven Threatened Flora and 264 Priority Flora are recorded for it. Most of the Threatened Flora occur on the wetter coastal strip, and in the inland pastoral section where many species of Priority Taxa occur there were no conservation reserves until the purchase of Burnerbinmah. It was therefore important to determine which Threatened and Priority Taxa occur on Burnerbinmah and to learn more about the vegetation of the area.

In 1996 the opportunity arose to survey the flora on Burnerbinmah as part of a Landscope Expedition. These expeditions are offered by the CALM publication *Landscope*, in association with The University of Western Australia's Extension Program. They provide expedition members with an opportunity to work on CALM research projects, to promote wider co-operation in addressing conservation and land management challenges in Western Australia.

METHODS

Participants

Three Landscope Expeditions worked on the Station, in September 1996, August 1997 and October 1998 with a total of 29 participants. An expedition with the Western Australian Naturalists' Club at Easter, March 1997, also gathered information. In total, twenty two days were spent on the work.

TABLE 1
Land types and systems of the Sandstone-Yalgoo-Paynes Find Rangeland Survey (Payne *et al*. 1998), represented on Burnerbinmah Station, with quadrats established on each system.

Land Type 4.	Breakaways, stony plain and sandy surfaced plain on granite with Mulga shrubland and minor halophytic shrubland quadrats	
She –Sherwood	Breakaways, kaolinised footslopes and extensive gently sloping plains on granite	A4 A5 A6 B3 B5 C3 C4 C5
Wag –Waguin	Undulating sandy plain and stripped surface with small breakaways on laterite and granite	A1 C7
Land Type 6.	Plain with gritty surface and low tors and domes on granite with acacia shrubland	
Chl –Challenge	Gently undulating plain with occasional hills, tors and low breakaways on granite	no quadrats established
Land Type 12.	Sandplain with grassy acacia shrubland	
Kal –Kalli	Level to gently undulating plain of red sand over laterite	A3 A9 A11 B2 B10 C2 C10
Land Type 13.	Wash plain on hardpan with Mulga shrubland	
Ham –Hamilton	Plains on hardpan and granite with narrow, incised drainage lines	A12
Tin –Tindalarra	Very gently inclined wash plain with narrow saline drainage tracts	B11 C11
Wod –Woodline	Nearly level sandy surfaced plain over hardpan	A8 B7 C8
Land Type 14.	Wash plain and sandy tracts on hardpan, with Mulga and wanderrie grasses	
Yng –Yanganoo	Wash plain with concentrated drainage zones and sandy tracts	No quadrats established
Land Type 17.	Alluvial plain with saline soil and predominantly halophytic shrubland	
Ero –Ero	Tributary flood plain on hardpan	A7 B4 C6
Land Type 18.	Calcreted drainage plain with mixed halophytic and non-halophytic shrubland	
Cun –Cunyu	Calcrete platform, narrow drainage floor, and fringing wash plain	A2 B1 C1
Mil –Mileura	Calcrete platform and alluvial plain with saline soil	B6 B8
Land Type 20.	Salt lakes and fringing alluvial plain with halophytic shrubland	
Car –Carnegie	Salt lake with fringing alluvial plain, kopi dunes and sandy banks	A10 B9 C9

Quadrats and land systems

It was considered most effective to set up permanent 20 x 20 metre quadrats and to sample them according to the methods of Bushland Plant Survey (Keighery 1994). This provided a method of collecting a larger range of species than might otherwise be obtained by opportunistic collections alone, when some, particularly very small ephemeral species, might be overlooked. The method of thorough sampling also provided a record of all Priority taxa present, some of which might have been missed by opportunistic sampling. It also provided a permanent record for specific sites which could be monitored in the future when the effects of reduced grazing might become more apparent. The size of quadrats was increased from the 10 x 10 metres recommended in Bushland Plant Survey which is designed for recording in the South West Botanical Province. The larger quadrat size, 20 x 20 metres, was required to record sufficient species in the more arid conditions of the Eremaean Botanical Province where plants are more widely spaced.

Quadrats were established in three types of plant community at each site, by selecting localities where a range of plant communities was present on one land system (Fig. 2). Six land types were sampled in this way, and ten land systems.

In September 1996, 28 quadrats were established. In 1997, 25 of the 28 quadrats were resampled during summer. In August 1997, all were resampled and 6 more quadrats were established. Another opportunity to collect further data arose in October 1998, when a third Landscope Expedition combined astronomy and botany. The range of recording times from early to late spring and in summer increased the opportunity of finding a larger range of species in flower. On each visit the group worked in three teams, denoted as A, B or C. Quadrats completed by each were then numbered consecutively so that each quadrat had a unique name.

As a result 22 days were spent establishing quadrats, in resurvey and opportunistic collections. Thirty four quadrats were established over two years, 28 in 1996, and of these 25 were sampled four times and four three times. The six quadrats, which were established in 1997, were sampled twice.

As the terrain was not generally very rugged, most study locations were reached by vehicle along tracks, but two land types were not sampled by quadrat establishment, each of which has only one land system represented on the Station. Yanganoo is poorly represented, as is Challenge, which in addition is rugged and difficult to access. General botanical collection was undertaken at other localities apart from those where the quadrats were set up, and Challenge was sampled in this way, by traverse on foot.

Quadrat recording

All quadrats were set up using an optical square to ensure correct corner angles and were permanantly marked with four steel fence droppers. Position of each quadrat was recorded by using a global positional system (GPS) unit.

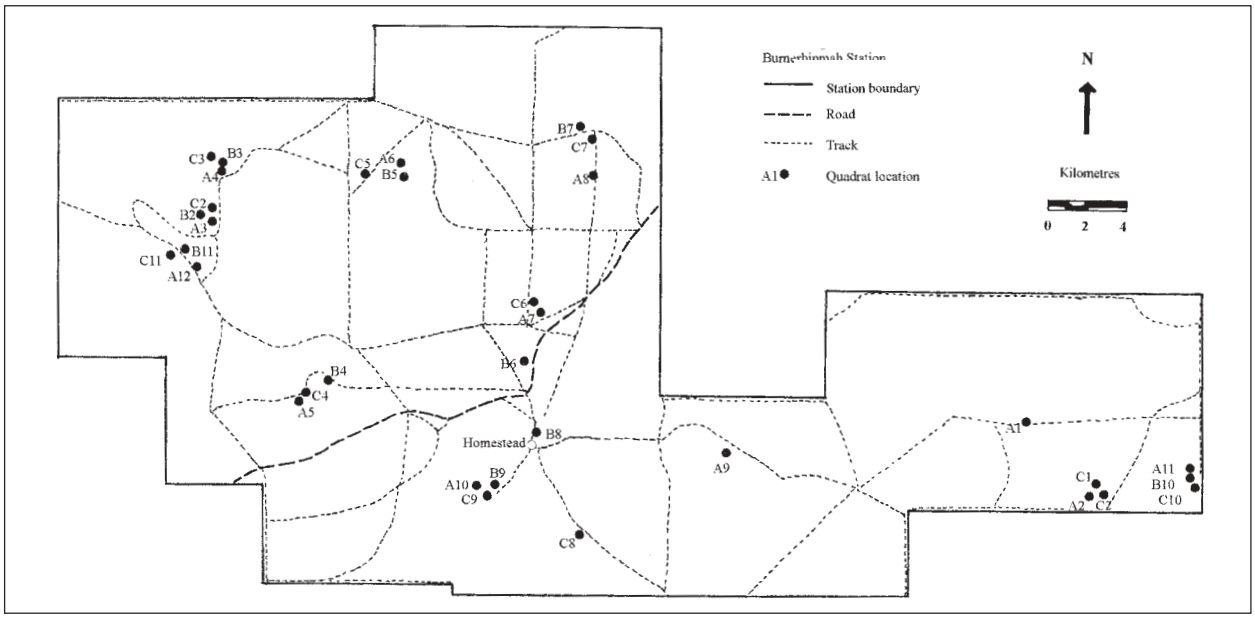

Figure 2. Study area showing location of survey sites.

Distance on ground from nearest landmark was also recorded. Photographic records were made at each visit using fixed points. During recording at each quadrat, lengths of rope were placed between the corner pegs to mark the boundaries, then removed at the conclusion of recording.

All taxa found flowering within each quadrat were collected as well as those from the surrounding area not represented within. Soil descriptions were recorded in 1998 by W.M.McArthur (unpublished), at all but two of the quadrats. Quadrat location, site data, vegetation structure (Muir 1977; Aplin 1979), cover and site condition were obtained, with a list of species for each stratum. At the end of each day specimens were pressed for later identification.

In addition, a manilla folder was used at each quadrat to fix a small piece of each species under plastic tape. After identification these specimens provide a quick reference so that on later visits only those species were collected that had not been found in flower previously.

Thirty nine further sites were sampled opportunistically.

The site and species classifications used the Czekanowski coefficient and 'unweighted pair-group mean average' fusion method (UPGMA; Sneath and Sokal 1973) using the PATN software package (Belbin 1993).

Nomenclature follows Paczkowska and Chapman (2000) and current usage at the Western Australian Herbarium (PERTH).

RESULTS

A list of taxa (species, subspecies and varieties) for the station was compiled from the specimens collected on these expeditions. With the aid of three volunteers, 612 voucher specimens were added to the collections of the Western Australian Herbarium and a reference herbarium was assembled for the station. The work also extends other monitoring programs in the region, and provides a data set for future assessment of grazing reduction on the vegetation.

Floristic analysis

A total of 551 taxa was recorded on Burnerbinmah station. The list was compiled from taxa found within and near the 34 quadrats, from opportunistic collections and from confirmed records held in PERTH. Of these 494 (89·6%) were native and 57 introduced (Appendix 1).

The largest families represented were the Asteraceae (78 native taxa, 6 introduced), Chenopodiaceae (49 native taxa, 2 introduced) and Mimosaceae (32 taxa). Several other families were represented by large numbers of taxa (Table 2). The most common genera were *Acacia* (32 taxa), *Eremophila* (25 taxa), *Maireana* (14 taxa), *Ptilotus* (13 taxa) and *Rhodanthe* (12 taxa).

TABLE 2

Largest flora families represented on Burnerbinmah.

FAMILY	NO. OFNATIVE TAXA	NO. OFINTRODUCED TAXA
Asteraceae	78	6
Chenopodiaceae	49	2
Mimosaceae	32	0
Poaceae	31	14
Myoporaceae	25	0
Myrtaceae	22	0
Brassicaceae	10	7
Papilionaceae	15	1
Amaranthaceae	15	0
Goodeniaceae	14	0
Proteaceae	13	0
Cyperaceae	12	0
Solanaceae	11	1
Malvaceae	10	1
Aizoaceae	8	2

Rare and Priority species

One of the aims of the work was to find Declared Rare and Priority taxa on the station. The decision to set up quadrats proved successful in that several very small, poorly known species listed as Priority taxa (Atkins 2001) were collected in the quadrats, and these may well have been overlooked had collecting been limited to opportunistic searches.

Nine priority taxa were found on the station (Table 3). For all except *Dicrastylis linearifolia* these were the first records on conservation lands. Those for *Dicrastylis linearifolia*, *Myriocephalus nudus* and *Goodenia neogoodenia* were south of their previously recorded ranges, whilst that of *Hyalosperma stoveae* extended its known range to the west, that of *Lepidium merrallii* to the north and that of *Myriocephalus nudus* to the south. *Gunniopsis rubra* was added to the Priority list in 1997 as Priority 1, after its discovery on the Station brought to attention its poorly known status. *Hyalosperma stoveae* was listed as Priority 1 in 1996, its discovery on Burnerbinmah was the fifth collection for the species, and the second in Western Australia. *Lepidium merrallii* was also listed as Priority 1 in 1996, the collection on Burnerbinmah station being the fifth collection for the species, and the first in the Geraldton District. *Phlegmatospermum drummondii* was gazetted as Rare when discovered here in 1997, but this discovery and a collection from north of Kalbarri in 1995 showed that this small, annual species was much more widespread than originally thought and it is now listed as Priority 3. *Goodenia pusilliflora* was listed as Priority 1 in 1996, but several recent collections, including five populations found on Burnerbinmah have resulted in its removal from the Priority List.

TABLE 3
Priority Flora found during the survey indicating the number of populations located.

TAXON	PRIORITY LISTING	NO. OF POPULATIONS	QUADRATS
Cryptandra imbricata	3	4	B7, B10, C10
Dicrastylis linearifolia	3	1	-
Euryomyrtus patrickiae	3	1	A3, C2
Goodenia neogoodenia	4	4	A7
Gunniopsis rubra	3	3	A1, B5, C5
Hyalosperma stoveae	*2*	*1*	B2, C8
Lepidium merrallii	2	1	-
Myriocephalus nudus	1	1	B4
Phlegmatospermum drummondii	3	1	A11

Biogeographical plant occurrences of significance

The location of the station close to the boundary of the Eremaean and South-west Botanical Provinces is reflected in the large number of taxa which are represented on the station at or near the limit of their ranges in Western Australia (Appendix 1).

Forty eight taxa were found at or near the south-western limit of their known range and 11 taxa were found on the station as a south-western extension of their known range. Similarly, the records of 51 taxa were at or near the north-eastern limit of their range and those of 16 taxa were an extension of their range to the north-east. Nine taxa were at the northern limit of their range and six taxa were a northern extension of their range, whilst 20 taxa were at the southern limit of their range and six taxa were southerly extensions of their range. Only four taxa were at the easterly limit of their range, but 17 taxa were at the westerly limit of their range and three taxa were westerly extensions of their range. Records of three taxa were at the north-western limit of their range and those of five were an extension of their range to the north-west. However, the record of only one taxon was a range extension to the south-east. This was of *Paracaleana lyonsii* ms, previously known only from an area some 300 km to the north-west of Burnerbinmah, in the southern Carnarvon Basin.

The lack of previous botanical collections in the area is reflected by the large number of range extensions recorded, for 48 taxa, of which 10 are introduced taxa.

Introduced species

Fifty six taxa of introduced plants were recorded on the station. Previous lack of collections of introduced taxa in this area is indicated by the large proportion which were found to be range extensions, 11 (23%) of the 48 range extensions, whereas of the total list recorded, only 10.3% were introduced taxa.

Eighteen of the 74 families included introduced taxa. Most of these were grasses, 14 of the 45 taxa of Poaceae being introduced. All nine taxa of Caryophyllaceae on Burnerbinmah were introduced. Asteraceae had the highest number of taxa recorded, 84, of which only 6 were introduced. Similarly, Brassicaceae was represented by 17 taxa of which 7 were introduced.

Of these introduced taxa, 15 were recorded only once. Several of these occurred here as extensions to the north west of their known ranges: *Micropterum papulosum*, *Brassica rapa*, *Hornungia procumbens*, *Raphanus raphanistrum*, *Silene nocturna*, *Spergula arvensis*, *Spergula pentandra*, *Chenopodium album*, *Plantago coronopus* subsp. *commutata* and *Zaluzianska divaricata*.

Twenty taxa were at or near the north-eastern limit of their known ranges. *Spergularia media* had not previously been recorded in Western Australia, *Elytrigia repens* was recorded for the second time, whilst *Alopecurus pratensis* and *A. geniculatus* had both been recorded only twice previously in W.A. *Spergularia salina* had been recorded previously only once in the Eremaean Botanical Region.

The introduced annual grass *Pentaschistis airoides* occurred most frequently, and was recorded in 22 of the 34 quadrats. *Cuscuta epithymum*, a parasitic twining annual, occurred in 21 quadrats, another annual grass, *Rostraria pumila*, in 15 and a rosetted annual or perennial, *Hypochaeris glabra*, in 14.

Pentaschistis airoides is a common, widespread weed particularly on granite rocks, in woodlands, shrublands and on disturbed sites in the south west of the state, from Carnarvon to Kalgoorlie and Balladonia. Burnerbinmah is on the north-western edge of its known range. *Cuscuta epithymum* occurs from north of Kalbarri to Busselton with a few scattered records further inland. *Rostraria pumila* is a common weed of grazed semi-arid woodlands and shrublands from Shark Bay to Eucla. *Hypochaeris glabra* is a common weed of roadsides, agricultural areas and bushland throughout the South-West (Hussey et al. 1997) (Florabase, Western Australian Herbarium (1998).

Frequency of introduced species was lowest on sandy soils, none being recorded in quadrats B2 and C2, in the sedgeland of *Chrystrix distigmatosa* with *Triodia tomentosa* on yellowish red or reddish brown sand, on the western side of the station. A third quadrat in this sedgeland, A3, on brown sand, had 2% of introduced species. Two quadrats on a sand dune at the eastern end of the station, C10 and B10, on yellowish red fine sand, also had 2%, which was a similar level at B7 in Mulga shrubland on yellowish red sandy loam. A11 in the same area as C10 and B 10 had a higher level of weeds, 7%.

Quadrats in Mulga shrubland generally had lower levels of introduced species as did those around and on granite outcrops. Particularly high levels were recorded in all wet areas and above 20 % in a wash area by a claypan at Corrialgo Pool, in the bottom of the gorge and reaching 30% at A12 on a creekline.

Vegetation

In the 34 quadrats established on Burnerbinmah Station, 460 taxa were recorded. For the floristic analysis, species occurring in only one quadrat were excluded. As a result the final data set consisted of 295 taxa in 34 sites, of which 132 were perennials. Species richness ranged from 35 to 79 taxa per site, with individual taxa occurring in two to 27 of the 34 sites. The high numbers of taxa recorded are a reflection of the repeated sampling of the quadrats during the spring months, August to October, when the highest numbers of annual species were present. The two-way table (Appendix 2) shows these taxa as 17 groups, A-Q. Taxa in species group L include a high number of annuals and grasses and this group is well represented in most of the community types for this reason.

The dendrogram shows the five major community types recognised in the analysis (Fig. 3) which also shows further subdivision to nine community types.

Community type 1 occurs on the shallow soils of c. pH 6 on rocky areas, breakaways and granite outcrops. Taxa in species group L are typical of community type 1, including *Acacia tetragonophylla*, *Ptilotus obovatus*, *P. gaudichaudii* and a wide range of annual herbs and grasses, including *Brachyscome ciliaris*, *B. ciliocarpa*, *Rhodanthe maryonii*, *Helipterum craspedioides*, *Velleia rosea*, *Pogonolepis muelleriana*, *Crassula colorata*, *Erodium cygnorum*, *Pentaschistis airoides* and *Calandrinia eremaea*. This community occurs largely on land type 4, primarily on the Sherwood land system, with one quadrat A4 at the base of a breakaway, on Waguin.

Community 1a was confined mainly to shallow soils of brown clay loam, sandy clay loam or light brown clay on weathered laterite and weathered granite surfaces. It was less species-rich than 1b, with an average of 49 species per quadrat, but also contained species from group N, including *Acacia aneura*, *A. ayersiana*, *Maireana georgei*, *M. glomerifolia*, *Micromyrtus sulphurea*, *Mirbelia rhagodioides*, *Philotheca brucei*, *Micropterum papulosum*, *Gunniopsis rubra* and *Levenhookia leptantha*.

Community 1b contained an average of 57 species per quadrat and occurs mainly on large granite outcrops on gritty, loamy sands of reddish brown or yellowish red over granite. Taxa in species groups I and J are typical of community 1b, these include: *Acacia acuminata*, *A. burkittii*, *A. quadrimarginea*, *Dodonaea inaequifolia*, *Malleostemon tuberculatus*, *Borya sphaerocephala*, *Goodenia berardiana*, *Tricoryne elatior*, *Caladenia incensa*, *Pterostylis* sp. inland, *Prasophyllum gracile* and *Drosera macrantha* ssp. *eremaea*.

Two quadrats which fall into this community type are atypical. They occurred on flat Mulga plain, with red sandy loam soil over hard pan. However, both had a similar number of species per quadrat, higher than other Mulga sites on the station, and were characterised by a species-rich understorey. C11 on shallow soil of 35 cm depth had 49 taxa, in tall shrubland with a rich representation of grasses and annual herbs. C8 on deeper soil had 56 taxa and had an open cover of shrubs over 1m, with a species rich understorey of shrubs under 1m tall, and of annual herbs and grasses. *Acacia aneura*, *Senna artemisioides* subsp. *filifolia*, *Maireana thesioides*, *Sida atrovirens* and *Monachather paradoxus* were species more typical of the community in these quadrats than in others of type 1 community. These two sites are on the western side of the station, which experiences a higher rainfall than the eastern side where the other Mulga sites were sampled and, presumably for this reason, have a more species-rich understorey.

Community type 2 is confined to Mulga shrubland on flat red, reddish brown, yellowish red sandy loams over hardpan with a pH of 6-6.5. The term 'Mulga' is used here to include not only *Acacia aneura* but other species in the complex, *A. ayersiana* and *A. minyura* (Pedley 2001).

The average species richness in community type 2 was 44 taxa per site. Taxa in species groups L, M and N are characteristic of this community type, including *Acacia aneura*, *A. ayersiana, A. minyura*, *A. ramulosa*, *Eremophila glandulifera* ms, *Ptilotus obovatus*, *Pentaschistis airoides*, *Monachather paradoxus*, *Rhodanthe maryoni*, *Brachyscome ciliocarpa*, *Waitzia acuminata*, *Goodenia occidentalis*, *Calandrinia eremaea* and *Crassula colorata*.

Quadrat A9 is an atypicial site within type 2 including species group P, dominated by *Callitris glaucophylla* and *A. minyura* and including *Acacia exocarpoides*, *Santalum spicatum*, *Scaevola spinescens*, *Olearia pimeleoides*,

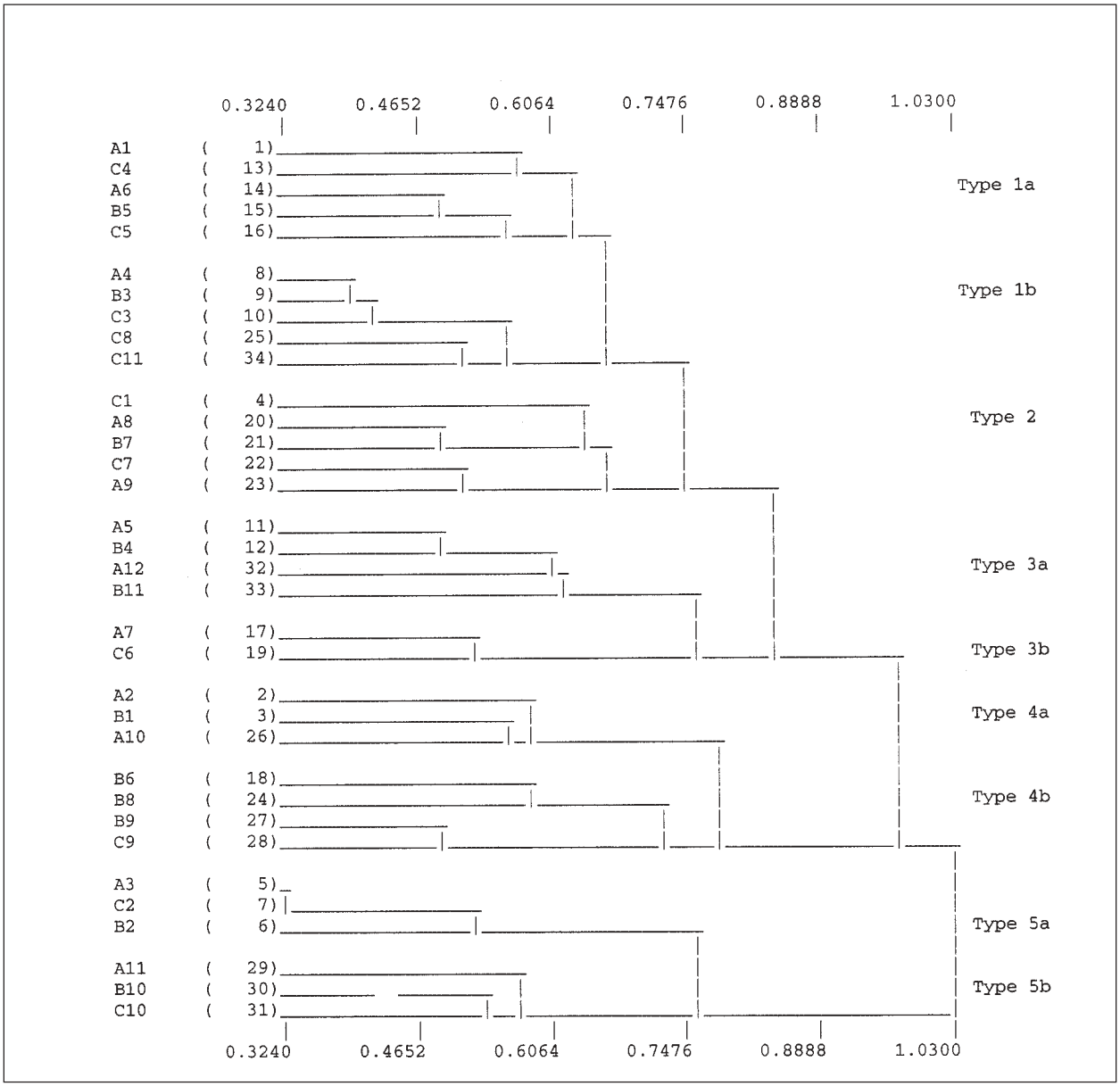

Figure 3. Dendrogram of the sites on Burnerbinmah Station showing the nine group level classification.

Enchylaena tomentosa, *Sclerolaena densiflora*, *Chenopodium gaudichaudianum*, *Maireana suaedifolia*, *Tetragonia cristata*, *Thysanotus manglesianus*, *Goodenia pusilliflora*, *Angianthus tomentosus*, *Gnephosis tenuissima* and *Plantago drummondii* which are not found in community type 2 apart from within this site. It is similar to other sites of this community in the good representation of species group M. It was more species rich, with 50 taxa, the other sites having a mean of 42.5 taxa. The soil was more acidic, a clayey fine sand, of pH 5.5.

Community type 3 occurs on wet areas and has a mean of 62 taxa per quadrat. It includes two subgroups, communities of wet drainage lines and of claypans. High numbers of introduced taxa are present in this community: *Sonchus oleraceus*, *Emex australis*, *Anagallis arvensis*, *Erodium cicutarium*, *Hordeum glaucum*, *Centaurea melitensis*, *Silene gallica*, *Pentaschistis airoides*, *Cuscuta epithymum* and *Hypochaeris glabra* being represented in both subcommunities. Some introduced taxa were found only in the communities of drainage lines, *Polycarpon tetraphyllum*, *Avena fatua* and *Osteospermum clandestinum*. Others, including *Acetosa vesicaria*, *Sisymbrium erysimoides* and *Spergularia rubra*, were found mainly around claypans.

Community type 3 species as a whole is characterised by shrubland with *Acacia tetragonophylla*, *Exocarpos aphyllus*, *Dodonaea viscosa* and *Pittosporum phylliraeoides* over *Ptilotus obovatus*, and a number of annual species found in species group L, *Rhodanthe maryonii*, *Brachyscome ciliocarpa*, *Crassula colorata*, *Calotis multicaulis*, *Helipterum craspedioides*, *Velleia rosea*, *Calotis hispidula*, *Cephalipterum drummondii*.

Community type 3a occurs on drainage lines on brown gritty sand, of pH 6.5 where recorded. It includes species groups B, I and L, including *Solanum lasiophyllum*, *Atriplex semilunaris*, *Cyperus gymnocaulos*, *Eriachne pulchella*, *Wahlenbergia gracilenta*, *Nicotiana occidentalis* subsp. *hesperis*, *Calandrinia ptychosperma*, *Haloragis trigonocarpa* and *Trachymene ornata*.

Community type 3b around claypans on reddish brown sandy loam over clay of pH 9 includes taxa in species group C, D and F. The community has open shrubland with *Acacia victoriae*, *A. tysonii*, *Exocarpos aphyllus*, *Melaleuca uncinata*, *Scaevola spinescens*, *Senna artemisioides* subsp. *filifolia*, *Rhagodia eremaea*, *Solanum orbiculatum*, *Pimelea microcephala*, *Maireana pyramidata*, *Atriplex amnicola*, *Eremophila maculata*, *Bergia perennis* subsp. *exigua*, *Marsilea drummondii* and many annuals, *Spergularia rubra*, *Plagiobothrys plurisepalus*, *Brachyscome lineariloba*, *Agrostis avenacea*, *Peplidium* sp. C, *Ranunculus pentandrus*, *Rhodanthe propinqua*, *R. stricta* and *Schoenia cassiniana*.

Community type 4 occurs on yellowish red sandy or clayey loams with a high pH of 8.5-9.5, sometimes associated with calcrete or gypsum. The vegetation is generally more salt tolerant than that of community 3 and is associated with the main drainage channels of Mongers Lake. The sites had a mean of 44 taxa. It separates into two groups: type 4a on low rises around lakes and type 4b on the flats of drainage zones.

Community type 4a has a very open shrub storey with a rich assemblage of annual herbs and grasses. Species groups A, E, F and L were well represented in this community. Perennial species include *Eremophila pantonii*, *Eriochiton sclerolaenoides*, *Zygophyllum fruticulosum*, *Enchylaena tomentosa*, *Senna artemisioides* subsp. *filifolia*, *Ptilotus divaricatus*, *Sclerolaena densiflora*, *Abutilon malvifolium* and *Ptilotus obovatus*. Annual species include *Ptilotus exaltatus*, *Bromus arenarius*, *Brachyscome ciliaris*, *Goodenia mimuloides*, *Erodium cygnorum*, *Cephalipterum drummondii*, *Angianthus tomentosus* and *Euphorbia drummondii*.

In community type 4b *Acacia victoriae*, *A. tysonii*, *Maireana trichoptera*, *Zygophyllum compressum*, *Z. auranticum*, *Frankenia fecunda*, *Solanum orbiculatum*, *Rhagodia preissii*, *Didymanthus roei*, *Halosarcia halocnemoides*, *H. indica* subsp. *bidens*, *H.pterygosperma* subsp. *denticulata* and *Sclerostegia tenuis* were more typical of the perennial species, including species of group Q.

Community type 5 occurs on sand plains and dunes and had a mean of 39 taxa per quadrat. Perennial species of this community type include *Acacia ramulosa*, *A. jamesiana*, *Micromyrtus flaviflora*, *Aluta aspera*, *Amphipogon caricinus*, *Stylidium induratum*, *Brunonia australis* and *Thysanotus manglesianus*. Common annual species include *Erodium cygnorum*, *Goodenia occidentalis*, *Lawrencella davenportii*, *Velleia hispida*, *Bellida graminea* and *Gnephosis tenuissima*. The community divides into two subgroups. Type 5a, on the western side of the station grows on gentle sloping areas, of loose brown, reddish brown or yellowish red sand over clayey sand over hard pan with pH 5.5. Species in group O largely define this type. It has perennial species including *Acacia coolgardiensis* subsp. *coolgardiensis*, over *Anthotroche pannosa*, *Euryomyrtus patrickiae*, *Keraudrenia integrifolia*, *Euryomyrtus maidenii*, *Chrysitrix distigmatosa*, *Triodia tomentosa* and *Thysanotus rectantherus*.

Type 5b occurs on the eastern side of the station, on reddish brown to yellowish red fine sand over hardpan with ph 5.5-7. In this area the sand forms dunes. Perennial species of this community are mainly in species group P. Typical species include *Eucalyptus hypochlamydia*, *Callitris glaucophylla*, *Acacia ligulata*, *Bossiaea walkeri*, *Cryptandra imbricata*, *Rhagodia preissii*, *Triodia rigidissima*, *Ptilotus obovatus* and *Solanum lasiophyllum*.

DISCUSSION

Acacia species occurred in 10 of the 17 species groups. They occurred most frequently on the shallow soils of granites and breakaways and in Mulga shrubland on sandplains and dunes. They also occurred less frequently on drainage lines and claypans, but were less frequent or absent on saline soils.

The current list of 551 taxa recorded for the station has improved knowledge of the Yalgoo and Murchison Bioregions. Asteraceae, Chenopodiaceae and Mimosaceae were the largest families represented and *Acacia* was the most common genus. This reflects the predominance of Mulga and mixed *Acacia* shrubland across the station, with halophytic shrubland on saline soils.

The results of the work on priority taxa shows the lack of previous botanical survey in the area. None had been found before on the station. Six of the nine taxa found are small annual species. Two of these were found at more than one locality on the station and they are all relatively widespread in their distribution, but poorly collected. The three shrub species are also relatively widespread in distribution and one was found at more than one locality on the station. Three of the species found were downgraded in their priority status as a result of the work, which has also resulted in removal of a tenth, *Goodenia pusilliflora*, from the Priority list.

The high number of records of biogeographical significance indicates not only the position of the station near the boundary of the Eremaean and South-West Botanical Provinces, but also the lack of previous plant collections in this area, of both native and introduced species.

The number of weeds recorded for the area was higher at 10.3% of the total list than that of 4.1% found during flora and vegetation studies of the southern Carnarvon Basin (Keighery *et al.* 2000). However, the same families–Poaceae, Caryophyllaceae, Brassicaceae and Asteraceae–had the highest number of weed species and, similarly, the highest levels were found in wet areas along creek lines and around claypans.

The community groups of the study area correlate well with substrate and topographical positions. Briefly, community type 1 occurred on shallow soils of rocky areas, large granite exposures and breakaways and was species-rich.

Community type 2 was less species-rich, occurring on sandy loams over hardpan in Mulga shrubland. Two of the quadrats in Mulga shrubland were more species rich, occurring on the wetter western side of the station and were more closely allied with community type 1.

Community types 3 and 4 both occurred in damp areas. Type 3 included freshwater creekline and claypan communities and was very species-rich, whilst type 4 had fewer species and included claypan communities and sites around Mongers Lake on more saline soils.

Community type 5 occurred on red/brown sands, and was the least species-rich. *Triodia* species are part of the community, which occurs both on the eastern and western sides of the station, but this separation results in two sub communities.

Thorough sampling within quadrats provided information on many small, poorly collected plants which might have been overlooked during general collecting. This method of sampling also increased the number of Priority taxa that were found during the survey, as six of the nine species were small and may not otherwise have been found.

The four visits at different seasons produced significant numbers of new records, with plants in flower at each visit which had not been identified previously.

A comparison of the five major community groups identified in the study, with the land types and component land systems defined by Payne *et al.* (1998) is shown in Table 4. The quadrats covered six of the eight land types represented on the station and ten of the twelve component land systems. The five major community types were represented by between one and four of the six land types. Community types four and five gave best correlation with the ten land systems. This classification also describes fifty major habitat types split into ten habitat groups. The other three community types showed better correlation on comparison with the ten habitat groups and component thirty four major habitat types represented on the station.

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TABLE 4
Comparison of the five major community types identified in the study with the land types and component land systems defined by Payne *et al.* (1998).

LAND TYPE/ LAND SYSTEM	SITE GROUPS				
	1	2	3	4	5
Mulga shrublands and halophytic shrublands on breakaways, stony and sandy surfaced plains on granite					
Sherwood	7		1		
Waguin	1	1			
Grassy Acacia shrublands on sandplains					
Kalli		1			6
Mulga shrublands on wash plains on hardpan					
Hamilton			1		
Tindalarra	1		1		
Woodline	1	2			
Halophytic shrublands on alluvial plains with saline soils					
Ero			3		
Mixed halophytic and non-halophytic shrublands on calcreted drainage plains					
Cunyu		1		2	
Mileura				2	
Halophytic shrublands around saltlakes and fringing alluvial plains					
Carnegie				3	

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APPENDIX 1

Flora list for Burnerbinmah Station

This list includes all taxa from the sampling quadrats, the opportunistic collections and unconfirmed records from the Western Australian Herbarium (PERTH). Nomenclature follows Paczkowska and Chapman (2000) and current usage at PERTH.

(ms denotes a manuscript name, * indicates an introduced taxon).

Family: Adiantaceae	
Cheilanthes adiantoides	poorly collected, 2nd record for W.A.
Cheilanthes austrotenuifolia	
Cheilanthes lasiophylla	
Cheilanthes sieberi subsp. *sieberi*	
Family: Aizoaceae	
Gunniopsis quadrifida	
Gunniopsis rodwayi	
Gunniopsis rubra	Priority 3 species, north-eastern limit of range
Gunniopsis septifraga	
**Mesembryanthemum nodiflorum*	northern limit of main range
**Micropterum papulosum*	northern extension of range
Tetragonia cristata	southern limit of range
Tetragonia eremaea	western range extension
Tetragonia moorei	poorly collected, western range extension
Tetragonia tetragonioides	north-western range extension
Family: Amaranthaceae	
Alternanthera nodiflora	
Gomphrena sp. 'Belele' (D.W.Goodall 3215)	poorly collected
Ptilotus chamaecladus	south-western limit of main range
Ptilotus divaricatus	
Ptilotus drummondii	
Ptilotus exaltatus	
Ptilotus exaltatus var. *villosus*	
Ptilotus gaudichaudii	
Ptilotus gomphrenoides	southern extension of range
Ptilotus grandiflorus var. *grandiflorus*	
Ptilotus macrocephalus	near southern limit of range
Ptilotus obovatus	
Ptilotus polystachyus	south-western extension of range
Ptilotus schwartzii	
Ptilotus sp. S.Patrick 2787	undescribed species
Family: Anthericaceae	
Arthropodium curvipes	north-eastern range extension
Arthropodium dyeri	
Dichopogon capillipes	north-eastern limit of range
Laxmannia arida	western limit of range
Thysanotus manglesianus	
Thysanotus pyramidalis	
Thysanotus rectantherus	north-eastern limit of range
Tricoryne elatior	north-eastern range extension
Family: Apiaceae	
Daucus glochidiatus	
Hydrocotyle pilifera var. *glabrata*	near northern limit of range
Trachymene ceratocarpa	
Trachymene cyanopetala	
Trachymene ornata	
Trachymene pilosa	north-eastern limit of range
Family: Asclepidaceae	
Marsdenia australis	south-western limit of range
Rhyncharrhena linearis	
Family: Asphodelaceae	
Bulbine semibarbata	
Family: Asteraceae	
Actinobole uliginosum	
Angianthus tomentosus	
**Arctotheca calendula*	north-eastern limit of range
Asteridea athrixioides	
Bellida graminea	
Brachyscome cheilocarpa	
Brachyscome ciliaris	
Brachyscome ciliocarpa	
Brachyscome lineariloba	
Brachyscome perpusilla	
Brachyscome pusilla	northern limit of range
Calocephalus ?knappii	southern limit of range
Calocephalus multiflorus	
Calotis hispidula	
Calotis multicaulis	
**Centaurea melitensis*	
Cephalipterum drummondii	
Ceratogyne obionoides	
Chthonocephalus pseudevax	
**Cotula bipinnata*	north-eastern limit of range
Cotula cotuloides	near north-eastern limit of range
Cratystylis subspinescens	
Dielitzia tysonii	
Erymophyllum ramosum	
Gilberta tenuifolia	
Gilruthia osbornei	
Gnephosis angianthoides	near north-eastern limit of range
Gnephosis arachnoidea	near southern limit of range
Gnephosis brevifolia	
Gnephosis tenuissima	
Helipterum craspedioides	near south-western limit of range
Hyalochlamys globifera	north-eastern limit of range
Hyalosperma glutinosum subsp. *venustum*	
Hyalosperma glutinosum subsp. *glutinosum*	north-eastern limit of main range

APPENDIX 1 (continued)

Hyalosperma stoveae	Priority 2 species, 5th collection, 2nd in W.A.
**Hypochaeris glabra*	near north-eastern limit of range
Isoetopsis graminifolia	near western limit of range
Kippistia suaedifolia	western limit of range
Lawrencella davenportii	
Lawrencella rosea	
Lemooria burkittii	near south-western limit of range
Millotia myosotidifolia	
Millotia perpusilla	
Minuria cunninghamii	
Myriocephalus guerinae	
Myriocephalus nudus	Priority 1 species, 5th collection.
Myriocephalus oldfieldii ms	
Myriocephalus pygmaeus	
Myriocephalus rudallii	near south-western limit of range
Olearia pimeleoides	
**Osteospermum clandestinum*	near north-eastern limit of range
Pluchea dentex	southern limit of main range
Podolepis canescens	
Podolepis capillaris	
Podolepis kendallii	
Podolepis lessonii	
Podotheca gnaphalioides	
Pogonolepis muelleriana	
Pogonolepis stricta	
Quinqueremulus linearis	near southern limit of range
Rhodanthe battii	
Rhodanthe chlorocephala subsp. *splendida*	
Rhodanthe citrina	
Rhodanthe haigii	near western limit of range
Rhodanthe heterantha	northern extension of range
Rhodanthe humboldtiana	near southern limit of range
Rhodanthe laevis	
Rhodanthe maryonii	
Rhodanthe polycephala	near north-eastern limit of range
Rhodanthe propinqua	near south-western limit of range
Rhodanthe pygmaea	
Rhodanthe stricta	
Schoenia cassiniana	
Senecio glossanthus	
Siloxerus multiflorus	near north-eastern limit of range
* *Sonchus oleraceus*	
Sondottia connata	
Streptoglossa cylindriceps	south-western limit of range
Tietkensia corrickiae	south-western extension of range
Trichanthodium exile	
Trichanthodium skirrophorum	
Triptilodiscus pygmaeus	near western limit of range
Waitzia acuminata	
Waitzia nitida	
Family: Boraginaceae	
Omphalolappula concava	
Plagiobothrys plurisepalus	2nd collection in WA Herbarium
Family: Boryaceae	
Borya sphaerocephala	north-eastern limit of range
Family: Brassicaceae	
**Brassica rapa*	near north-eastern limit of range
**Brassica tournefortii*	
Harmsiodoxa brevipes	poorly collected, north-eastern limit of range
**Hornungia procumbens*	north-eastern extension of range
Lepidium merrallii	Priority 2 species, 3rd collection in W.A., north-eastern extension of range
Lepidium muelleri-ferdinandii	near south-western limit of range
Lepidium oxytrichum	near south-western limit of range
Lepidium phlebopetalum	
Menkea australis	
Phlegmatospermum drummondii	Priority 3 species, 6th collection, north-eastern limit of range
**Raphanus raphanistrum*	north-eastern extension of range
**Sisymbrium erysimoides*	
**Sisymbrium irio*	
**Sisymbrium orientale*	
Stenopetalum anfractum	near south-western limit of range
Stenopetalum filifolium	
Stenopetalum lineare	near western limit of range
Family: Caesalpiniaceae	
Senna artemisioides subsp. *filifolia*	
Senna artemisioides subsp. *petiolaris*	
Senna sp. 'Austin' (A.Strid 20210)	
Family: Campanulaceae	
Wahlenbergia communis	
Wahlenbergia gracilenta	
Wahlenbergia preissii	north-eastern limit of range
Wahlenbergia tumidifructa	
Family: Caryophyllaceae	
**Polycarpon tetraphyllum*	near north-eastern limit of range
**Silene gallica* var. *gallica*	near north-eastern limit of range
**Silene nocturna*	north-eastern extension of range
**Spergula arvensis*	north-eastern extension of range
**Spergula pentandra*	north-eastern extension of range
**Spergularia diandra*	
**Spergularia media*	1st record for W.A.
**Spergularia rubra*	
**Spergularia salina*	2nd record for Eremaean Botanical Province, otherwise limited to south-west
Family: Casuarinaceae	
Casuarina obesa	
Family: Centrolepidaceae	
Centrolepis eremica	
Centrolepis polygyna	north-eastern extension of range

APPENDIX 1 (continued)

Family: Chenopodiaceae	
Atriplex amnicola	
Atriplex bunburyana	
Atriplex codonocarpa	
Atriplex holocarpa	
Atriplex semilunaris	
Atriplex vesicaria	
**Chenopodium album*	northern extension of range
Chenopodium curvispicatum	south-western limit of range
Chenopodium gaudichaudianum	near southern limit of range
Chenopodium melanocarpum	
**Chenopodium murale*	
Chenopodium saxatile	south-western extension of range
Didymanthus roei	
Dysphania glandulosa	south-western extension of range
Einadia nutans	south-western extension of range
Enchylaena lanata	north-eastern limit of range
Enchylaena tomentosa	
Eriochiton sclerolaenoides	
Halosarcia fimbriata	
Halosarcia halocnemoides	undescribed subspecies
Halosarcia indica subsp. *bidens*	
Halosarcia pterygosperma	
Halosarcia pterygosperma subsp. *denticulata*	southern extension of range from Shark Bay
Halosarcia syncarpa	north-eastern limit of range
Maireana amoena	
Maireana carnosa	
Maireana convexa	near south-western limit of range
Maireana diffusa	northern extension of range
Maireana georgei	south-western limit of main range
Maireana glomerifolia	
Maireana planifolia	
Maireana planifolia × villosa	
Maireana pyramidata	
Maireana suaedifolia	western limit of range
Maireana thesioides	
Maireana trichoptera	
Maireana triptera	
Maireana villosa	near southern limit of range
Rhagodia drummondii	
Rhagodia eremaea	south-western limit of range
Rhagodia preissii subsp. *preissii*	
Salsola tragus	
Sclerolaena burbidgeae	
Sclerolaena densiflora	near south-western limit of range
Sclerolaena diacantha	
Sclerolaena eriacantha	south-western range extension
Sclerolaena eurotioides	
Sclerolaena gardneri	
Sclerolaena lanicuspis	near southern limit of range
Sclerolaena uniflora	
Sclerostegia moniliformis	north-western extension of range
Sclerostegia tenuis	poorly collected, north-western extension of range

Family: Chloanthaceae	
Dicrastylis linearifolia	Priority 3 species, southern extension of range
Spartothamnella teucriiflora	south-western extension of range
Family: Colchicaceae	
Wurmbea ?densiflora	
Family: Convolvulaceae	
Convolvulus erubescens	
Convolvulus remotus	
Porana ?sericea	
Family: Crassulaceae	
Crassula colorata	
Crassula colorata var. *acuminata*	
Crassula exserta	northern limit of range
Family: Cupressaceae	
Callitris glaucophylla	
Family: Cuscutaceae	
**Cuscuta epithymum*	
Family: Cyperaceae	
Chrysitrix distigmatosa	north-eastern limit of range
Cyperus alterniflorus	
Cyperus gymnocaulos	
Cyperus rigidellus	near southern limit of range
Cyperus squarrosus	south-western limit of range
Cyperus vaginatus	
Isolepis congrua	
Lepidosperma sp.	
Schoenus humilis	
Schoenus nanus	north-eastern limit of range
Schoenus subaphyllus	
Schoenus variicellae	
Family: Droseraceae	
Drosera bulbosa subsp. *major*	poorly recorded, 3rd record for W.A.
Drosera indica	south-western range extension
Drosera macrantha subsp. *eremaea*	poorly recorded
Family: Elatinaceae	
Bergia perennis subsp. *exigua*	southern limit of range
Family: Epacridaceae	
Leucopogon sp. 'Clyde Hill' (M.A.Burgman 1207)	north western limit of range
Family: Euphorbiaceae	
Euphorbia drummondii	
Euphorbia ?tannensis subsp. *eremophila*	near south-western limit of range
Pseudanthus intricatus ms	
Stachystemon sp.	
Family: Frankeniaceae	
Frankenia fecunda	
Frankenia ?glomerata	Priority 1 species, bridges range between north and south-west
Frankenia interioris var. *parviflora*	north-western extension of range

APPENDIX 1 (continued)

Frankenia laxiflora	
Frankenia pauciflora	
Frankenia sessilis	near western limit of range
Frankenia setosa	
Family: Gentianaceae	
Centaurium clementii	southern extension of range
Family: Geraniaceae	
**Erodium aureum*	
**Erodium cicutarium*	near north-eastern limit of range
Erodium cygnorum	
Family: Goodeniaceae	
Brunonia australis	
Dampiera roycei	western limit of range
Goodenia berardiana	
Goodenia havilandii	
Goodenia mimuloides	
Goodenia neogoodenia	Priority 4 species, southern extension of range
Goodenia occidentalis	
Goodenia pinnatifida	
Goodenia pusilliflora	northern limit of range
Scaevola chrysopogon × *restiacea*	
Scaevola spinescens	
Velleia glabrata	south-western limit of range
Velleia hispida	south-western limit of range
Velleia rosea	
Family: Gyrostemonaceae	
Gyrostemon ramulosus	
Family: Haloragaceae	
Gonocarpus nodulosus	
Haloragis odontocarpa	near south-western limit of range
Haloragis trigonocarpa	near south-western limit of range
Myriophyllum decussatum	near southern limit of range
Family: Hydrocharitaceae	
Ottelia ovalifolia	northern and inland extension of range
Family: Hypoxidaceae	
Hypoxis glabella	north-eastern extension of range
Family: Juncaceae	
**Juncus bufonius*	north-eastern limit of main range
Juncus flavidus	poorly collected, northern extension of range
Juncus pallidus	north-eastern extension of range
Family: Juncaginaceae	
Triglochin calcitrapa	
Triglochin centrocarpa	
Triglochin mucronata	
Triglochin nana	
Triglochin protuberans	poorly collected, 4th collection
Triglochin sp. A Flora of Australia (G.J.Keighery 2477)	
Triglochin sp. B Flora of Australia (P.G.Wilson 4294)	
Family: Lamiaceae	
Hemigenia sp. 'Edah' (J.W.Green 1601)	
Hemigenia sp. 'Paynes Find' (A.C.Beauglehole 49138)	
Prostanthera althoferi subsp. *althoferi*	
Prostanthera patens	eastern limit of range
Family: Lobeliaceae	
Isotoma petraea	
Lobelia heterophylla	
Lobelia winfridae	
Family: Loranthaceae	
Amyema fitzgeraldii	near southern limit of range
Amyema nestor	
Lysiana casuarinae	
Family: Malvaceae	
Abutilon cryptopetalum	south-western limit of range
Abutilon malvifolium	5th record for W.A., south-western limit of range
Abutilon oxycarpum	south-western limit of range
Alyogyne pinoniana	
Lawrencia glomerata	
Lawrencia helmsii	south-western limit of range
**Malva parviflora*	
Sida atrovirens ms	
Sida calyxhymenia	
Sida fibulifera	
Sida ?intricata	poorly collected
Family: Marsileaceae	
Marsilea drummondii	
Family: Mimosaceae	
Acacia acuminata	north-eastern limit of main range
Acacia acuminata subsp. *acuminata*	north-eastern limit of main range
Acacia aneura	near south-western limit of range
Acacia aneura × *craspedocarpa*	
Acacia assimilis subsp. *assimilis*	north-eastern limit of range
Acacia aulacophylla	
Acacia ayersiana	near south-western limit of range
Acacia burkittii	near south-western limit of range
Acacia coolgardiensis subsp. *coolgardiensis*	north-eastern limit of main range
Acacia coolgardiensis subsp. *effusa*	
Acacia ?coriacea	southern extension of range
Acacia craspedocarpa	south-western limit of range
Acacia eremaea	
Acacia exocarpoides	
Acacia fragilis	northern extension of range
Acacia grasbyi	near south-western limit of range
Acacia jamesiana	near south-western limit of range
Acacia ?kempeana	near south-western limit of range
Acacia ligulata	
Acacia longispinea	south-western limit of range

APPENDIX 1 (continued)

Acacia masliniana	
Acacia minyura	near south-western limit of range
Acacia murrayana	
Acacia quadrimarginea	
Acacia ramulosa	
Acacia ramulosa var. l*inophylla*	near south-western limit of range
Acacia resinosa	northern limit of range
Acacia rhodophloia	near south-western limit of range
Acacia ?stowardii	
Acacia tetragonophylla	
Acacia tysonii	
Acacia victoriae	
Family: Myoporaceae	
Eremophila alternifolia	near south-western limit of range
Eremophila compacta	
Eremophila eriocalyx	
Eremophila forrestii	
Eremophila georgei	
Eremophila gibbosa	north-western extension of range
Eremophila glandulifera ms	
Eremophila granitica	
Eremophila ?jucunda	south-western limit of range
Eremophila latrobei subsp. *latrobei* ms	
Eremophila longifolia	
Eremophila mackinlayi	southern limit of range
Eremophila maculata	
Eremophila maculata subsp. *brevifolia* ms	
Eremophila miniata	
Eremophila muelleriana	
Eremophila oldfieldii subsp. *angustifolia* ms	
Eremophila oppositifolia subsp. *angustifolia*	
Eremophila pantonii	
Eremophila platycalyx	
Eremophila punicea	
Eremophila ?rostrata	Priority 1 species
Eremophila serrulata	
Eremophila shonae subsp. *shonae* ms	southern limit of range
Eremophila spuria ms	southern limit of range
Family: Myrtaceae	
Aluta aspera	
Callistemon phoeniceus	
Calytrix divergens	near southern limit of range
Darwinia capitellata	
Eucalyptus hypochlamydea	near northern limit of range
Eucalyptus kochii subsp. *amaryssia* ms.	north-western edge of range
Eucalyptus leptopoda subsp. *arctata*	
Eucalyptus oldfieldii	
Eucalyptus pileata	northern limit of range
Euryomyrtus maidenii ms	near western limit of range
Euryomyrtus patrickiae	Priority 3 species, near western edge of range
Homalocalyx thryptomenoides	
Malleostemon roseus	small-flowered form
Malleostemon tuberculatus	near north-eastern limit of range
Melaleuca eleuterostachya	near north-eastern limit of range
Melaleuca lateriflora subsp. *acutifolia* ms	
Melaleuca ?xerophylla	large south-western range extension
Micromyrtus flaviflora	
Micromyrtus sulphurea	
Thryptomene decussata	south-western limit of range
Thryptomene mucronulata	
Family: Nyctaginaceae	
Boerhavia ?coccinea	
Family: Ophioglossaceae	
Ophioglossum lusitanicum	
Family: Orchidaceae	
Caladenia hirta	
Caladenia incensa ms	
Paracaleana lyonsii ms	large south-eastern extension of range
Prasophyllum gracile	near north-eastern limit of range
Pterostylis sp. 'inland' (A.C.Beauglehole 11880)	north-eastern limit of range
Thelymitra sargentii	north-eastern limit of range
Family: Orobanchaceae	
**Orobanche minor*	north-eastern limit of range
Family: Oxalidaceae	
**Oxalis corniculata*	
**Oxalis pes-caprae*	north-eastern limit of range
Family: Papilionaceae	
Bossiaea walkeri	
Gastrolobium laytonii	
Glycine canescens	
Jacksonia arida ms	
Mirbelia ramulosa	
Mirbelia rhagodioides	
Swainsona affinis	
Swainsona campestris	large range extension from south-east W.A.
Swainsona gracilis	
Swainsona ?halophila	
Swainsona oroboides	near western limit of range
Swainsona ?paucifoliolata	
Swainsona perlonga	poorly collected, eastern limit of range
Swainsona rostellata	near south-western limit of range
Templetonia egena	
Family: Phormiaceae	
Dianella revoluta	
Family: Pittosporaceae	
Bursaria occidentalis	
Pittosporum phylliraeoides	
Family: Plantaginaceae	
**Plantago coronopus* subsp. *commutata*	north-eastern extension of range
Plantago debilis	near northern limit of range
Plantago drummondii	
Family: Poaceae	
Agrostis avenacea	
**Alopecurus geniculatus*	3rd record for W.A.
**Alopecurus pratensis*	poorly recorded, northern range extension

APPENDIX 1 (continued)

Amphibromus nervosus	
Amphipogon caricinus	
Aristida contorta	
Austrodanthonia caespitosa	
Austrostipa elegantissima	
Austrostipa flavescens	north-eastern limit of range
Austrostipa nitida	
Austrostipa scabra	
Austrostipa trichophylla	
**Avena fatua*	near north-eastern limit of range
**Briza minor*	north-eastern limit of range
Bromus arenarius	
Bromus ?rubens	north-eastern limit of range
Cymbopogon ambiguus	
**Ehrhartia longiflora*	near north-eastern limit of range
Enneapogon caerulescens	
Eragrostis dielsii	
Eragrostis eriopoda	south-western limit of range
Eragrostis falcata	near western limit of range
Eragrostis kennedyae	southern extension of range
Eragrostis lanipes	south-western limit of range
Eragrostis pergracilis	
Eriachne flaccida	near south-western limit of range
Eriachne helmsii	near south-western limit of range
Eriachne ovata	
Eriachne pulchella	south-western limit of range
**Hordeum glaucum*	
**Lamarkea aurea*	eastern limit of main range
Monachather paradoxus	
Paspalidium clementii	south-western limit of main range
**Pentaschistis airoides*	near north-eastern limit of range
**Polypogon monspeliensis*	
**Rostraria cristata*	north-eastern limit of range
**Rostraria pumila*	
**Schismus barbatus*	
Thyridolepis mitchelliana	near western limit of range
Thyridolepis multiculmis	near southern limit of range
Tragus australianus	
Triodia rigidissima	near western limit of main range
Triodia scariosa	
Triodia tomentosa	near western limit of range
**Vulpia muralis*	north-eastern limit of range
**Vulpia myuros* var. *myuros*	northern limit of range
Family: Polygalaceae	
Comesperma integerrimum	
Family: Polygonaceae	
**Acetosa vesicaria*	
**Emex australis*	
Muehlenbeckia florulenta	
Family: Portulacaceae	
Calandrinia disperma	2nd and 3rd records for W.A.
Calandrinia eremaea	
Calandrinia granulifera	
Calandrinia polyandra	
Calandrinia primuliflora	
Calandrinia ptychosperma	
Calandrinia sp. 'Bungalbin' (G.J.Keighery & N.Gibson 1656)	3rd record for W.A., southern range extension
Calandrinia sp. 'Coolcalalaya' (G.J.Keighery & N.Gibson 698)	3rd record for W.A., south-eastern range extension
Family: Primulaceae	
**Anagallis arvensis*	
**Anagallis arvensis* var. *caerulea*	
Samolus repens	
Family: Proteaceae	
Grevillea acacioides	near north-western limit of range
Grevillea deflexa	near south-western limit of range
Grevillea eriostachya	
Grevillea excelsior	near north-eastern limit of range
Grevillea hakeoides subsp. *stenophylla*	near eastern limit of range
Grevillea juncifolia	
Grevillea levis	near eastern limit of range
Grevillea obliquistigma	
Grevillea pityophylla	
Grevillea sarissa	near western limit of range
Hakea minyma	
Hakea preissii	
Hakea recurva	
Persoonia sp.	
Family: Ranunculaceae	
Ranunculus pentandrus var. *platycarpus*	western extension of range
Ranunculus sessiliflorus var. *sessiliflorus*	north-eastern limit of range
Family: Rhamnaceae	
Cryptandra imbricata	Priority 3 species
Family: Rubiaceae	
Psydrax latifolia	south-western extension of range
Family: Rutaceae	
Philotheca brucei	
Philotheca brucei subsp. *brevifolia*	
Philotheca tomentella	
Family: Santalaceae	
Exocarpos aphyllus	
Leptomeria preissiana	
Santalum acuminatum	
Santalum spicatum	
Family: Sapindaceae	
Alectryon oleifolius	bridges gap in range between populations of north-west and south-east

APPENDIX 1 (continued)

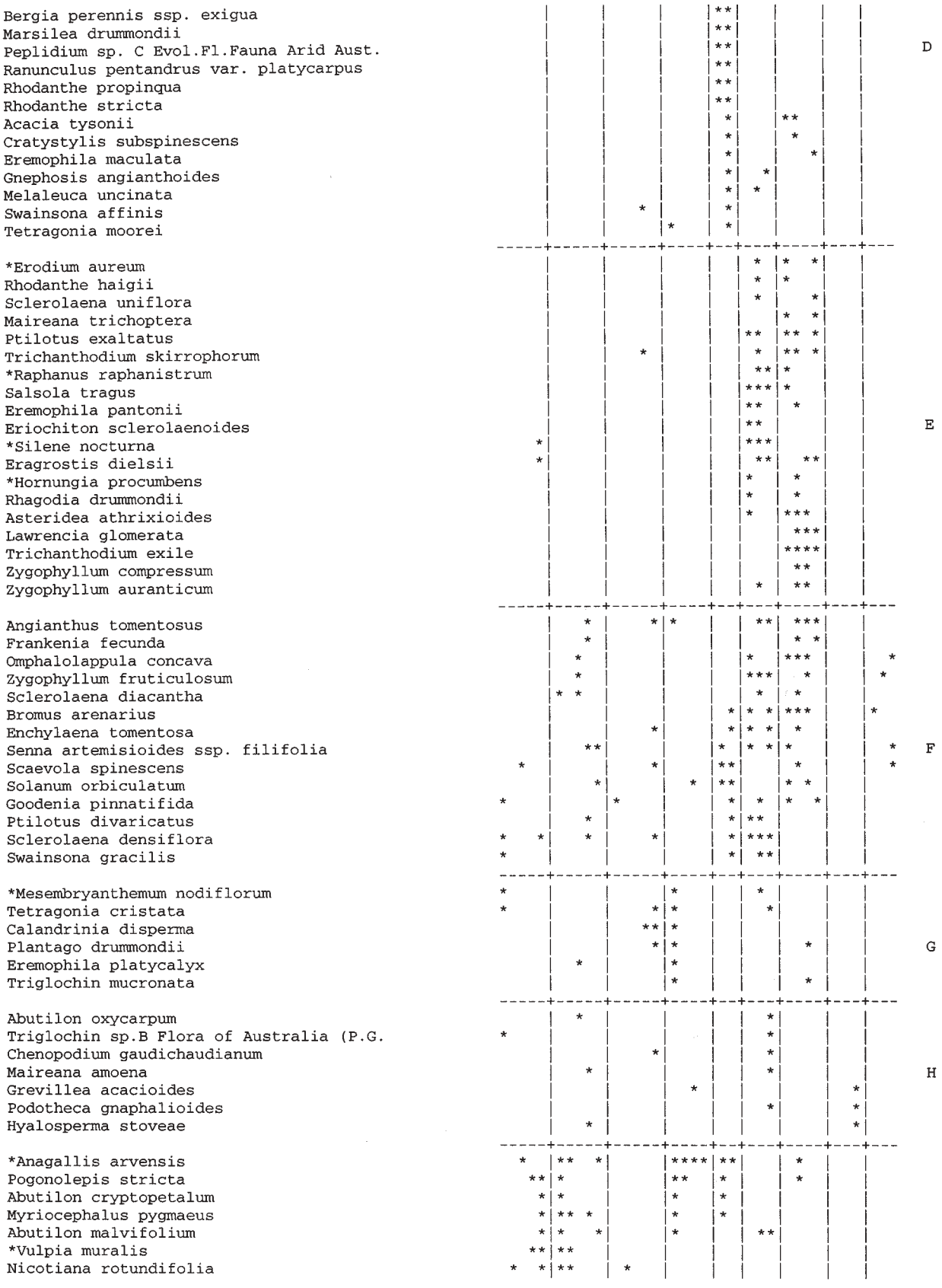
Dodonaea inaequifolia	
Dodonaea microzyga var. *acrolobata*	
Dodonaea viscosa	
Dodonaea viscosa subsp. *mucronata*	
Dodonaea viscosa subsp. *angustissima*	
Family: Scrophulariaceae	
Glossostigma diandrum	
Glossostigma drummondii	
**Parentucellia latifolia*	near north-eastern limit of range
Peplidium muelleri	southern limit of range
Peplidium sp. C Evol.Fl.Fauna Arid Aust. (N.T.Burbidge & A.Kanis 8158)	southern limit of range
**Zaluzianskya divaricata*	north-eastern extension of range
Family: Solanaceae	
Anthotroche pannosa	
Duboisia hopwoodii	
Nicotiana cavicola	
Nicotiana occidentalis subsp. *hesperis*	
Nicotiana occidentalis subsp. *obliqua*	
Nicotiana rosulata subsp. *rosulata*	
Nicotiana rotundifolia	
Solanum cleistogamum	
Solanum lasiophyllum	
**Solanum nigrum*	
Solanum orbiculatum	
Solanum orbiculatum subsp. *orbiculatum*	
Family: Sterculiaceae	
Brachychiton gregorii	
Keraudrenia integrifolia	
Rulingia luteiflora	
Family: Stylidiaceae	
Levenhookia leptantha	
Stylidium induratum	western limit of range
Stylidium longibracteatum	
Family: Thymelaeaceae	
Pimelea microcephala	
Family: Urticaceae	
Parietaria cardiostegia	
Family: Zygophyllaceae	
Zygophyllum auranticum	
Zygophyllum compressum	south-western limit of range
Zygophyllum eremaeum	
Zygophyllum fruticulosum	
Zygophyllum glaucum	
Zygophyllum ovatum	
Zygophyllum simile	

APPENDIX 2

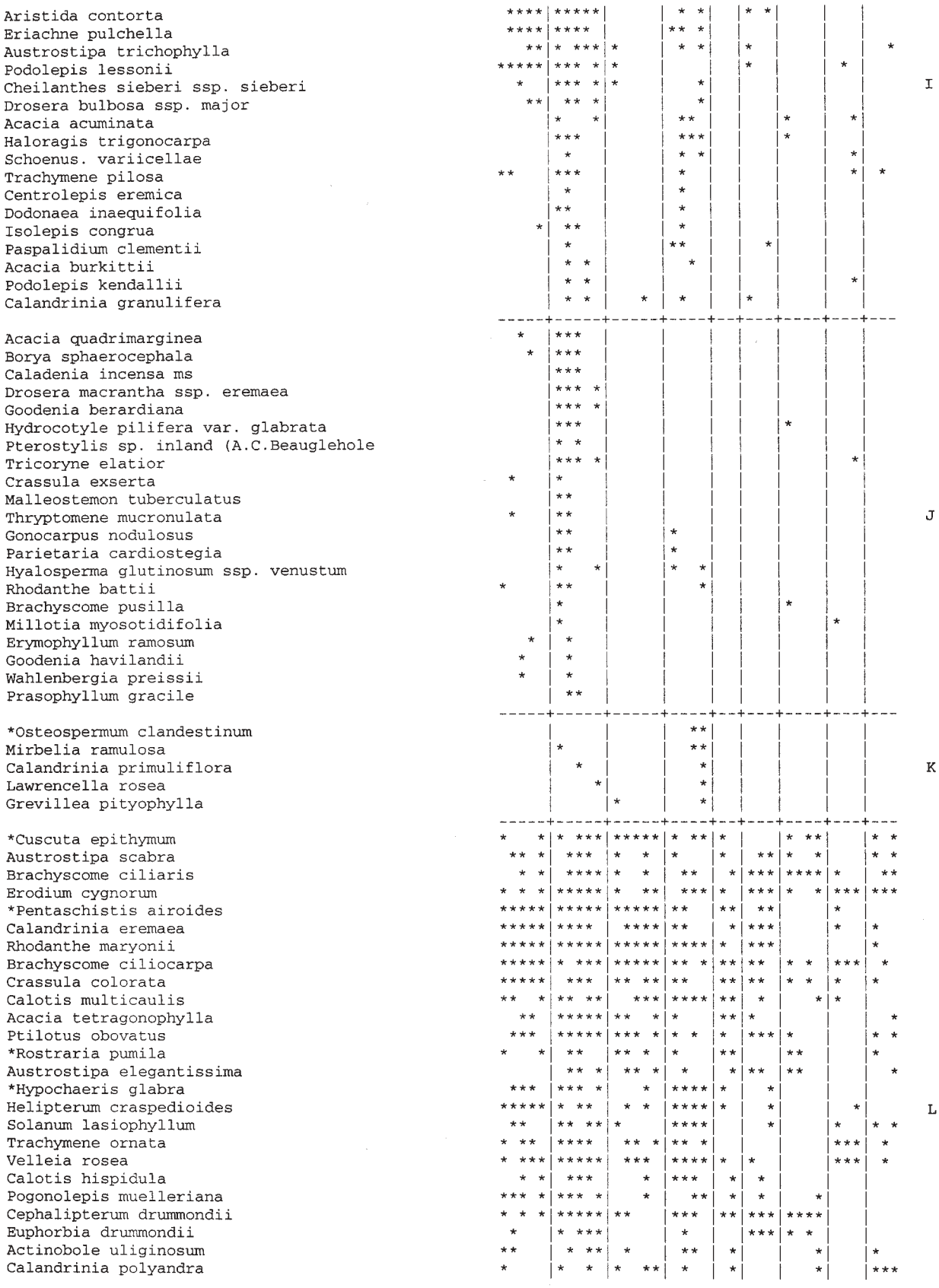
Sorted two-way table of the Burnerbinmah sites showing species occurrence (rows) by community type (site codes appear as columns).

	COMMUNITY TYPE								
	1a	1b	2	3a	3b	4a	4b	5a	5b
									SPECIES GROUPS
	ACABC	ABCCC	CABCA	ABAB	AC	ABA	BBBC	ACB	ABC
	14655	43381	18779	5411	76	211	6899	322	111
		1		21		0			100
*Sonchus oleraceus			*	****	**		* *		
*Erodium cicutarium			*	**	**		*		
*Emex australis				***	**	**			
*Hordeum glaucum				***	*	* *	**		A
Nicotiana occidentalis ssp. hesperis				** *		*	*		
Swainsona rostellata				* *	*	*	*		
Goodenia pusilliflora	**	*	*	*	**	*			
Senecio glossanthus	*			*	*		**		*
*Arctotheca calendula				*	*				
Ptilotus macrocephalus				*	*				
*Centaurea melitensis				***	*				
*Silene gallica var. gallica				***	*				
*Cotula bipinnata				**	*				
Atriplex semilunaris				**		*			
*Polycarpon tetraphyllum				**					
Cyperus gymnocaulos				**					
Wahlenbergia communis				**					
*Avena fatua		*		**					*
Daucus glochidiatus				**			*		*
Hyalochlamys globifera				* *					
Wahlenbergia gracilenta			*	** *					
Rhodanthe chlorocephala ssp. splendida			*	* *				*	B
*Solanum nigrum	*			*					
Gnephosis brevifolia	* *			*					
Rhyncharrhena linearis			**	*					
*Vulpia myuros var. myuros	*		*	*					
Eriachne flaccida	*			* *					
Eriachne ovata	*			**					
Rhodanthe pygmaea	*			*					
Acacia exocarpoides			*	*					
Calandrinia ptychosperma		*		***					
Triglochin calcitrapa				* *					
Ptilotus chamaecladus				* *		*			
Chenopodium melanocarpum				**					
Cyperus alterniflorus				**					
Swainsona oroboides				**					
Sida fibulifera		*		*					
*Acetosa vesicaria					*		**		
Acacia victoriae					*		**		
Tetragonia eremaea					*		*		
Lepidium phlebopetalum	*				*		**		
*Sisymbrium erysimoides					*	**	*		
Rhagodia eremaea					*	*			
*Oxalis corniculata				*	*				C
Exocarpos aphyllus				*	**				
Myriocephalus oldfieldii ms				*	*				
Pimelea microcephala					*				*
Dodonaea viscosa				*	*	*			
Pittosporum phylliraeoides				*	*	*			
Maireana pyramidata					*	*			
*Spergularia rubra	*				**				
Plagiobothrys plurisepalus	*				**				
Gnephosis arachnoidea	*				*				
Hyalosperma glutinosum ssp. glutinosum	* *				*				
Atriplex amnicola		*			**				
Brachyscome lineariloba			*		**				
Agrostis avenacea					**				

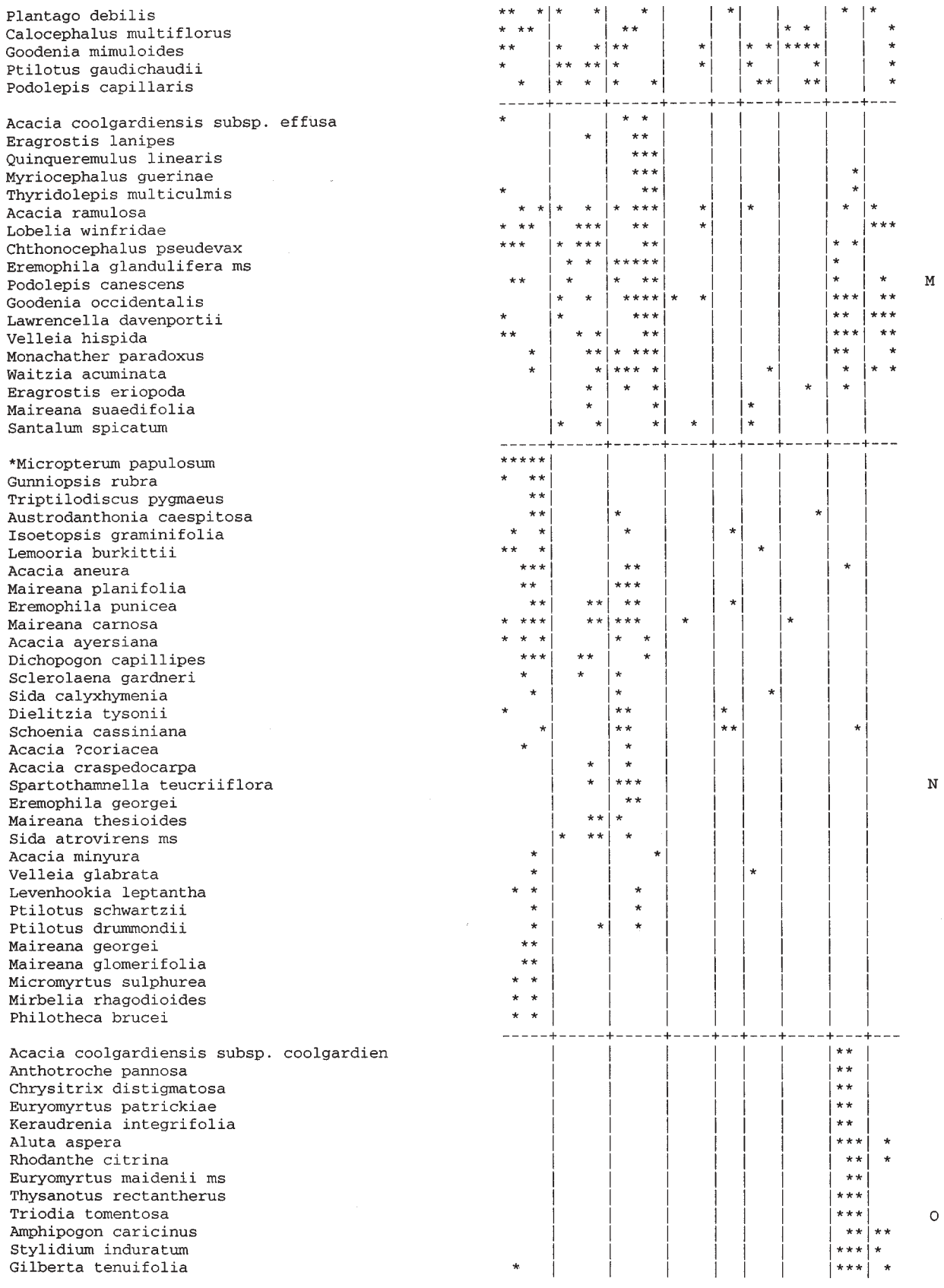
APPENDIX 2 (continued)



APPENDIX 2 (continued)



APPENDIX 2 (continued)



APPENDIX 2 (continued)