# MALLEE VEGETATION OF THE SOUTHERN NULLARBOR AND ROE PLAINS, AUSTRALIA

by R. F. Parsons*

## SUMMARY

The distribution and composition of mallee vegetation in the coastal strip from the Head of the Bight to Caiguna are described, and their relationship to soil and climatic factors discussed. All the eucalypts show marked gaps in their east-west spread. A distinctive sclerophyllous flora is described from siliceous sand topsoils in the western Roe Plain. This is surrounded by alkaline loamy soils which may act as edaphic barriers isolating it from similar floras west of the Nullarbor Plain. The role of climate and sea level changes in producing the observed distribution is discussed. A plant species list for 14 mallee communities is appended.

## INTRODUCTION

Although mallee vegetation is known to occur in parts of the coastal strip from the Head of the Bight to Caiguna, Western Australia (Fig. 1), very little is known about its extent or nature (Tate 1879; Willis 1951, 1959).

The following introductory account is based on field work in November 1967, so that annual and ephemeral species are not dealt with. The strip from the coast to

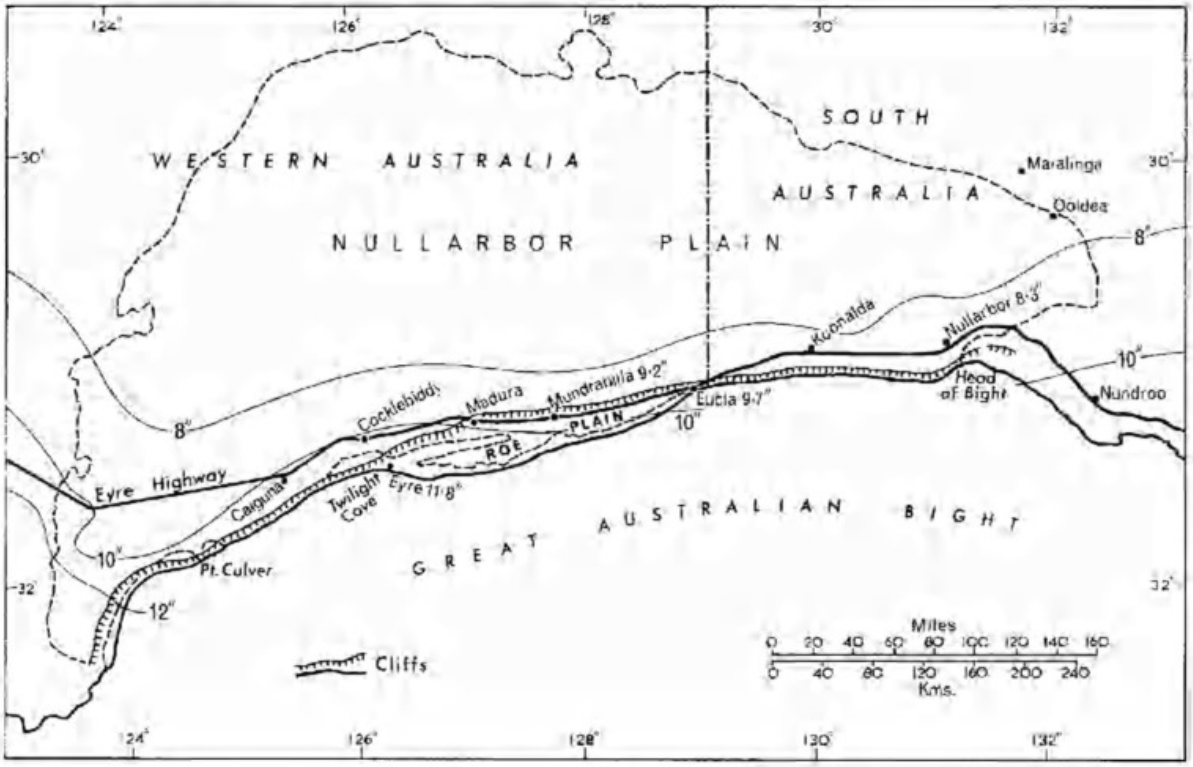


Fig. 1. The study area and its surroundings, showing the approximate margin of dunes (dashed line, from Jennings 1967), some mean annual isohyets, and annual rainfall means for the period 1902-1926 plus 1933-38 for four stations (Australia: Bureau of Meteorology).

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the northern-most limit of mallee vegetation was examined from the Head of the Bight in the east to Caiguna in the west by driving on most traversible tracks. Specimens of all plant species present were taken from the sites shown on Fig. 2 and were supplemented by limited collections from other areas. The species from

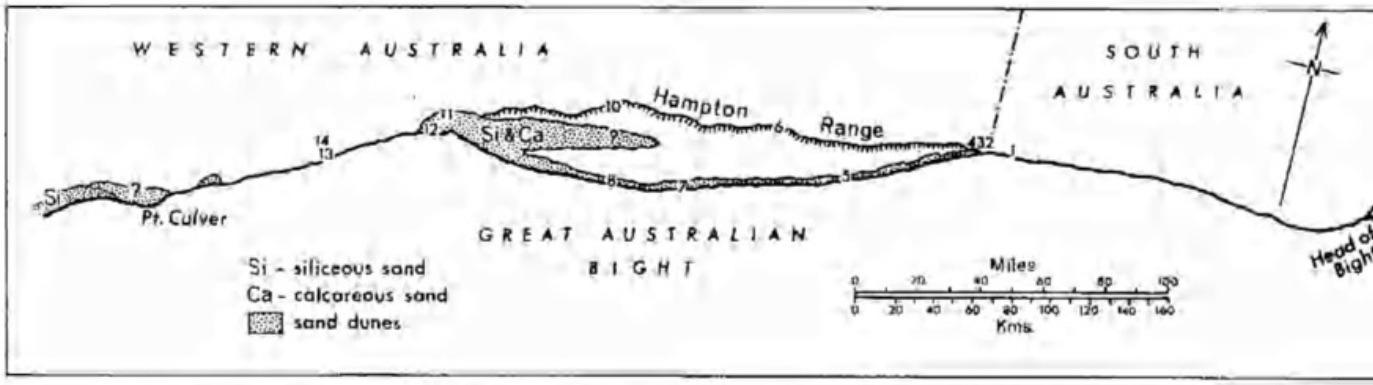


Fig. 2. The location of collecting sites listed in Appendix 1 and the location of sand dunes in the study area after Northcote *et al.* (1967, 1968) and Jennings (1967). Areas not shown as sand dunes are loamy soils on Tertiary limestone.

each site are listed in Appendix 1; the records of Willis (1951, 1965) from the cliffs behind Madura have been included (as site 10) for the sake of completeness. All specimens were identified by, and are lodged at, the State Herbarium of South Australia, except for *Eucalyptus diversifolia*, specimens of which have been retained by the author. All specimens of *E. foecunda*, *E. oleosa*, *E. socialis* and *E. rugosa* were checked by D. F. Blaxell and L. A. S. Johnson.

## GEOMORPHOLOGY

The study area comprises the Roe Plain and the southern margin of the Nullarbor Plain, if the latter is defined geologically and topographically (Jennings 1963) and not botanically. In this region the Nullarbor is a very flat plain of Miocene limestone (the Nullarbor limestone), except where it is covered with dunes of aeolian calcarenite around Twilight Cove (Fig. 2; Jennings 1967). The Roe Plain is about 200 feet lower than the Nullarbor Plain, is separated from it by a scarp called the Hampton Range and is floored with Eocene limestone. Dunes of three different ages occupy most of the westward end and a seaward fringe; Jennings loc. cit.

## CLIMATE

The area has a dry Mediterranean type climate (Fig. 3), with mean annual rainfall increasing southwards (Fig. 1).
Percentage mean variability from mean annual rainfall is greater than 20% and the rain comes mostly as light showers; mean rainfall per wet day is less than 0·2 in (5 mm) (Leeper 1960).

## SOILS

Most of the area is covered by loamy, calcareous, alkaline soils formed on Tertiary limestone, and are usually less than 60 cm deep (Northcote *et al.* 1967;

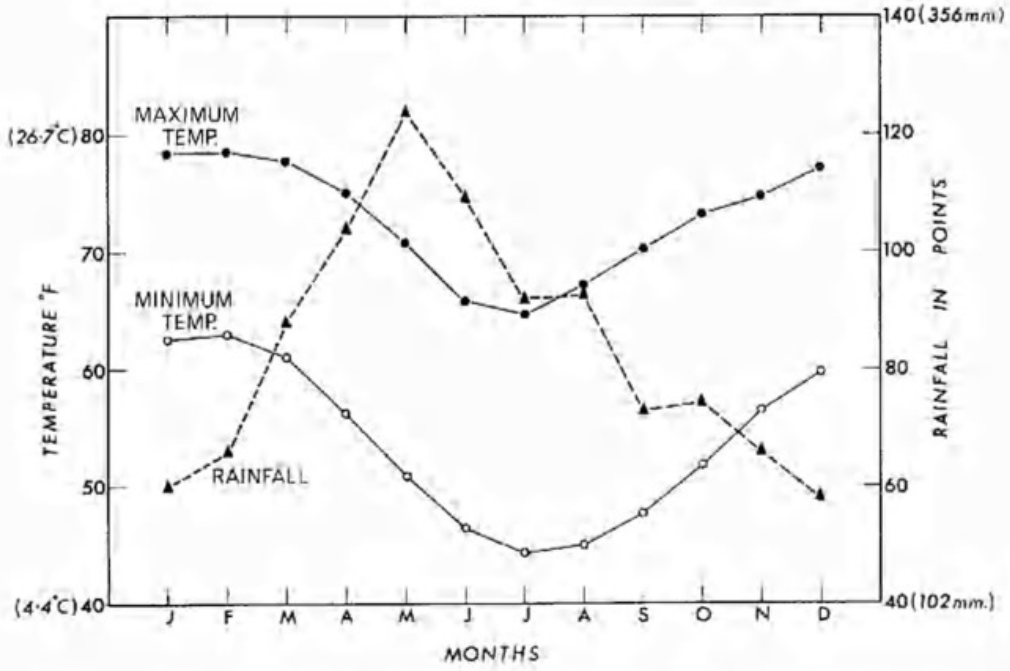


Fig. 3. Mean monthly rainfall and maximum and minimum screen temperatures at Eucla. Data from Australia; Bureau of Meteorology (1956).

Northcote *et al.* 1968). However, there are also large areas of dunes (Fig. 2) of various types and ages. The young dunes nearest the coast were of calcareous beach sand, except at Twilight Cove, where the sand is white and siliceous with a very small shell content. The beach sands further west, past Point Culver, appear to be siliceous also (Northcote *et al.* 1967). There are at least two types of older dunes. Deep calcareous sandy types (Table 1 Site 7) were the only ones seen in the eastern Roe Plain (Sites 5 & 7), while dunes of siliceous sand over aeolian calcarenite (Table 1 Site 11) were the only ones seen in the west (Sites 8, 9 and 11). Much more work is necessary before the distribution of each type can be mapped.

TABLE 1

Description of two dune soils in the study area.

| Site 7 | | |
|---|---|---|
| Depth (cm) | Colour | Description |
| 0–13 | pale brown | Calcareous loamy sand with small $CaCO_3$ nodules |
| 13–38 | pink | Calcareous loamy sand with small $CaCO_3$ nodules |
| 38–140 | pink | Calcareous loamy sand with more frequent $CaCO_3$ nodules |
| 140–152 | very pale brown | Calcareous sand with $CaCO_3$ nodules and shell fragments |
| **Site 11** | | |
| Depth (cm) | Colour | Description |
| 0–10 | pale brown | Sand |
| 10–51 | very pale brown | Sand |
| 51–66 | yellow | Sand |
| 66– | | Sheet limestone |

## BIOTIC INFLUENCES

The introduced rabbit (*Oryctolagus cuniculus*) is the most common grazing mammal in the area; in 1947, thirty-five trappers were able to trap up to 20,000 rabbits a week in the Cocklebiddy area (Morrison 1948). An abundance of rabbits made commercial hunting still profitable in 1967. Rabbits are almost certain to have very adverse effects on the seedling regeneration of mallee eucalypts (Parsons 1968) and that of many other plants (Hall, Specht and Eardley 1964) in this area.

Native animals are discussed by Tate (1879) and McEvey and Middleton (1968), while sheep and cattle grazing has occurred in the area since the 1870's (Dunkley 1967). Hundreds of tons of bitter quandong (*Santalum* sp.) have been cut from the area for incense making and timber (Brown 1919). Large-scale fires do not occur in the mallee and this area; mallee fires occur only on very hot days and burn out only a few acres (pers. comm., Harvey Gurney, Eucla).

## DISTRIBUTION OF MALLEE VEGETATION

The term mallee vegetation is used here to include all communities dominated by mallee species of *Eucalyptus*. The distribution of mallee vegetation in the South Australian part of the study area based on field traverses is shown in Fig. 4.

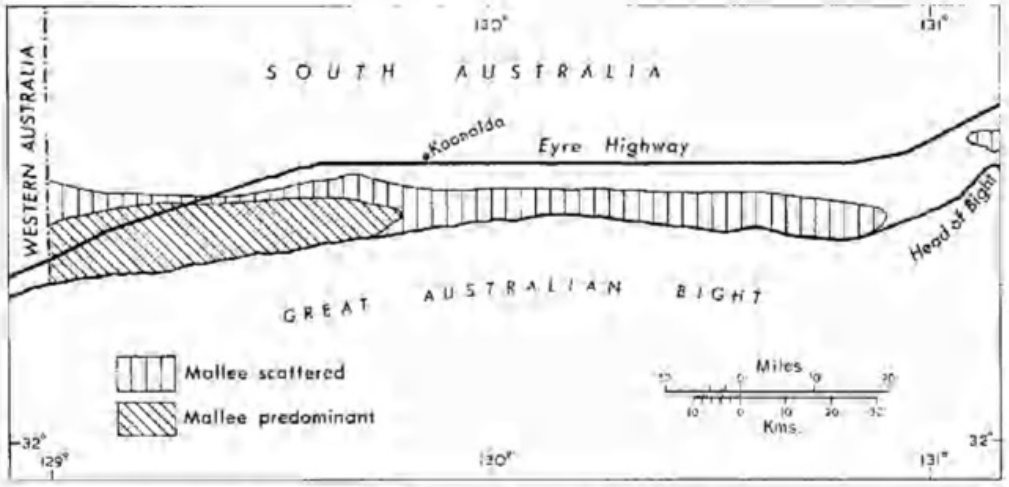


Fig. 4. Approximate distribution of mallee vegetation in the South Australian part of the Nullarbor Plain. "Mallee predominant" indicates 50% or more of the area carries mallee eucalypts; "mallee scattered" indicates less than 50% of the area carries mallee eucalypts.

A vegetation map of the Western Australian part of the area will be published shortly by Dr. J. S. Beard, King's Park and Botanic Gardens, Perth. All that needs to be said here about the Western Australian sector, is that (1) Mallee is predominant along the top of the entire Hampton Range but thins out north of this and disappears at about 20 miles (32 km) north of the Eyre Highway. (2) Mallee is predominant on all that part of the Nullarbor Plain west of Madura and south of the Eyre Highway. (3) Mallee is predominant in the western part of the Roe Plain, but becomes increasingly scattered, and almost confined to a narrow coastal strip, towards the east.

All the mallee on the southern Nullarbor Plain is in areas wetter than 8 inches (20 cm) mean annual rainfall. Mallee eucalypts occur all the way between the large mallee areas in Western Australia and Eyre Peninsula except for a complete break of 16 miles (26 km) west of the Head of the Bight, the driest part of the southern Australian coastline, where mean annual rainfall is probably slightly greater than 8·3 in (210 mm), the rainfall at Nullarbor.

Mallee is usually predominant in areas wetter than about 10 in (250 mm) mean annual rainfall. The absence of mallee from large areas in the east of Roe Plain, while it occurs to the north in presumably drier areas along the Hampton Range is difficult to explain. Much more rainfall and soil data are obviously necessary.

In the wetter south-west of the Roe Plain, mallee is widespread on the shallow loamy soils on Tertiary limestone and on dunes of all ages. In drier parts of the Plain, especially in the east, it tends to be more common on sandy dune soils because these are likely to supply more water to plants in this area than the loamy ones (Rowan and Downes 1963).

In general, mallee occupies the wettest parts of the Nullarbor and Roe Plains; in drier areas it is replaced by a variety of vegetations, including *Acacia sowdenii* woodlands and shrub steppe (Willis 1951, 1959).

## STRUCTURAL TYPES DOMINATED BY MALLEE EUCALYPTS

### (a) *Heath*

Although Fig. 4 shows "mallee predominant" at the coast, both here and at the coast south of Caiguna, there is a zone of heath (Wood and Williams 1960) for about 500 feet (160 m) behind the sea cliffs from which eucalypts are absent. Landward from this is a zone of heath from ¼–1 mile (800–1600 m) wide containing mallee eucalypts up to 5 feet (1·5 m) high. *Melaleuca lanceolata* is common and often dominant in this heath, for which floristic lists are given in Appendix 1 (Site 1, 2 and 13). Asymetric growth forms and leaf tip necrosis suggest that wind-borne salt spray is important in maintaining the low stature of this vegetation (Parsons and Gill 1968) and high evapotranspiration caused by wind exposure is probably also effective. Landward from the heath, taller mallee eucalypts become dominant (see also Tate 1879).

### (b) *Semi-Arid Mallee*

This sub-form of Wood and Williams (1960) is widespread on the loamy soils of the Nullarbor and the Roe Plain. In fact, except for the coastal heaths, this was the only mallee vegetation found in such soils to about as far west as Cocklebiddy. Height of the eucalypts ranges from 5 feet (1·5 m) where the sub-form grades into heath, to about 30 feet (9 m). *Melaleuca quadrifaria* is a frequent co-dominant with the eucalypts to at least as far east as a point 16 miles (26 km) east of the South Australian border (Plate 1 (a)). *M. lanceolata* is a common large shrub and *Cratystylis conocephala* the most widespread small shrub, usually occurring with a large number of chenopods (Appendix 1, Sites 3 and 4). This type of semi-arid mallee is also found on old dunes (Site 5). Another type found on dunes on the Roe Plain has a denser eucalypt stratum and a sparse understorey dominated by *Rhagodia preissii* (Sites 7 and 12). A third type seen is found on the scarp of the Hampton Range (Site 6).

Lastly, a distinctive type with an understorey dominated by *Triodia* cf. *scariosa* is found both on sandy dune soils (Site 9) and in small patches on loamy soils on the Nullarbor Plain south of Cocklebiddy and Caiguna.

(c) *Sclerophyll mallee*

This sub-form of Wood and Williams (1960) was found on dunes on the western Roe Plain as far east as site 8 south of Madura. The dunes carry mallee eucalypts and scattered trees of *Callitris verrucosa* up to 15 feet (4·5 m) high with a dense understorey (Plate 1 (b)) containing sclerophyllous shrubs like *Hakea nitida* and *Beaufortia empetrifolia* (Appendix 1, Sites 8 and 11). This type was found only on dune soils of siliceous sand over limestone (Table 1).

On the Nullarbor limestone from 6 miles (10 km) south of Caiguna, to the coastal heath, sclerophyll mallee with a dense understorey dominated by *Casuarina helmsii* occurs (Site 14, Plate 1 (c)). It also appears on such soils from 6–11 miles (10–18 km) south of Cocklebiddy. Thus this type occurs on the wettest areas of Nullarbor limestone examined. In drier areas it grades into semi-arid mallee with *Cratystylis conocephala* as the dominant shrub.

## DISTRIBUTION OF *EUCALYPTUS* SPECIES

(a) *Eucalyptus socialis*

This is the species whose southern Nullarbor and Roe Plains representatives were known as *E. transcontinentalis* or *E. oleosa* var. *glauca* before the work of Brooker (1968). It has the driest lower rainfall limit of the eucalypts in the area, as it extends farthest to the north and west in that part of the Nullarbor Plain studied (Fig. 5). In all such marginal areas examined, a band of *E. socialis* was the northern or westernmost mallee found. Thus a more or less continuous zone, where *E. socialis* is the only eucalypt, may enclose the wetter mallee areas, where *E. socialis* and other eucalypts occur. The only known break in its east-west distribution is one of 16 miles (26 km) just west of the Head of the Bight (Table 2).

(b) *E. oleosa*

This taxon was generally known as both *E. oleosa* and *E. oleosa* var. *angustifolia* before the work of Brooker (1968). It occurs on the Nullarbor and Roe Plains to at least as far east as Koonalda (Fig. 5). It is rare south of Koonalda, and may not occur much further east, giving a maximum possible break in distribution of about 52 miles (82 km) before it reappears on sandy soils near the Head of the Bight (Table 2). No other definite east-west breaks are yet known in the area.

TABLE 2

Edaphic range and degree of discontinuity for a number of trees species. 'Discontinuity' indicates maximum possible size of main gap in east-west distribution in the Nullarbor Plain area.

| Species | Soil | | | Discontinuity miles (km) |
|---|---|---|---|---|
| | Loams on limestone | Deep calcareous sand | Siliceous sand* | |
| *Eucalyptus socialis* | X | X | | 16 (25) |
| *E. oleosa* | X | X | X | 52 (82) |
| *E. gracilis* | X | X | X | 64 (102) |
| *E. dumosa* complex | X | X | X | 163 (245) |
| *E. incrassata* | | | X | 268 (429) |
| *E. foecunda* | X | | X | 372 (595) |
| *E. diversifolia* | X | | X | 312 (499) |
| *E. cooperana* | | | X | Not applicable |

* Includes siliceous sand over limestone.

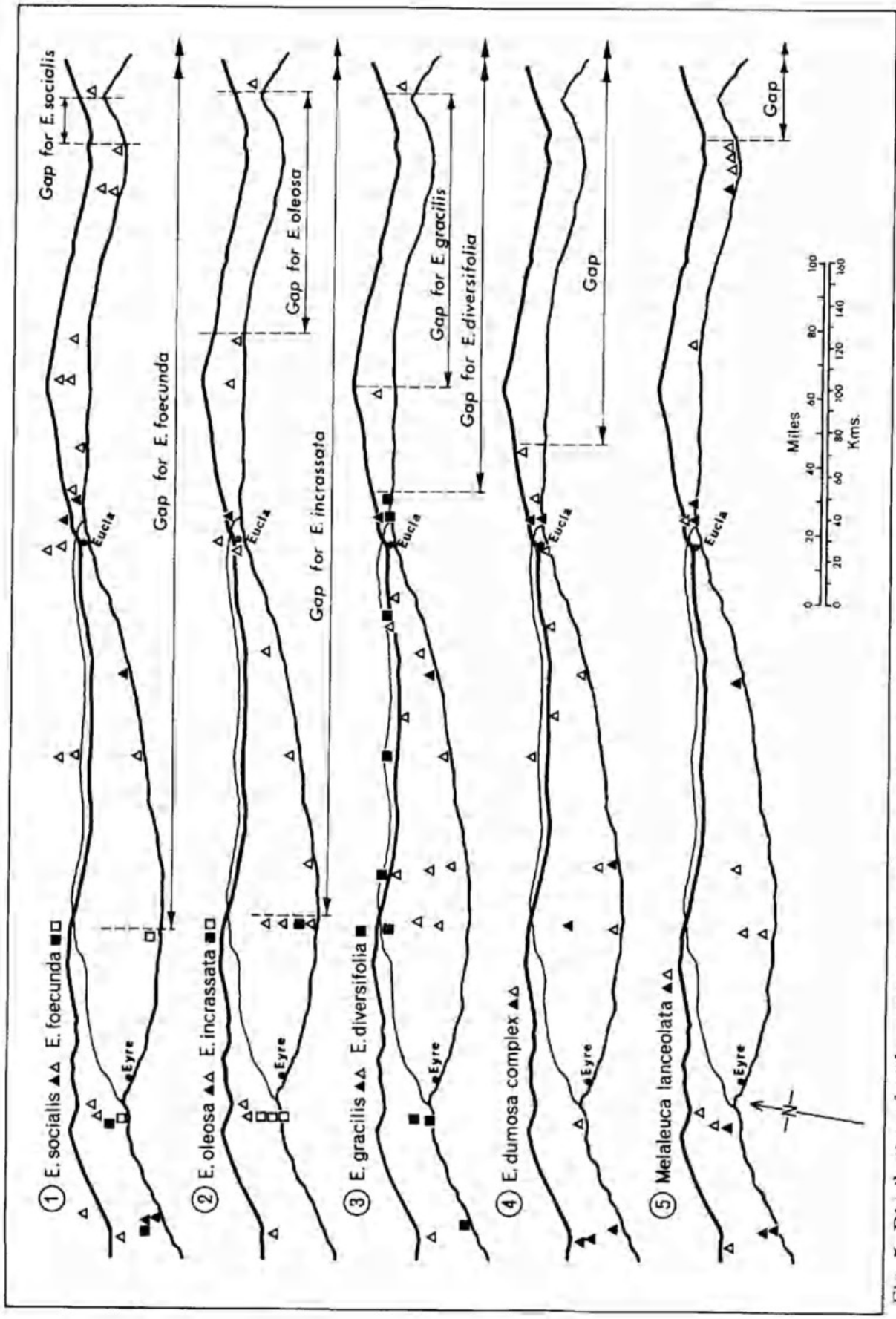


Fig. 5. Distribution of eight species in the study area, showing known gaps in east-west spread. Closed symbols for herbarium records, open symbols for field identifications. Coarse line shows Eyre Highway.

The extension of *E. socialis* into areas drier than those supporting *E. oleosa* in the present study seems to occur elsewhere too. Thus in New South Wales *E. socialis* extends much further north of the 10 in. (25 cm) mean annual rainfall isohyet than *E. oleosa* (pers. comm., M. I. H. Brooker, Western Australian Herbarium, Perth), and in South Australia at Chowilla Station (mean annual rainfall 8·5 in (22 cm)), *E. socialis* is found (Kuchel 1967) noted as *E. transcontinentalis*) while *E. oleosa* does not occur before wetter areas are reached.

(c) *E. gracilis*

Although this species was not found on the Nullarbor Plain in areas drier than about 9 in. (23 cm) mean annual rainfall, it is recorded from sandy areas north of the Plain around the 7 in. (18 cm) isohyet (Ford and Sedgwick 1967).

(d) *E. dumosa* complex

This group is in need of taxonomic revision (Burbidge 1947) so no attempt was made to identify the complex to species level in the field. Herbarium specimens taken were identified as *E. brachycalyx*, *E. conglobata* and *E. rugosa* (see Appendix 1 for distribution). This complex has not been found on the Nullarbor more than 28 miles (45 km) east of Eucla, nor during a very brief inspection of the sandy country at the Head of the Bight. The nearest eastern record seems to be an *E. dumosa* complex specimen (FRI 17848) from 15 miles (24 km) west of Nundroo.

The wetter lower rainfall limit of the *E. dumosa* complex than *E. socialis*, *E. oleosa* and *E. gracilis* found in this study has also been noticed elsewhere (Jessup 1948).

(e) *E. incrassata*

This name is used to include the varieties *costata* and *angulosa*. It was not found anywhere east of Madura, and the nearest eastern record is that of Cleland (1966), 30 miles (48 km) east of White Well. The record of *E. incrassata* near Eucla cited by Willis (1951, 1959) and McEvey and Middleton (1968) is now known to be an error; the specimen is *E. dumosa complex* (pers. comm., G. Chippendale, Forest Research Institute, Canberra). The occurrence of *E. incrassata* only on sand topsoils (Table 2), in dry areas around its lower rainfall limit has been noted in other areas (Parsons and Rowan 1968). Its general distribution has been discussed elsewhere (Parsons 1969).

(f) *E. foecunda*

Like *E. incrassata* it was not found east of Madura; in this case the nearest record to the east appears to be near Koonibba (Cleland 1966 as *E. leptophylla*) giving a gap of 372 miles (595 km). It has been recorded on finer-textured soils than *E. incrassata* both in this study (Table 2) and elsewhere (Parsons and Rowan 1968). This suggests a definite difference between the two species in edaphic range, despite their frequent occurrence together in many areas (Litchfield, 1956).

(g) *E. diversifolia*

This species is dealt with by Parsons (1969), and will not be discussed further here.

(h) *E. cooperana*

This Western Australian species was only found throughout the area of siliceous sand over aeolian calcarenite north of Twilight Cove (Plate 1 (d)).

This is the eastern-most locality from which the species has been recorded (Gardner 1961).

(i) *E. micranthera*

This Western Australian species appears to be the only other eucalypt recorded from the area (from near Eyre by Gardner 1960); it was not found during the present study.

## DISTRIBUTION OF *MELALEUCA LANCEOLATA*

The distribution of *M. lanceolata* was carefully noted to supplement the valuable introductory accounts of its distribution given by Willis (1948) (as *M. pubescens*), and Blake (1968). Intensive work has reduced the 170 mile (272 km) distribution gap east of Eucla recorded by Willis (1948) to 70 miles (112 km) (Fig. 5). Along the Nullarbor coast *M. lanceolata* is found in the driest areas in which mallee eucalypts occur and this is also true at Koonamore Station (Carrodus, Specht and Jackman 1965); elsewhere it seems to be absent from the driest mallee areas (Jessup (1948) as *M. pubescens*).

## DISCUSSION

The eucalypts show two main types of distribution. *E. socialis*, *E. oleosa*, *E. gracilis* and the *E. dumosa* complex are frequent and widespread through most of the mallee area, while *E. incrassata*, *E. foecunda* and *E. cooperana* are found only where mean annual rainfall exceeds about 11 inches (28 cm).

Eucalypt distribution on the siliceous sands shows some interesting features. The driest area of siliceous sands examined carried *E. oleosa*, *E. gracilis* and the *E. dumosa* complex (Site 9). In wetter areas, such soils carried *E. incrassata*, *E. foecunda* and *E. cooperana* (Sites 8 and 11). *E. incrasata* and *E. cooperana* were only recorded on siliceous sands, which may be because sands are likely to be better water suppliers to plants in this climate than the much more widespread loams.

However, the role of soil chemical factors also needs to be considered. Are any other species found only on siliceous sands and not on the more alkaline loams? The sclerophyllous flora of the siliceous sand area is much richer in species than the surrounding flora on loam soils, and 27 plant species were found only on siliceous sand and not on the wetter loam country south of Caiguna (Appendix 1). Many of these 27 species seem to occur principally on siliceous sand plain areas west of the Nullarbor (Beard, no date). It is possible that many of these species are unable to tolerate soils as alkaline as the loams on limestone. If so, then much of the flora of the siliceous sand areas of the western Roe Plain is completely isolated from similar areas by edaphic barriers:—the large expanses of loams on limestone of the Nullarbor and Roe Plains.

South west of Twilight Cove, the Nullarbor limestone continues for about 65 miles (104 km) before sand dunes are reached near Pt. Culver. Some of these dunes are known to be siliceous (Fig. 2) but the sands near Pt. Culver are poorly known botanically.

The simplest hypothesis to account for the apparently isolated species occurrences on siliceous sand in the western Roe Plain is to postulate a continuous strip of siliceous sand topsoils linking the Roe Plain with siliceous sand areas further west during Quaternery low sea levels. This could provide continuous species distributions which were subsequently fragmented by rising sea levels (Parsons 1969).

This hypothesis could account for the occurrence of many of the species confined to siliceous sand in the western Roe Plain. One notable exception is

*Spyridium spathulatum*, known elsewhere in Western Australia only from the Rawlinson Range.

Of the two eucalypts which were only recorded from siliceous sand, *E. incrassata* is known from shallow loamy soils on limestone in wetter areas elsewhere (Litchfield 1956), while *E. cooperana* appears only to have been recorded from sandy non-calcareous topsoils, both in the Roe Plain and elsewhere.

Discontinuities in the east-west spread of all the eucalypts were noted. As all except *E. cooperana* have been recorded on shallow loams on limestone (Table 2; Litchfield 1956), there are probably no edaphic barriers to the spread of these other species in the area. The known gaps in distribution (Table 2) coincide with the driest parts of the coastline. A habitat suitable for continuous east-west distribution of these species could thus be provided by an increase in effective rainfall. Alternatively, lower sea levels in the Last Glacial would produce a coastal lowland south of the present coast and in a wetter latitude (Parsons 1969), which may have provided a suitable habitat.

Although attention has been focused here on major gaps in the east-west spread of the species, there are a number of interesting disjunct occurrences to the north of the study area; *E. foecunda* at Ooldea and Tarcoola (Burbidge (1947) as *E. leptophylla*), *E. dumosa* complex at Maralinga and *Melaleuca lanceolata* at Ooldea (Willis 1948). The significance of these must await further study.

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## REFERENCES

Australia; Bureau of Meteorology, 1956. "Climatic Averages Australia" (Bureau of Meteorology: Melbourne).

Beard, J. S. (ed.), no date. "Descriptive Catalogue of West Australian Plants (Soc. for growing Aust. Plants: Sydney).

Blake, S. T. (1968). A revision of *Melaleuca leucadendron* and its allies. Contrib. Qld. Herb. No. 1.

Brooker, M. I. H., 1968. Phyllotaxis in *Eucalyptus socialis* F. Muell. and *E. oleosa* F. Muell. Aust. J. Bot., **16**: pp. 455-468.

Brown, T., 1919. Nullarbor Plain. Proc. S. Aust. Brch. R. Geogr. Soc. Aust., **19**: pp. 141-152.

Burbidge, N. T., 1947. Key to the South Australian species of *Eucalyptus*. Trans. R. Soc. Aust., **71**: pp. 137-163.

Carrodus, B. B., Specht, R. L., and Jackman, M. L., 1965. The vegetation of Koonamore Station, South Australia. Trans. R. Soc. S.A., **89**: pp. 41-57.

Cleland, J. B., 1966. West coast plants. S. Aust. Nat., **40**: pp. 53-65.

Dunkley, J. R. (1967). The geographical and historical background. *In* Dunkley, J. R., and Wigley, T. M. L. (eds.). "Caves of the Nullarbor" (Speleological Research Council: University of Sydney).

Eichler, H. (1965). "Supplement to J. M. Black's Flora of South Australia" (Govt. Printer, Adelaide).

Ford, J., and Sedgwick, E. H., 1967. Bird distribution in the Nullarbor Plain and Great Victoria Desert region, Western Australia. Emu, **76**: pp. 99-124.

Gardner, C. A. (1960). Trees of Western Australia no. 63-70. W. Aust. Dept. Agric. Bull. No. 2755.

Gardner, C. A. (1961). Trees of Western Australia no. 83-86. W. Aust. Dept. Agric. Bull. No. 2846.

HALL, E. A. A., SPECHT, R. L., and EARDLY, C. E., 1964. Regeneration of the vegetation on Koonamore vegetation reserve, 1926-1962. Aust. J. Bot., **12**: pp. 205-264.
JENNINGS, J. N., 1963. Some geomorphological problems of the Nullarbor Plain. Trans. R. Soc. S. Aust., **87**: pp. 41-62.
JENNINGS, J. N. (1967). The surface and underground geomorphology. *In* Dunkley, J. R., and Wigley, T. M. L. (eds.) "Caves of the Nullarbor". (Speleological Research Council: University of Sydney.)
JESSUP, R. W., 1948. A vegetation and pasture survey of counties Eyre, Burra and Kimberley, South Australia. Trans. R. Soc. S. Aust., **72**: pp. 33-68.
KUCHEL, R. (1967). Vegetation of the Chowilla area. Univ. Adelaide Dept. Adult Education Publ. No. 6: pp. 32-40.
LEEPER, G. W. (1960). Climates. *In* "The Australian Environment". 3rd ed. (C.S.I.R.O. Aust.: Melbourne.)
LITCHFIELD, W. H., 1956. Species distribution over part of the Coonalpyn Downs, South Australia. J. Bot., **4**: pp. 68-116.
MCEVEY, A. R., and MIDDLETON, W. G., 1968. Birds and vegetation between Perth and Adelaide. Emu, **68**: pp. 161-212.
MORRISON, P. C., 1948. We went west: Eucla to Cocklebiddy. Wild Life, **10**: pp. 119-124.
NORTHCOTE, K. H., BETTENAY, E., CHURCHWARD, H. M., and MCARTHUR, W. M. (1967). "Atlas of Australian Soils. Sheet 5". (C.S.I.R.O. Aust.: Melbourne.)
NORTHCOTE, K. H., ISBELL, R. F., WEBB, A. A., MURTHA, G. G., CHURCHWARD, H. M., and Bettenay, E. (1968). "Atlas of Australian Soils. Sheet 10" (C.S.I.R.O. Aust.: Melbourne.)
PARSONS, R. F., 1969. Distribution and palaeogeography of two mallee species of *Eucalyptus* in southern Australia. Aust. J. Bot., **17**: pp. 323-330.
PARSONS, R. F., and GILL, A. M., 1967. The effects of salt spray on coastal vegetation at Wilson's Promontory, Victoria, Australia. Proc. R. Soc. Vic., **81**: pp. 1-10.
ROWAN, J. N., and DOWNES, R. G. (1963). A study of the land in north-western Victoria. Soil Conservation Authority Vic. Tech. Comm. 2.
TATE, R., 1879. The natural history of the country around the Head of the Great Australian Bight. Trans. Phil. Soc. Adelaide for 1879: pp. 94-128.
WILLIS, J. H., 1948. On the nature and distribution of "moonah" (*Melaleuca pubescens* Schauer). Vict. Nat., **65**: pp. 76-84.
WILLIS, J. H., 1951. Botany of the Russell Grimwade expedition. Mem. Nat. Mus. Vic., **17**: pp. 33-64.
WILLIS, J. H., 1959. Notes on the vegetation of Eucla district, W.A. Muelleria, **1**: pp. 92-96.
WILLIS, J. H., 1965. F.N.C.V. excursion to Western Australia, August 31—September 22, 1963. Vict. Nat., **81**: pp. 330-337.
WOOD, J. G., and WILLIAMS, R. J. (1960). Vegetation. In "The Australian Environment" 3rd ed. (C.S.I.R.O. Aust.: Melbourne.)

## APPENDIX 1

Occurrence of plant species in 14 mallee communities.

For location of sites see Fig. 2. For structural type of each community see text. Column 14A lists herbarium specimens collected and identified by Mr. P. G. Wilson between Caiguna and the coast south of it. All these are held at the Western Australian Herbarium.

h = herbarium specimen
f = field identification; no specimen taken
n = herbarium specimen from within 25 km of site indicated
w = recorded by Willis (1951, 1965)
x = not recorded from South Australia (by Eichler 1965)
\+ = recorded only on siliceous sand topsoils in this study

Taxonomic nomenclature follows Beard (no date) for plants restricted to Western Australia and Eichler (1965) for all others, except where mentioned in the text.

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 14A |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ASPLENIACEAE | | | | | | | | | | | | | | | |
| *Pleurosorus rutifolius* (R. Br.) Fée | | | | | | | | | | w | | | | | |
| CUPRESSACEAE | | | | | | | | | | | | | | | |
| *Callitris verrucosa* (A. Cunn. ex Endl.) F v M.* | | | | | | | | f | h | | f | | | | |

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 14A |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **POACEAE** | | | | | | | | | | | | | | | |
| *Agrostis* sp. | | | | | | h | | | | | | | | | |
| *Amphipogon* cf. *turbinatus* R.Br.[x+] | | | | | | | | | | | h | | | | |
| *Danthonia caespitosa* Gaudich. | | | | | | | | | | | | | | h | |
| *Stipa acrociliata* Reader | h | | h | | | | | | | | | | | | |
| *S. drummondii* Steud. | | | | | h | | | | | | | | | | |
| *S. eremophila* Reader | | | | | | h | | | | | | | | | |
| *S. hemipogon* Benth. | | | | | | | h | | | | | | | | |
| *S. scabra* Lindl. | | | h | h | | | | | | | | | | | |
| *S. verticellata* Nees ex Spreng. | | | | | | | | | | w | | | | | |
| *Triodia scariosa* cf. Burbidge | | | | | | | | | h | | | | | | |
| **CYPERACEAE** | | | | | | | | | | | | | | | |
| *Gahnia lanigera* (R.Br.) Benth. | | | | | | | | | | | h | | | h | |
| *Lepidosperma drummondii* Benth.[x] | | | | | | | | h | h | | h | | f | | |
| *Schoenus armeria* Boeckel.[x+] | | | | | | | | | | | h | | | | |
| *S. lanatus* Labill.[x+] | | | | | | | h | | | | | | | | |
| *S. nitens* (R.Br.) Poir.[+] | | | | | | | | | | | h | | | | |
| *Schoenus pleiostemoneus* F v M.[x+] | | | | | | | | | | | h | | | | |
| **RESTIONACEAE** | | | | | | | | | | | | | | | |
| *Loxocarya flexuosa* (R.Br.) Benth.[x+] | | | | | | | | | | | h | | | | |
| **LILIACEAE** | | | | | | | | | | | | | | | |
| *Bulbinopsis semibarbata* (R.Br.) Borzi | h | | | | | | | | | | | | | | |
| *Dianella revoluta* R.Br. | | | | | | f | h | | f | | | | | | h |
| *Lomandra glauca* (R.Br.) Ewart | | | | | | | | h | | | h | | | | |
| *Tricoryne elatior* R.Br.[+] | | | | | | | | | | | | | | | |
| **CASUARINACEAE** | | | | | | | | | | | | | | | |
| *Casuarina helmsii* Ewart & Gordon | | | | | | | | | | | f | | | h | |
| *C. huegeliana* Miq.[x] | | | | | | | | | | | | | | n | |
| **PROTEACEAE** | | | | | | | | | | | | | | | |
| *Adenanthos sericea* Labill. var. *brevifolia* Benth.[+] | | | | | | | | | | | n | | | | |
| *Grevillea* cf. *pinaster* Meissn.[x+] | | | | | | | | | | | h | | | | |
| *G. sparsiflora* F v M.[x] | | | | | | | | | | | | | | | h |
| *Hakea nitida* R.Br.[x+] | | | | | | | | h | | | f | | | | |
| **SANTALACEAE** | | | | | | | | | | | | | | | |
| *Exocarpos aphyllus* R.Br. | | h | f | | | | h | | | | | | | | h |
| *E. sparteus* R.Br. | | | | | | | | | | | | | | n | |
| *Santalum acuminatum* (R.Br.) A.DC. | | | | | h | | | | | | | | | | |
| **LORANTHACEAE** | | | | | | | | | | | | | | | |
| *Amyema miquelii* (Lehm. ex Miq.) Tiegh. | | | | | | | | | | h | | | | | |
| **CHENOPODIACEAE** | | | | | | | | | | | | | | | |
| *Arthrocnemum halocnemoides* Nees | | | | h | h | | | | | | | | | | |
| *Atriplex acutibracta* Anderson | | | h | | | | | | | | | | | | |
| *A. hastata* L. var. *salina* Wallr. | | | | | | | h | | | | | | | | |
| *A. hymenotheca* Moq.[x] | | | | | h | | | | | | | | | | |
| *Bassia patenticuspis* Anderson | | | h | | h | f | | | | | | | | | |
| *B. uniflora* (R.Br.) F v M. | h | | h | | | | | | | | | | | | |
| *Enchylaena tomentosa* R.Br. | h | h | | | | h | | | | | | | | | |
| *Kochia eriocłada* (Benth.) Gauba | h | | h | | h | h | | | | | | | | | |
| *K. excavata* var. *trichoptera* Black | | | | | | | | | | | | | | | h |
| *K. planifolia* F v M. | | h | | | | | | | | | | | | | |
| *K. sedifolia* F v M. | h | | | | | | | | | | | | | | |
| *K. villosa* Lindl. | h | | | | | | | | | | | | | | |
| *Rhagodia crassifolia* R.Br. | | | | | | h | | | | | | | | | h |
| *R. preissii* Moq. | | | | | | | h | | h | w | h | | | | |
| *Threlkeldia diffusa* R.Br. | | h | h | | h | h | | | | | | | | | h |
| **AMARANTHACEAE** | | | | | | | | | | | | | | | |
| *Ptilotus obovatus* (Gaudich.) F v M. | | | | | | h | | | | | | | | | |

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 14A |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **AIZOACEAE** | | | | | | | | | | | | | | | |
| *Carpobrotus* sp. | | | | | | | f | | | | | | | | |
| *Disphyma australe* (Ait.) N. E. Brown | f | | | | | | | | | | | | | | |
| **LAURACEAE** | | | | | | | | | | | | | | | |
| *Cassytha melantha* R.Br. | | | | | | | | | | | | | | h | |
| **BRASSICACEAE** | | | | | | | | | | | | | | | |
| *Stenopetalum robustum Endl.*[x] | | | | | | | | | | w | | | | | |
| **PITTOSPORACEAE** | | | | | | | | | | | | | | | |
| *Billardiera* sp.[+] | | | | | | | | | h | | | | | | |
| *Pittosporum phylliraeoides* DC. | | | | | | h | | | | w | | | | | |
| **MIMOSACEAE** | | | | | | | | | | | | | | | |
| *Acacia cochlearis* Wendl.[x+] | | | | | | | | h | | | | h | | | |
| *A. erinacea* Benth. | | | | | | | | | | | | | | | h |
| *A.* cf. *nitidula* Benth.[x+] | | | | | | | | | | | h | | | | |
| **CAESALPINIACEAE** | | | | | | | | | | | | | | | |
| *Cassia nemophila* Cunn. ex Vogel | | | | | | | | | | | | | | n | |
| **FABACEAE** | | | | | | | | | | | | | | | |
| *Bossiaea leptacantha* E. Pritzel[x+] | | | | | | | | h | | | | | | | |
| *Daviesia preissii* Meissn.[x+] | | | | | | | | | | | n | | | | |
| *Pultenaea obcordata* (R.Br. ex Ait.) Benth.[x+] | | | | | | | | | | | h | | | | |
| *Templetonia retusa* (Vent.) | | | | | | h | | | | | | | | | h |
| **ZYGOPHYLLACEAE** | | | | | | | | | | | | | | | |
| *Nitraria schoberi* L. | | | | | f | | | | | | | | | | |
| *Zygophyllum billardieri* DC. | | | h | | | | | | | | | | | | |
| *Z. glaucum* F v M. | | | h | f | | | | | | | | | | | h |
| **RUTACEAE** | | | | | | | | | | | | | | | |
| *Correa reflexa* var. *coriacea* P. G. Wilson | | | | | | | | | | | | | | | h |
| *Geijera linearifolia* (DC.) Black | | h | h | | h | h | | | | | | | | | |
| *Microcybe multiflora* Turcz. | | | | | | | | | | | | | | | h |
| *M. pauciflora* Turcz. | | | | | | | | | | | | | | | h |
| **POLYGALACEAE** | | | | | | | | | | | | | | | |
| *Comesperma polygaloides* F v M. | | | | | | | | | | | | | | h | |
| *C. volubile* Labill. | | | | | | | | | | w | | | | | h |
| **EUPHORBIACEAE** | | | | | | | | | | | | | | | |
| *Beyeria leschenaultii* (DC.) Baill. var. *ledifolia* (Klotzsch) Gruning | | | | | | | | | | | | | h | | |
| **SAPINDACEAE** | | | | | | | | | | | | | | | |
| *Dodonaea stenozyga* F v M. | | | | h | | | | | | | | | | | |
| *Heterodendrum oleaefolium* Desf. | | | | | | | | | | w | | | h | | |
| **RHAMNACEAE** | | | | | | | | | | | | | | | |
| *Pomaderris forrestiana* F v M. | | | | | | | | | | w | | | | | |
| *Spyridium parvifolium* (Hook.) Benth. ex F v M. | h | | | | | | | | | | | | | | |
| *S. spadiceum* var. *calvescens* (Reissek) Benth.[x] | | | | | | | | | | | h | | h | | |
| *S. spathulatum* (F v M.) F v M. ex Benth.[+] | | | | | | | | h | | | | | | | |
| *S. tridentatum* (Steud.) Benth.[+] | | | | | | | | | | | n | | | | |
| *Trymalium myrtillus* S. Moore[x] | | | | | | | | | | | | | | | h |
| **DILLENIACEAE** | | | | | | | | | | | | | | | |
| *Hibbertia nutans* Benth.[x] | | | | | | | | | | | h | | h | | |
| *H. uncinata* (Benth.) F v M.[x] | | | | | | | | | | | | | | | h |

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 14 A |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FRANKENIACEAE | | | | | | | | | | | | | | | |
| *Frankenia sessilis* Summerh. | | | | | h | | | | | | | | | | |
| THYMELAEACEAE | | | | | | | | | | | | | | | |
| *Pimelea serpyllifolia* R.Br. | | | | h | | | | | | | | | | | h |
| MYRTACEAE | | | | | | | | | | | | | | | |
| *Beaufortia empetrifolia* (Reichb.) Schau.[x] | | | | | | | | h | | | h | | | | |
| *Calytrix tetragona* Labill. | | | | | | | | | | | h | | | | h |
| *Eucalyptus brachycalyx* Blakely | | | | | | | | | | h | | | | | |
| *E. conglobata* (R.Br. ex Benth.) Maiden | | | | h | | | | | | | | | | n | |
| *E. cooperana* F v M.[x+] | | | | | | | | | | | h | | | | |
| *E. diversifolia* Bonpl. | | | | | | h | | | | h | h | h | | | |
| *E. foecunda* Schau. | | | | | | | | h | | | h | | | h | |
| *E. gracilis* F v M. | | | | h | h | | f | | f | | | | | | |
| *E. incrassata* Labill.[+] | | | | | | | | f | | | f | | | | |
| *E. oleosa* F v M. ex Miq. | h | h | h | h | h | | f | | f | w | | | h | | |
| *E. rugosa* R.Br. ex Blakely | | h | | | | | | | | | | | | h | |
| *E. socialis* F v M. ex Miq. | | | n | | | | | | | | | | | h | |
| *Melaleuca conferta* Benth. | | | | | | | | | | | h | | h | h | |
| *M. lanceolata* Otto | h | h | f | | h | | | | | w | n | h | h | h | |
| *M. quadrifaria* F v M. | | h | f | f | h | | | | | w | | | | | |
| EPACRIDACEAE | | | | | | | | | | | | | | | |
| cf. *Acrotriche cordata* (Labill.) R.Br.[+] | | | | | | | | h | | | | | | | |
| *A. patula* R.Br. | | | | | | | | | | w | | | | | |
| *Conostephium* sp.[−] | | | | | | | | | | | h | | | | |
| *Leucopogon* aff. *squarrosus* Benth.[x+] | | | | | | | | | | | h | | | | |
| *Lysinema ciliatum* R.Br.[x+] | | | | | | | | | | | h | | | | |
| *Styphelia hainesii* F v M.[x] | | | | | | | | | | | | | | | h |
| LOGANIACEAE | | | | | | | | | | | | | | | |
| *Logania stenophylla* F v M. | | | | | | | | | | | | | | | h |
| BORAGINACEAE | | | | | | | | | | | | | | | |
| *Halgania* nr. *lavandulacea* Endl. | | | | | | | | | | | | | | | h |
| LABIATAE | | | | | | | | | | | | | | | |
| *Prostanthera microphylla* A.Cunn. ex Benth. | | | | | | h | | | | | | | | | |
| *Westringia dampieri* R.Br. | | | | | | | | | | | | | | | h |
| *W. rigida* R.Br. | | | | h | | | | | | | | | | | |
| MYOPORACEAE | | | | | | | | | | | | | | | |
| *Eremophila alternifolia* R.Br. var. *latifolia* F v M. ex Benth. | | | | | | h | | | | w | | | | | |
| *E. decipiens* Ostenf.[x] | | | | | h | | | | | | | | | | |
| *E. dempsteri* F v M.[x] | | | | | | | | | | | | | | n | |
| *E. weldii* F v M. | | h | h | h | h | | | | | | | | | | |
| *Myoporum* sp. | | | | | | h | | | | | | | | | |
| GOODENIACEAE | | | | | | | | | | | | | | | |
| *Goodenia* sp. | | | | | | | | | | | h | | | | |
| *G. affinis* De Vriese | | | | | | | | | | | | | | | h |
| *Lechenaultia* cf. *tubiflora* R.Br.[x+] | | | | | | | | | | | n | | | | |
| ASTERACEAE | | | | | | | | | | | | | | | |
| *Cratystylis conocephala* (F v M.) S. Moore | | | h | f | h | | | | | | | | | | |
| *Helipterum floribundum* DC. | | | | | | | | | | | n | | | h | |
| *Olearia exiguifolia* F v M. | | | | | | | | | | w | | | | | |
| *O. muelleri* (Sond.) Benth. | | | h | h | h | | | | | w | | | | | |
| *O. pimeleoides* (DC.) Benth. | | | | | | | | | | | | | | | h |
| *Podolepis rugata* Labill. | | | | | | | | | | | | | | | h |
| *Senecio* aff. *lautus* Forst. f. ex Willd. | | | | | | | | | | | | | | | h |

## EXPLANATION OF PLATE

### Plate 1

(a) Tall semi-arid mallee on the Roe Plain 14 miles (22 km) south of Moodini. *Eucalyptus gracilis* on right; *Melaleuca quadrifaria* on left and in background. Figure is six feet tall.
(b) Sclerophyll mallee about 12 feet (4 m) high at Site 11. *Eucalyptus diversifolia* on left; *Callitris verrucosa* on right.
(c) Sclerophyll mallee about 8 feet (2·7 m) high at Site 14. *Eucalyptus socialis* and *Casuarina helmsii* are clearly visible.
(d) A stand of *Eucalyptus cooperana* 1 mile (1·6 km) south of site 11, showing the characteristic, starkly white stems.