THE COMPOSITION AND DISTRIBUTION OF THE VEGETATION OF NORTH-WEST EYRE PENINSULA

by F. TIVER, A. D. SPARROW & R. T. LANGE*

Summary

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The vegetation of inland north-western Eyre Peninsula, South Australia, is sampled for phytosociological analysis by transect quadratting. Using a combination of numerical classification (Bray-Curtis dissimilarity with average-linkage clustering) and ordination (detrended correspondence analysis), seven main vegetation associations are identified: *Eucalyptus dumosa–Westringia rigida, Eucalyptus gracilis–Stipa, Eucalyptus gracilis–Eucalyptus oleosa, Eucalyptus oleosa–Melaleuca pauperiflora, Eucalpytus oleosa–Enchylaena tomentosa, Eucalyptus brachycalyx* and *Eucalyptus yumbarrana–Triodia irritans.* The last occurs on the siliceous Moornaba sands, and the other six on the calcareous Woorinen Formation. Environmental parameters correlate only weakly with a floristic gradation over the calcareous soils, suggesting that historical influences may be important in determining the distributions of the vegetation types.

KEY WORDS: Eyre Peninsula, vegetation survey, vegetation analysis, classification, ordination, plant associations.

Introduction

Until recently, the vegetation of north-western Eyre Peninsula remained relatively unknown. The first detailed study was that of Crocker (1946). Unfortunately the accompanying map only extends northwest as far as Poochera, where the vegetation is described as *Eucalyptus oleosa – E.gracilis – E.dumosa* edaphic complex. Specht (1972) also included only the southern-most portion of the area in his maps, describing the vegetation south of the Eyre Highway as *Eucalyptus socialis – E. gracilis* open scrub and that north of it as *Eucalyptus incrassata – Melaleuca uncinata* open scrub. Boomsma & Lewis (1980) described 16 communities, defined by the tall dominants, which occur on north-west Eyre Peninsula. Their distribution maps are not detailed enough to be able to extract the relative importance of any of these communities.

Descriptive surveys such as those mentioned above are not always capable of repetition by others (Nilsson 1986). For this reason, most modern surveys use quantitative data of the whole flora, and various forms of computer-assisted multivariate analysis, which result in a higher degree of objectivity and repeatability. A numerical classification of the vegetation of western Eyre Peninsula, one of the few such studies in South Australia, was undertaken by Margules & Nicholls (1987). Using complete species data from 104 plots each of 0.1 ha, cluster analysis was used to identify six vegetation communities on western Eyre Peninsula. This survey did not extend northwards onto the sand dune formations. Statistical models were constructed to relate the occurrence of the six communities to three environmental variables: depth of carbonate layer, distance from the coast and latitude. Although allowing prediction of likely vegetation types in other remnant patches, these factors do not adequately describe the environmental factors important in determining the vegetation pattern.

The aims of this study were to classify the vegetation of north-western Eyre Peninsula (Fig. 1) using repeatable, numerical methods, and to provide some explanation of the main factors controlling the vegetation pattern.

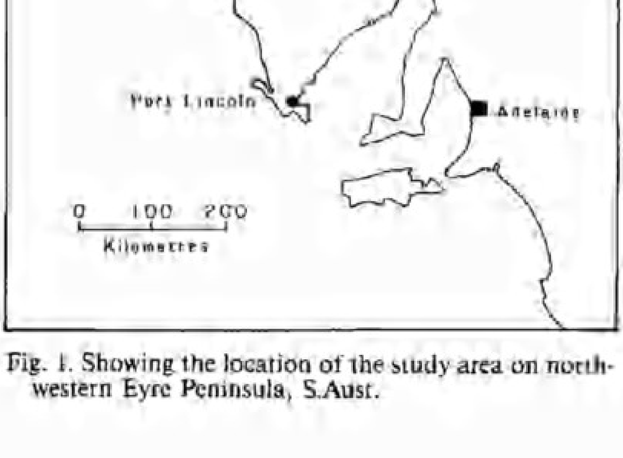

Fig. 1. Showing the location of the study area on north-western Eyre Peninsula, S.Aust.

* Dept of Botany, University of Adelaide, GPO Box 498, Adelaide, S. Aust. 5001

Geology, Landform and Soils of the Study Area

Most of the surface geological formations of western Eyre Peninsula (see Fig. 2) are derived from calcareous sands. It has been suggested that these sands were blown in from the exposed marine continental shelf during periods of low sea level and aridity, which occurred during the Pleistocene ice ages (Crocker 1946; Twidale & Campbell 1985). Another possibility is that the sands represent palaeo-dune systems that were formed by wave and wind action during periods of high relative sea level (Short *et al.* 1986).

The Bridgewater Limestone is composed of calcarenite, grains of calcareous sand cemented together with calcite crystals. In the maritime zone it is exposed as coastal cliffs but is otherwise covered by unconsolidated, deep, calcareous shelly sand of low water-holding capacity (Wright 1985). The Bakara Calcrete consists of calcarenite in which the shell fragments have been progressively dissolved and replaced by nodular and platy calcrete. To reduce the ecological complexity of the survey, these coastal limestone formations were excluded from the study.

The Woorinen Formation closely corresponds to the Chandada Plain landform in which the dunes have consolidated to form an undulating plain with no surface drainage (Twidale & Campbell 1985). Calcrete is usually present as a bed of nodules beneath the surface. The soils are calcareous throughout, and range in texture from sands to clay loams. They are usually shallow and reddish brown, but sandier grey varieties and redder varieties with higher clay content have been reported; they have been extensively cleared for agriculture (Wright 1985). Areas of the calcareous sands normally associated with the Bridgewater Limestone also occur on the Woorinen Formation. Near the coast these sands are coarse and shelly, but further inland they are firmer with less-apparent shell fragments. Wright (1985) reports deficiencies in a wide range of minerals in these sands.

The Molineaux or Moornaba Sand is of extremely recent origin (c. 10 000 years b.p. onwards) and composed of sand dunes aligned in a NW-SE direction. Bleached white siliceous sands with a yellowish B horizon occur on the dunes. The underlying soils of the inter-dune corridors contain calcareous earths typical of the Woorinen Formation.

Methods

Sampling Strategy

A system of transects was chosen as the best compromise between equal coverage of the region

Fig. 2 The study area, showing major surface geological formations (after Blisset 1969).

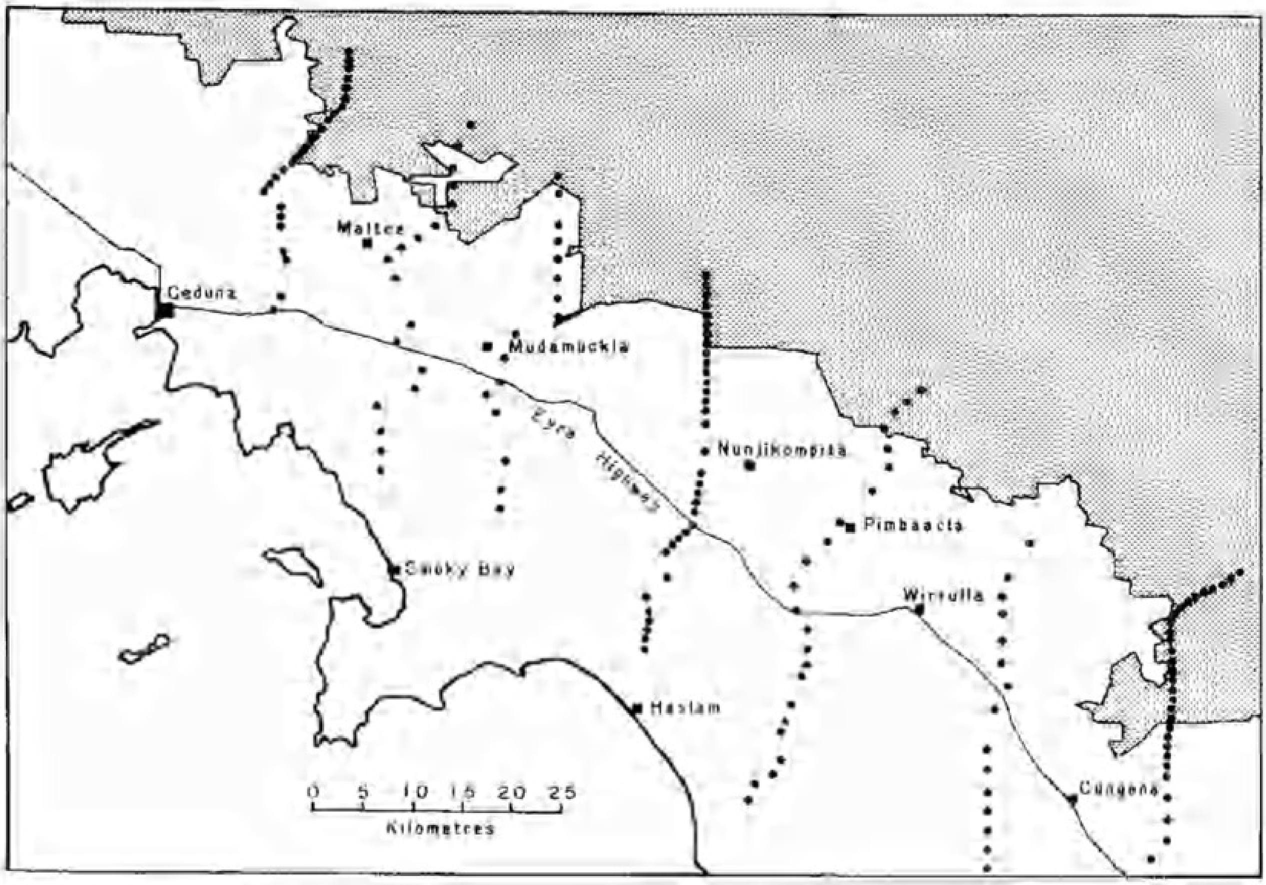

Fig. 3 The study area, showing location of sites along seven transects. Shading represents uncleared vegetation.

and efficiency of time spent on data collection. Transects were placed in suitable areas of native vegetation, running north and south from Ceduna, Maltee, Mudamuckla, Nunjikompita, Pimbaacla, Wirrulla and Cungena (Fig. 3). Transects were extended southwards only as far as the boundaries of the Bridgewater formation and its overlying coastal sands, and northwards as far as was accessible by four-wheel-drive vehicle. In the northern part of the study area, sites were placed 1 km apart, but in the southern part of the area, which is widely cleared for agriculture, native vegetation was often restricted to roadside remnants, and some sites had to be located as much as 2 km apart.

Field experience showed that quadrats of 0.1 ha as recommended by Whittaker (1978) and used by Margules & Nicholls (1987) were an appropriate size to achieve a good representation of species present without overlapping different vegetation types. One 50 x 20 m rectangular quadrat was measured at each site.

Vegetation Data

In each of the 162 sites sampled, all seed-plant species were recorded, although only native perennials were used for analysis. Annual species were excluded because their occurrence depends on recent seasonal events; their inclusion would therefore lower the repeatability of the results. Introduced species were also excluded, since they do not form part of the natural vegetation pattern.

Total cover was estimated for each species present, and expressed as a semi-quantitative score, an adaption of the cover scale as Braun-Blanquet (1932); see Table 1.

Environmental Data

Anticipating some influence on floristic composition by various disturbance factors, disturbance by erosion, grazing, animal tracks, undergrowth clearance and earthworks was visually assessed on a scale ranging from 0 (nil) to 4 (severe). Sixty-two sites rated 2 (mild) or greater were excluded from analyses for definition of vegetation types.

Landform was assessed in the field as dune-crest, dune-flank, rise or plain (including wide interdune corridors). A soil core was dug in the centre of each quadrat and the depth to limestone recorded, in intervals of 10 cm. Texture was determined using the field method described by Northcote (1971). Existing rainfall maps were not detailed enough for the purposes of this study, so a rainfall map was constructed, using complete Bureau of Meteorology rainfall records for 24 recording stations within or near the study area. This enabled the average rainfall at each site to be estimated and classed into 12 mm intervals.

Vegetation Analysis

The need to classify vegetation raises the question of whether vegetation types occur as discrete entities with distinct boundaries, or whether classifications are merely abstractions imposed by ecologists onto a continuously variable vegetation (Greig-Smith 1983). If vegetation consisted of random combinations of species a continuum would result and classification into discrete groups would be an entirely arbitrary process. If, on the other hand, variation was always discontinuous and no intergradation occurred, there would be a finite number of vegetation types in existence, and classification would be a simple matter. The actual case lies between these two extremes, ranging from the near discontinuous and distinct vegetation types to almost continuous ecotones (Webb 1954). Consequently, a combination of two complementary analysis techniques is recommended when investigating vegetation patterns; a classification to define vegetation types, and an ordination to examine the relationships between the groups and the extent of ecotonal behaviour between them (Gauch 1982).

For classification purposes, the dissimilarity between all pairs of sites was calculated with the Bray-Curtis distance coefficient, and then sites

TABLE 1. *Semi-quantitative scores expressing percentage cover (adapted from Braun-Blanquet 1932).*

Cover Score	Percentage Cover
0	absent
1	0 – 1
2	1 – 2
3	2 – 10
4	10 – 50
5	50 – 100

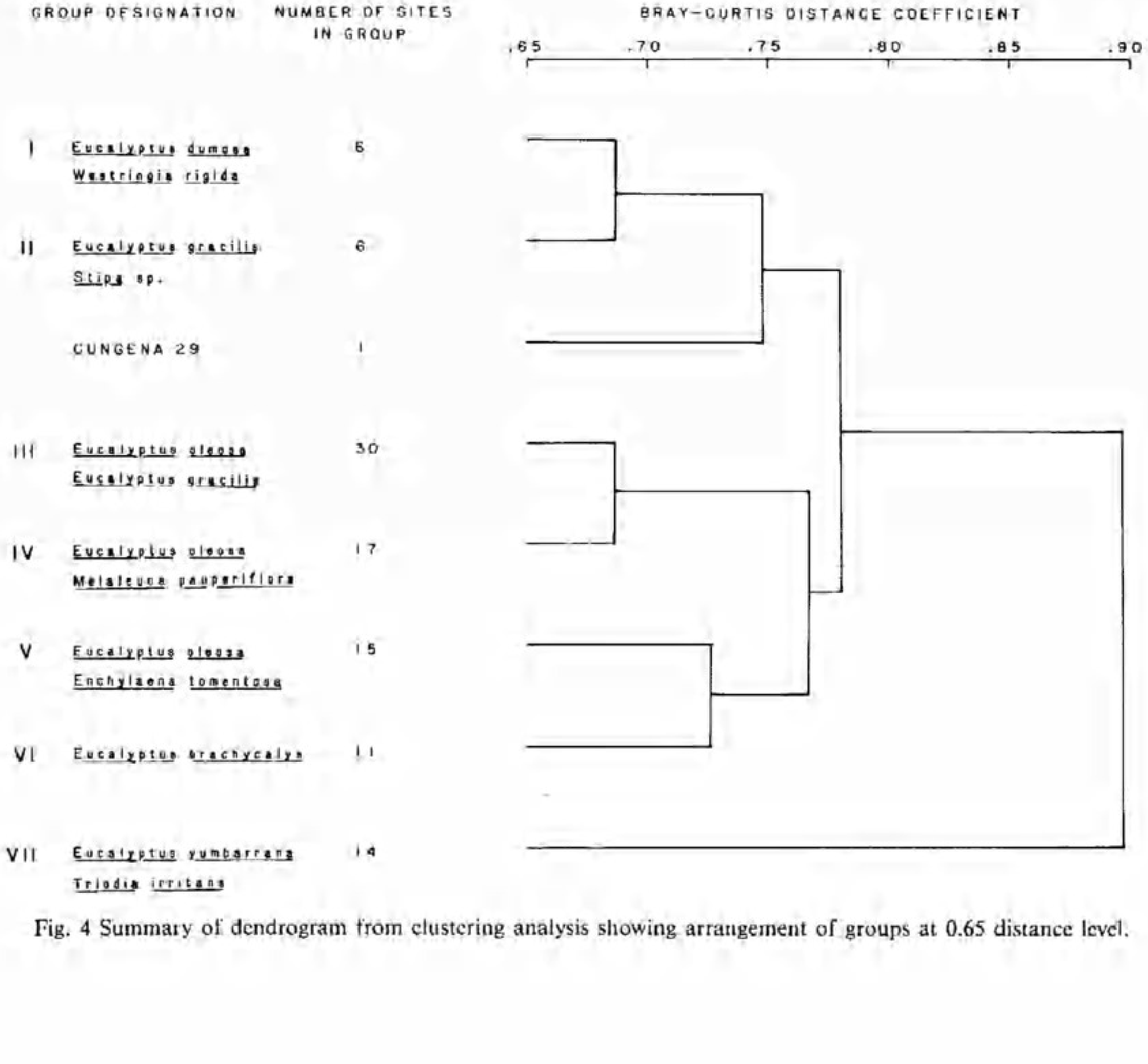

Fig. 4 Summary of dendrogram from clustering analysis showing arrangement of groups at 0.65 distance level.

grouped from the least to the most dissimilar by the unweighted pair group method using arthmetic averages (UPGMA; Legendre & Legendre 1983) to produce a hierarchical dendrogram, the branches of which represent vegetation types. The complementary ordination method chosen was detrended correspondence analysis, DCA (Gauch 1982). Ordination methods such as DCA rank sites along a series of axes which describe the major floristic variation. The results are displayed as a scattergram from which continuity and disjunction of vegetation types can be determined and with which environmental factors can be correlated. The numerical taxonomy computer software package NTP (Belbin *et al.* 1984) was used for both analyses.

For the purpose of preparing vegetation maps, the sixty-two disturbed sites were returned to the data set, and a further cluster analysis performed. By the proximity of these sites on the dendrogram to sites of known vegetation type, most of the remaining sites were identified as belonging to one of the major vegetation types.

Results

The classification dendrogram is summarised in Fig. 4. Field notes indicated that the groupings defined at the 0.65 distance level were the most readily interpreted, a higher level producing groups with large internal variation, and a lower level producing too many groups for consideration. Seven major vegetation types were identified at the 0.65 level, one of which, type VII, was widely dissimilar from the other groups, only fusing with them at 0.90 level. A minor vegetation type was also identified. Represented by only one site, Cungena 29, this site was dominated by *Callitris preissii*, rather than a eucalypt species.

The relationships between the vegetation types can be seen from the ordination; a plot of the first two ordination axes is given in Fig. 5. The first axis explained 50% of the variation in the data set, and corresponds to the first major branching of the dendrogram, separating vegetation type VII from the others. The separation between the remaining six communities is largely supported by the ordination, although there is a certain degree of overlap, most marked between types I and II, and types V and VI. The relationship of these six vegetation types to each other obviously tends towards the "ecotone" rather than the distinct "association" end of the scale in vegetation pattern as described by Webb (1954).

The species consistent in each of the vegetation types are presented in Table 2 and Fig. 6 summarises the associated landforms, soils and rainfall. Table 3 gives a full listing of species found in the seven vegetation types. Understorey species are equally important as shrubs and trees in delineating vegetation type.

The vegetation types, their distributions (Fig. 7) and their environmental correlates are discussed below. The types have been named "associations" according to usual ecological practice, even though they do not fully fit the formal definition of "association" given by Braun-Blanquet (1932).

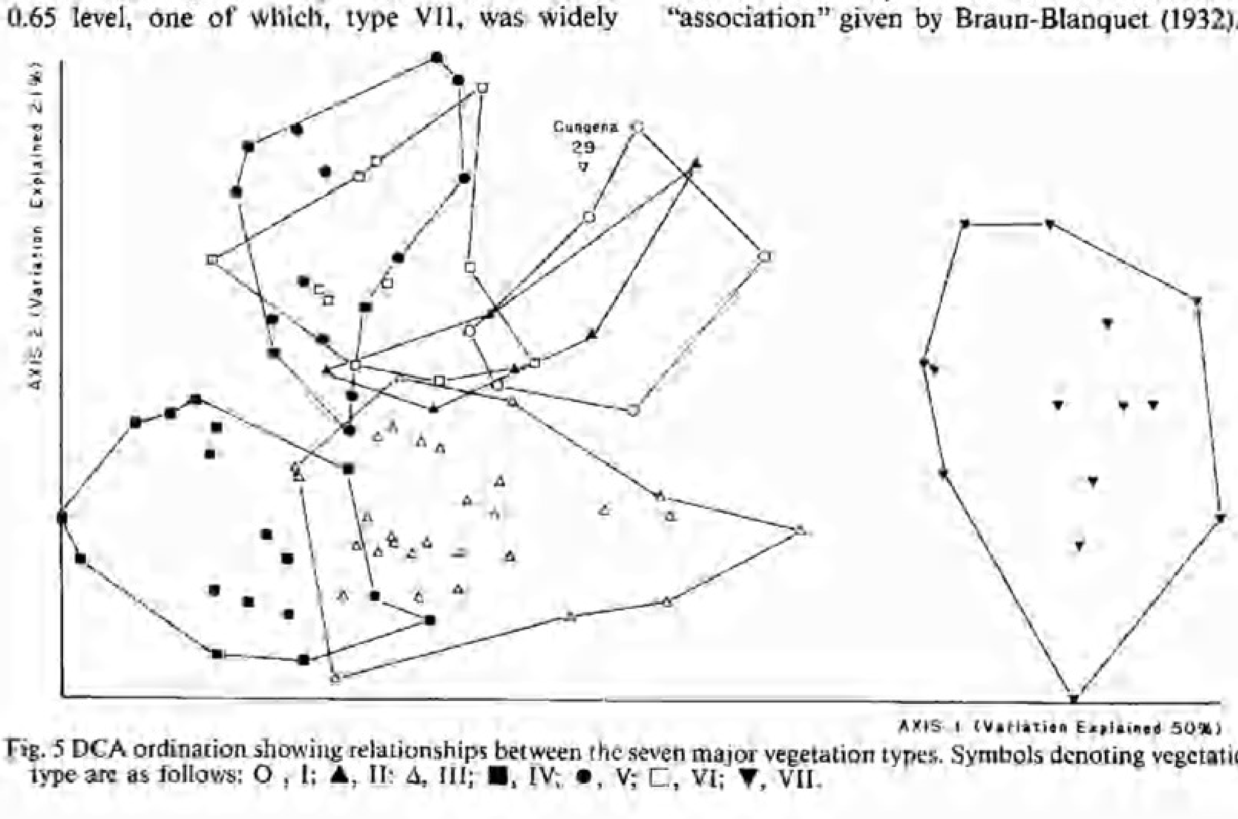

Fig. 5 DCA ordination showing relationships between the seven major vegetation types. Symbols denoting vegetation type are as follows: O, I; ▲, II; Δ, III; ■, IV; ●, V; □, VI; ▼, VII.

TABLE 2. *Plant species characteristic of the seven major vegetation types. Marked species had a cover score of two or greater when present, and could be considered dominants.*

VEGETATION TYPE	CHARACTERISTIC PLANT SPECIES Key Species (75–100% of sites)	Usually Present (50–74% of sites)
I	*Cassia nemophila* var. *nemophila* • *Eucalyptus dumosa* • *Geijera linearifolia* • *Westringia rigida* • *Acacia colletioides* *Eremophila glabra* *Melaleuca lanceolata* *Zygophyllum apiculatum*	*Eucalyptus gracilis* • *Eucalyptus oleosa* • *Dianella revoluta* *Exocarpos aphyllus* *Pittosporum phylliraeoides* *Rhagodia preissii*
II	*Eucalyptus gracilis* • *Stipa* sp. • *Enchylaena tomentosa* *Geijera linearifolia*	*Acacia colletioides* • *Eucalyptus oleosa* • *Eremophila glabra* *Melaleuca lanceolata* *Sclerolaena obliquicuspis*
III	*Eucalyptus gracilis* • *Eucalyptus oleosa* • *Westringia rigida* • *Zygophyllum aurantiacum*	*Eremophila scoparia* • *Triodia irritans* • *Maireana erioclada* *Rhagodia crassifolia*
IV	*Eucalyptus oleosa* • *Melaleuca pauperiflora* •	*Rhagodia crassifolia*
V	*Eucalyptus oleosa* • *Enchylaena tomentosa* • *Geijera linearifolia* *Zygophyllum aurantiacum*	*Maireana erioclada* • *Rhagodia crassifolia* • *Scleroleana diacantha* *Sclerolaena obliquicuspis* *Threlkeldia diffusa*
VI	*Eucalyptus brachycalyx* • *Maireana erioclada* *Rhagodia crassifolia*	*Melaleuca pauperiflora* • *Enchylaena tomentosa* *Sclerolaena diacantha* *Threlkeldia diffusa* *Zygophyllum aurantiacum*
VII	*Eucalyptus yumbarrana* • *Melaleuca eleuthrostachya* • *Triodia irritans* •	*Dianella revoluta* *Eremophila crassifolia* *Podolepis capillaris*

The Vegetation Associations

Association I: Eucalyptus dumosa-Westringia rigida

The closest counterpart in the literature is the *Melaleuca lanceolata* association of Boomsma & Lewis (1972), which is said to occur with a number of species as co-dominants, including *Eucalyptus dumosa* and *E. gracilis*. Their classification includes a much wider range of vegetation associations than is here defined. It occupies a somewhat irregular distribution throughout the study area, restricted to rising ground on shallow calcrete, and the least sandy soils (sandy loams and loams).

Association II: Eucalyptus gracilis-Stipa

This vegetation association could be described as a depauperate variation of Association I. Although some of the same species are present, *Eucalyptus gracilis* is the most important tall species uniting the group. The lower diversity understorey often includes a high percentage of perennial grass (*Stipa*). The relationship of Associations I and II is indicated by their proximity on the dendrogram (Fig. 4) and overlap on the ordination (Fig. 5).

The association has not been previously recorded on western Eyre Peninsula, and *E. gracilis* has only ever been reported as a co-dominant with other mallee species for the whole state (Boomsma & Lewis 1980). Its distribution is also irregular, occurring on the dry central to northern section of the Cungena transect, but also scattered through the southern Pimbaacla and Wirrulla transects at higher rainfall. Very shallow, light soils on low lying ground are consistent with its occurrence. The resulting harsh moisture conditions probably reduce the number of understorey species present to those which can tolerate them, such as the shallow-rooted *Stipa* and *Sclerolaena* spp.

Association III: Eucalyptus gracilis-oleosa

Association III probably forms the core of the *Eucalyptus oleosa / E. gracilis* association identified by Crocker (1946) and Specht (1972), although Specht appears to misidentify *E. oleosa* as *E. socialis*. It is the most common vegetation association in the northern part of the study area, but was not recorded by Margules & Nicholls (1987).

Its occurrence in the southern section of the Nunjikompita transect at slightly higher rainfall seems to suggest that its distribution is more restricted by soil than climatic factors. It is not present in the south-western part of the study area because the calcareous sands there favour other vegetation associations such as IV and VI, or on the south-eastern section where calcrete outcrops favour Associations I and II.

The occasional occurrence of Association III on dune flanks may be explained by historical factors. It is the most common inter-dune vegetation of the northern part of the study area, occurring on medium depth to shallow soils. Since the Molineaux sands have been deposited over only the last few thousand years, they are relatively unstable. In some instances sand from these dunes has drifted on to calcareous earths in the interdunes already occupied by Association III vegetation, and the long-lived species such as *E. oleosa* and *E. gracilis* persist on a soil which would perhaps not at present favour their establishment. The understorey in these cases tends to include species less typical of the association, such as *Triodia irritans*.

Association IV: Eucalyptus oleosa-Melaleuca pauperiflora

Association IV contains a very species-poor and sparse understorey of chenopods such as *Rhagodia crassifolia* and *Maireana erioclada*. A known vegetation association including *Eucalyptus oleosa, Rhagodia crassifolia, Zygophyllum aurantiacum, Sclerolaena diacantha* and *Melaleuca lanceolata* (Margules & Nicholls 1987), is probably equivalent to it, their *Melaleuca lanceolata* a possible misidentification of *M. pauperiflora*.

Association IV occurs mainly in the southernwestern part of the study area, on shelly calcareous sands, with scattered occurrences in the north, for example, on the Nunjikompita transect, where outliers of this soil type occur on rises in the inter-dunes. These outliers are probably remnants of the old coastal dune environment which would have been present before the Molineaux sands were deposited. Although the vegetation association appears to occur at slightly higher rainfall, this may simply be a result of the soil type which favours its occurrence being characteristic of the southern coastal higher rainfall areas. The low diversity of the association may be an indication that only a few understorey species are able to persist on the coarse shelly sands.

Association V: Eucalyptus oleosa-Enchylaena tomentosa

Vegetation falling within Association V is very variable and a large number of disturbed roadside sites were most closely allied to it, indicating that it may not be a naturally occurring association, but a result of disturbance. Many of the species are unpalatable, such as *Geijera linearifolia*, or low growing chenopods, which suggests removal of more palatable understorey species by grazing. Further investigation would be required to ascertain if any of the sites represent a naturally occurring Association V.

Association VI: Eucalyptus brachycalyx

Vegetation Association VI includes *Eucalyptus brachycalyx* as the important upper-storey species, together with a range of low chenopods similar to that of Association V. The floristic similarity results in considerable overlap between these two associations on the ordination (Fig. 5). It is most common towards the coast, occurring in the southern central and western part of the study area on shallower soils than Association IV.

AssociationVII: Eucalyptus yumbarrana-Triodia irritans

It is probable that *Eucalyptus yumbarrana* was previously recorded as *Eucalyptus socialis*, and that the *E. socialis/Melaleuca uncinata* sandhill association of Specht (1972) corresponds to Association VII, as does Margules & Nicholls' Community I if their *Melaleuca adnata* is re-identified as *M. eleutherostachya*.

Vegetation Association VII is restricted to the sand-dunes of the northern, low rainfall part of the study area. The species characterising it are entirely different from those found in the other vegetation associations, and include many species with distributions in higher rainfall parts of the state, such as *Lomandra leucocephala* and *Gahnia lanigera* (Jessop & Toelken 1986). This major floristic disjunction corresponds to a similar observation in north-western Victoria, where the most marked discontinuity of mallee vegetation was between a *Eucalyptus incrassata/Hibbertia/Leptospermum* association with "southern temperate" affinities, and all the other associations, in which semi-succulent herbs, especially chenopods, were prominent (Noy-Meir 1971).

The disjunction observed is related to the geology, since the heavier soils of the exposed Woorinen Formation present in the inter-dune corridors typically support vegetation of Associations I, II or III. The combined effect of coarse texture and

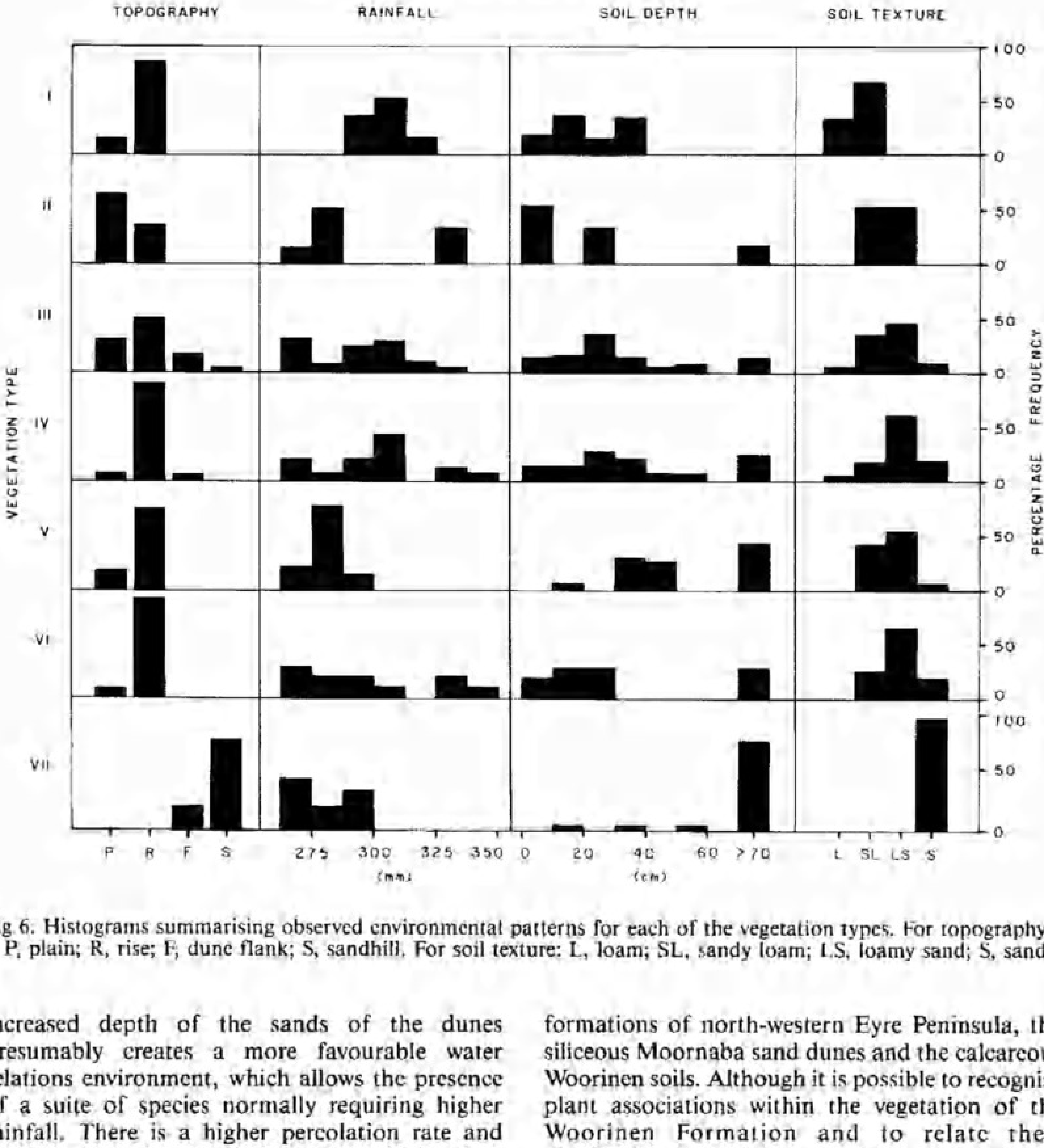

Fig. 6. Histograms summarising observed environmental patterns for each of the vegetation types. For topography: P, plain; R, rise; F, dune flank; S, sandhill. For soil texture: L, loam; SL, sandy loam; LS, loamy sand; S, sand.

increased depth of the sands of the dunes presumably creates a more favourable water relations environment, which allows the presence of a suite of species normally requiring higher rainfall. There is a higher percolation rate and deeper penetration of rainfall into sands than into clays, while evaporation dries the surface soil to a similar depth regardless of texture, so that at the end of a long dry period, there would be more water available in the root zone of sandy soils than in clays (Walter & Stadelmann 1974). Clays also have a higher water holding capacity due to their smaller pore size (Ball 1986). This means that a larger amount of rainfall is required to bring air-dry clay to a range where water is available to plants than for sands.

Discussion

There is a clear vegetational discontinuity between the two predominating geological formations of north-western Eyre Peninsula, the siliceous Moornaba sand dunes and the calcareous Woorinen soils. Although it is possible to recognise plant associations within the vegetation of the Woorinen Formation and to relate their distributions to environmental features in a general way, sharp discontinuities do not exist. The strong gradation of associations is typical of the mallee on Woorinen Formation and its equivalents across the whole of S. Aust. (Sparrow unpublished data).

There are two possible interpretations of these observations. Firstly, since there is no strong environmental discontinuity within the Woorinen Formation, the gradation may reflect combinations of species with independent environmental responses, which, further confounded by disturbance, results in almost continuous ecotones. Alternatively, the gradation of mallee associations could be caused by some degree of independence of the mallee and understorey strata. The mallees,

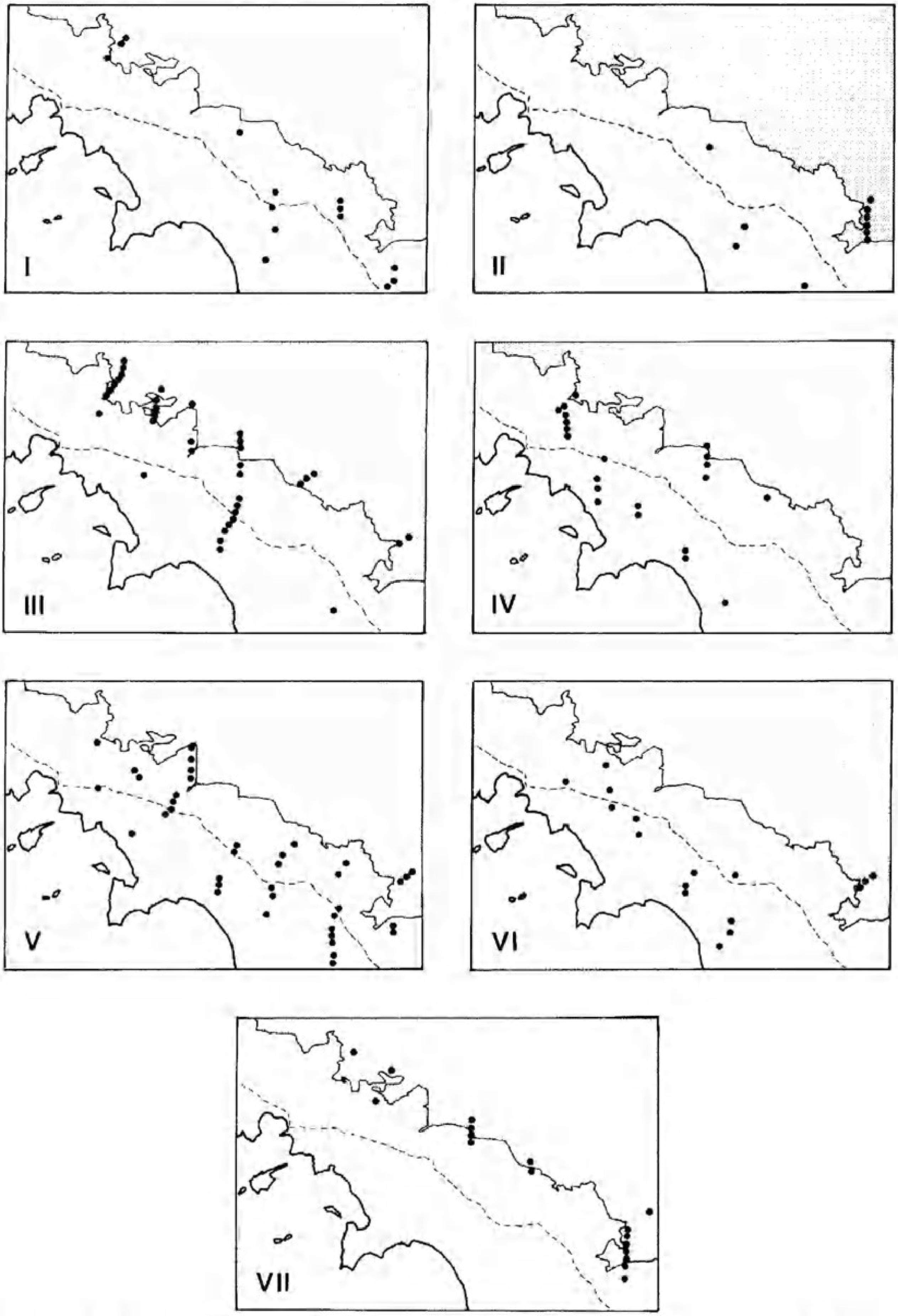

Fig. 7 Distribution maps of the seven major vegetation types. Shading represents uncleared vegetation and the broken line marks the Eyre Highway.

TABLE 3: *Full species list (nomenclature following Jessop & Toelken 1986) showing occurrence in the seven major vegetation types. Occurrence in sites that could not be assigned to a major vegetation type are grouped in the final column. Introduced species are indicated with an asterisk.*

Species	Vegetation Type							
	I	II	III	IV	V	VI	VII	Other
Acacia calamifolia Sweet ex Lindley	+	+	+	–	–	–	+	–
Acacia colletioides Benth.	+	+	+	–	+	+	+	+
Acacia hakeoides Cunn. ex Benth.	+	–	+	–	+	+	–	–
Acacia ligulata Cunn. ex Benth.	+	–	–	–	–	–	+	+
Acacia merralli F. Muell.	+	+	+	+	+	+	+	+
Acacia notabilis F. Muell.	+	–	–	–	–	–	–	–
Acacia oswaldii F. Muell.	+	+	+	–	+	–	–	+
Acacia rigens Cunn. ex Don	–	–	–	–	–	–	+	–
Acacia sclerophylla Lindley	–	+	+	–	+	–	–	–
Acacia spinescens Benth.	–	–	–	–	–	–	–	–
Alyxia buxifolia R. Br.	–	–	–	–	+	–	–	–
Amyema melaleucae (Miq.) Tieghem	–	–	–	–	–	–	–	+
Atriplex acutibractea R. Anderson	+	+	+	+	+	+	+	+
Atriplex stipitata Benth.	–	+	–	–	+	–	–	–
Atriplex vesicaria Heward ex Benth.	–	+	+	+	+	+	–	–
Beyeria lechenaultii (DC.) Baillon	+	–	–	–	–	–	–	–
Beyeria opaca F. Muell.	–	–	+	+	+	–	+	–
Billardiera cymosa F. Muell.	–	–	–	+	–	–	+	–
Boronia coerulescens F. Muell.	–	–	–	–	–	–	+	–
Callitris preissii ssp. *preissii* Miq.	–	+	–	–	–	–	–	–
Callitris preissi ssp. *verrucosa* (Cunn. ex Endl.) J. Garden	–	–	–	–	+	–	–	+
Carpobrotus rossii (Haw.) Schwantes	–	–	–	+	+	+	–	–
**Carrichtera annua* (L.) DC.	–	+	–	+	+	+	–	+
Cassia nemophila var *coriacea* (Benth.) Symon	+	+	+	–	+	–	–	+
Cassia nemophila var *nemophila* Cunn. ex J. Vogel	+	+	–	+	–	–	+	–
Cassia nemophila var *platypoda* (R. Br.) Benth.	+	+	–	+	+	–	+	+
Cassytha glabella R. Br.	+	–	–	–	–	–	–	–
Cassytha melantha R. Br.	+	–	+	+	+	+	+	–
Casuarina cristata Miq.	–	–	–	–	+	–	–	+
Chenopodium desertorum (J. Black) J. Black	–	–	–	–	–	–	+	–
Cratystylis conocephala (F. Muell.) S. Moore	+	–	+	+	+	+	–	+

TABLE 3 cont. *Full species list (nomenclature following Jessop & Toelken 1986) showing occurence in the seven major vegetation types. Occurrence in sites that could not be assigned to a major vegetation type are grouped in the final column. Introduced species are indicated with an asterisk.*

Species	Vegetation Type							
	I	II	III	IV	V	VI	VII	Other
Cryptandra leucophracta Schldl.	–	–	–	–	–	–	+	–
Cryptandra tomentosa Lindley	–	–	–	–	–	–	+	–
Danthonia spp. Lam. & DC.	–	+	–	–	–	–	+	–
Daviesia asperula Crisp	–	–	–	–	–	–	+	–
Daviesia benthamii Meissner	–	–	–	–	–	–	+	–
Dianella revoluta R. Br.	+	+	+	+	+	+	+	+
Dillwynia uncinata (Turcz.) J. Black	–	–	–	–	–	–	+	–
Dodonaea bursariifolia F. Muell.	+	–	+	–	–	–	+	–
Dodonaea stenozyga F. Muell.	–	–	+	+	–	–	–	+
Dodonaea viscosa ssp. *angustissima* (DC.) J.G. West	+	–	–	–	–	–	+	–
Enchylaena tomentosa R. Br.	+	+	+	+	+	+	+	+
Eremophila crassifolia (F. Muell.) F. Muell.	–	–	+	+	–	–	+	–
Eremophila deserti (Cunn. ex Benth.) Chinn	+	–	–	–	+	–	–	+
Eremophila glabra (R. Br.) Ostenf.	+	+	+	+	–	+	+	–
Eremophila scoparia (R. Br.) F. Muell.	+	+	+	+	+	+	–	–
Eremophila weldii F. Muell.	+	+	+	+	+	+	+	–
Eucalyptus brachycalyx/concinna Blakely/Maiden & Blakely	+	+	+	+	+	+	+	+
Eucalyptus dumosa Cunn. ex Schauer	+	+	+	+	+	+	+	+
Eucalyptus foecunda Schauer	–	–	–	–	–	–	+	–
Eucalyptus gracilis F. Muell.	+	+	+	+	+	+	–	+
Eucalyptus incrassata Labill.	–	–	–	–	–	–	+	–
Eucalyptus oleosa F. Muell. ex Miq.	+	+	+	+	+	+	+	+
Eucalyptus socialis F. Muell. ex Miq	–	–	+	–	–	–	–	–
Eucalyptus striaticalyx W. Fitzg.	–	–	+	–	–	–	+	–
Eucalyptus yumbarrana Boomsma	–	–	+	–	–	–	+	+
Eutaxia microphylla (R Br. in W.T. Aiton) J. Black	–	–	–	–	–	–	+	–
Exocarpos aphyllus R. Br.	+	+	+	+	+	+	+	+
Exocarpos sparteus R. Br.	–	–	–	–	–	–	+	–
Gahnia lanigera (R. Br.) Benth.	–	–	+	–	–	–	+	–
Geijera linearifolia (DC.) J. Black	+	+	+	+	+	+	+	+
Goodenia varia R. Br.	–	–	–	–	–	–	+	–

TABLE 3 cont. *Full species list (nomenclature following Jessop & Toelken 1986) showing occurence in the seven major vegetation types. Occurrence in sites that could not be assigned to a major vegetation type are grouped in the final column. Introduced species are indicated with an asterisk.*

Species	Vegetation Type I	II	III	IV	V	VI	VII	Other
Grammosolen truncatus (Ising) Haegi	–	–	+	–	–	–	+	–
Grevillea huegelii Meissner	–	+	+	+	+	+	–	–
Hakea francisiana Maconochie	–	–	–	–	–	–	+	–
Halgania cyanea Lindley	–	–	–		–	–	+	–
Halgania lavandulacea Endl.	–	–	–	–	–	–	+	–
Helichrysum bilobum Wakef.	–	–	–	–	–	–	+	–
Hybanthus floribundus (Lindley) F. Muell.	–	–	–	–	–	–	+	–
Ixiolaena pluriseta Haegi	–	–	–	–	–	–	+	–
Lasiopetalum behrii F. Muell.	–	–	–	–	–	–	+	-
Lepidosperma laterale R. Br.	–	–	–	–	–	–	+	–
Leptospermum coriaceum (F. Muell.) Cheel	–	–	–	–	–	–	+	–
Leucopogon cordifolius Lindley	–	–	–	–	–	–	+	–
Logania nuda F. Muell.	–	–	–	–	–	–	+	–
Lomandra collina (R. Br.) Ewart	–	–	–	–	–	–	+	–
Lomandra effusa (Lindley) Ewart	+	–		–	–	–	–	–
Lomandra leucocephala (R. Br.) Ewart	–	–	–	–	–	–	+	–
**Lycium ferocissimum* Miers	–	–	–	+	–	+	–	–
Maireana appressa Paul G. Wilson	+	+	+	+	+	+	–	–
Maireana brevifolia (R. Br.) Paul G. Wilson	–	–	–	–	+	+	–	+
Maireana enchylaenoides (F. Muell.) Paul G. Wilson	–	+	–	–	–	–	–	–
Maireana erioclada (Benth.) Paul G. Wilson	–	–	–	–	+	–	–	–
Maireana pentatropis (Tate) Paul G. Wilson	+	+	+	+	+	+	–	–
Maireana sedifolia (F. Muell.) Paul G. Wilson	–	–	–	–	+	–	–	–
Maireana trichoptera (J. Black) Paul G. Wilson	+	–	+	–	+	+	+	–
Melaleuca acuminata F. Muell.	+	+	+	–	–	–	+	+
Melaleuca eleutherostachya F. Muell.	–	–	+	–		+	+	–
Melaleuca lanceolata Otto	+	+	+	–	+	+	+	+
Melaleuca pauperiflora F. Meull.	+	–	+	+	+	+	+	+
Microcybe multiflora Turcz.	–	–	+	–	–	–	–	–
Muehlenbeckia gunnii (Hook. f.) Walp.)	+	–	–	–	–	+	–	–
Myoporum platycarpum R. Br.	+	–	–	+	+	–	–	+
Olearia brachyphylla (F. Muell. ex Sonder) Wakef.	–	+	+	–	+	+	–	–

TABLE 3 cont. *Full species list (nomenclature following Jessop & Toelken 1986) showing occurence in the seven major vegetation types. Occurrence in sites that could not be assigned to a major vegetation type are grouped in the final column. Introduced species are indicated with an asterisk.*

Species	Vegetation Type I	II	III	IV	V	VI	VII	Other
Olearia floribunda (Hook. f.) Benth.	–	–	–	–	–	–	+	–
Olearia magniflora (F. Muell.) F. Muell. ex Benth.)	+	+	+	+	+	+	–	–
Olearia muelleri (Sonder) Benth.	+	+	+	+	+	+	+	–
Olearia pimelioides (DC.) Benth.	–	–	–	–	–	–	+	–
Pimelea microcephala R. Br.	–	–	–	–	+	–	–	–
Pittosporum phylliraeoides DC.	+	+	+	–	+	+	+	+
Podolepis capillaris (Steetz) Diels	–	–	+	–	–	–	+	–
Ptilotus obovatus (Gaudich.) F. Muell.	+	–	–	–	–	–	–	–
Ptilotus spathulatus (R. Br.) Poiret	+	+	–	–	+	–	–	–
Pultenaea elachista (F. Muell.) Crisp	–	–	+	+	–	–	+	–
Rhagodia crassifolia R. Br.	+	+	+	+	+	+	+	+
Rhagodia parabolica R. Br.	–	–	–	–	+	–	–	–
Rhagodia preissii Miq.	+	+	+	+	+	+	+	+
Rhagodia spinescens var. *deltophylla* F. Muell.	+	+	–	–	+	–	–	–
**Salsola kali* L.	+	–	–	+	+	–	–	+
Santalum acuminatum (R. Br.) A. DC.	+	+	+	+	+	+	+	–
Scaevola bursariifolia J. Black	–	–	–	+	+	–	–	–
Scaevola spinescens R. Br.	+	+	+	–	+	–	–	+
Schoenus subaphyllus Kük	–	–	–	–	–	–	+	–
Sclerolaena diacantha (Nees) Benth.	+	+	+	+	+	+	–	+
Sclerolaena obliquicuspis (R. Anderson) Ulbr.	+	+	+	+	+	+	–	+
Sclerolaena uniflora R. Br.	–	+	+	–	–	–	–	+
Sida corrugata Lindley	+	–	–	–	–	–	–	–
**Solanum coactiliferum* J. Black	–	–	–	–	–	–	+	
Stelligera endecaspinis A. J. Scott	–	–	+	–	–	+	+	–
Stipa spp. L.	+	+	+	+	+	+	+	+
Templetonia battii F. Muell.	–	–	–	–	+	–	–	–
Threlkeldia diffusa R. Br.	+	+	+	+	+	+	–	–
Triodia irritans R. Br.	+	–	+	–	–	+	+	+
Velleia connata F. Muell	–	–	–	–	–	–	+	–
Vittadinia dissecta (Benth.) N. Burb.	–	–	–	–	–	–	+	

TABLE 3 cont. *Full species list (nomenclature following Jessop & Toelken 1986) showing occurence in the seven major vegetation types. Occurrence in sites that could not be assigned to a major vegetation type are grouped in the final column. Introduced species are indicated with an asterisk.*

Species	Vegetation Type I	II	III	IV	V	VI	VII	Other
Westringia rigida R. Br.	−	+	+	+	+	−	−	
Zygophyllum ammophilum F. Muell.		+	+		+	−	−	
Zygophyllum apiculatum F. Muell.	+	+	−	−	+	−	−	−
Zygophyllum aurantiacum/ovatum (Lindley) F. Muell./Ewart & J. White	+	+			+	−	−	
Zygophyllum glaucum F. Muell.	+	−	+	+	+	+	+	−

being very long-lived plants, may be indicating some historical influence, while the shorter-lived understorey species reflect current environmental conditions. Lange & Nicolson (1982) report mallees recording former extensions of a palaeosol, and Twidale & Campbell (1985) and Short *et al.* (1986) provide ample evidence of dynamic changes in the surface geology of north-western Eyre Peninsula during the Holocene.

A further issue is the occurrence of uncommon vegetation associations in the area. One example is the *Callitris preissii* association represented by a single site on the dendrogram; another, towards the northern end of the Mudamuckla transect and removed from analysis due to disturbance, was unique for the presence of *Casuarina cristata*. A regular sampling strategy inevitably leads to the omission of rare vegetation types, so there are undoubtedly other uncommon associations in the area.

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