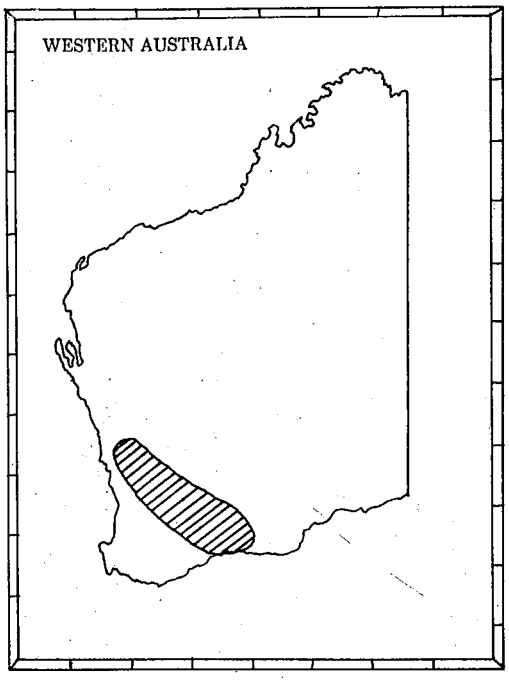
KINGS PARK RESEARCH NOTES - NUMBER 9 1984

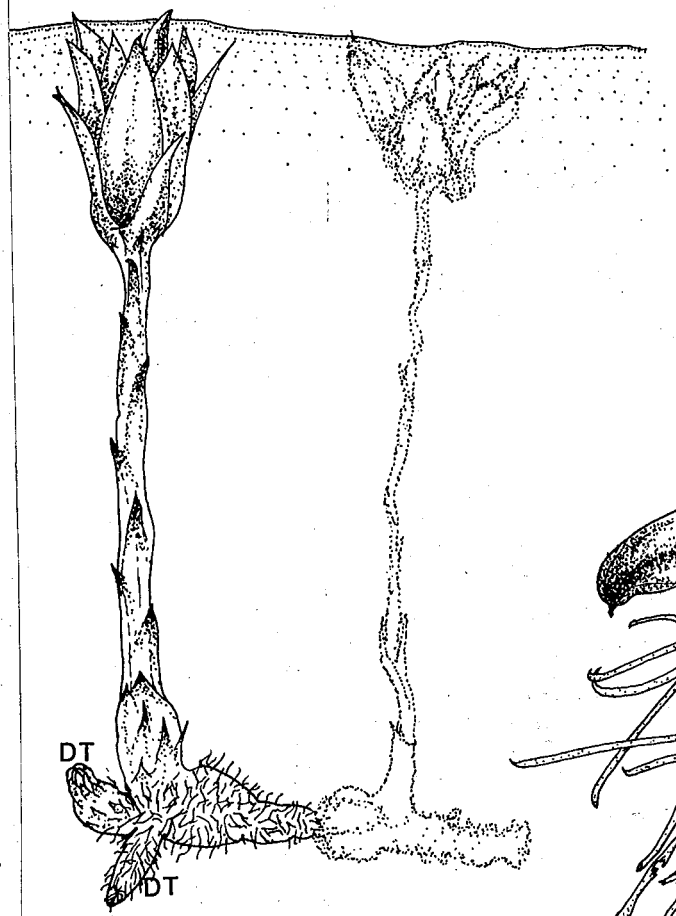


Known distribution of Rhizanthella gardneri

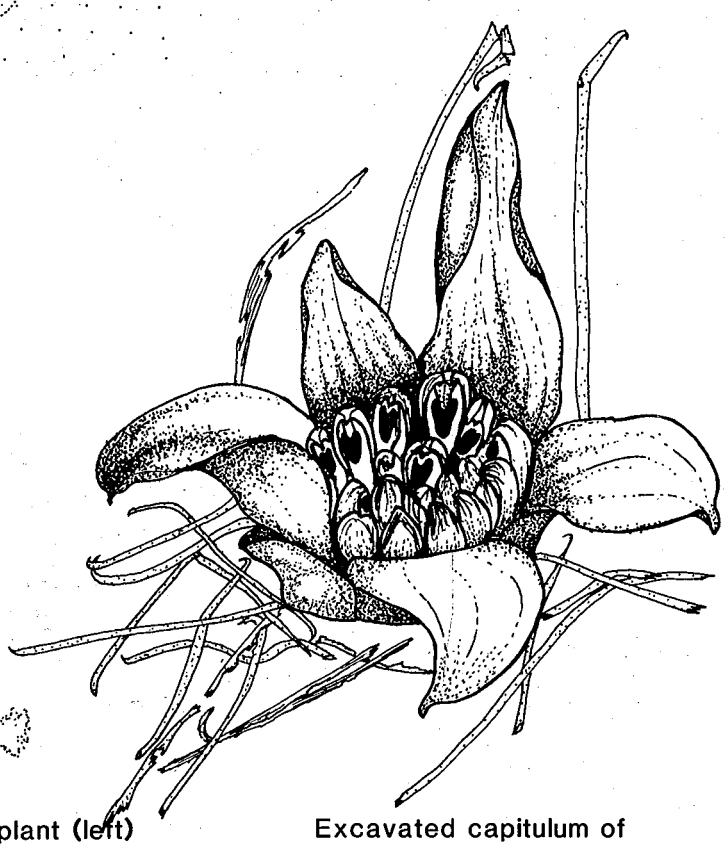
BIOLOGY AND DISTRIBUTIONAL STATUS OF RHIZANTHELLA GARDNERI Rogers

THE WESTERN AUSTRALIAN UNDERGROUND ORCHID

K.W.Dixon and J.S.Pate



Relationship of current flowering plant (left) with daughter tuber (DT) to previous seasons spent plant with old flowering head intact



Excavated capitulum of Rhizanthella gardneri

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Plate 1
From left to right; typical search procedure in Babakin locality of *Rhizanthella gardneri*; cluster of three capitula of *Rhizanthella gardneri* at various stages of emergence; capitulum with involicral bracts reflexed following excavation and revealing orchid flowers within; archaeological-type excavation of flowering plant showing relationship of current flowering structures to previous season's spent flowering stem (dark area) to left of present season's flower stalk.

BIOLOGY AND DISTRUBUTIONAL STATUS OF *RHIZANTHELLA GARDNERI* ROGERS (ORCHIDACEAE) THE WESTERN AUSTRALIAN UNDERGROUND ORCHID

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ABSTRACT

First discovered and described in 1928, the underground orchid *Rhizanthella gardneri* has remained one of the most elusive members of our native flora, being discovered accidentally during clearing of bushland for agriculture only a further seven times up to 1979. Since then, due mainly to the present investigation, localities where populations of the orchid are known to still survive have been increased to five, all but one of these involving unoccupied crown land.

During this investigation almost 150 sightings of the orchid have been made by the deliberate, non-destructive means of scraping leaf litter in stands of the associated 'host' species *Melaleuca uncinata*. With this spate of new discoveries further information on the complex phenology, nutrition and reproductive biology of the species has come to light. This report outlines the history of these discoveries, the search methodology, and provides details of the reserve and vacant crown land so far examined for the orchid. Observations are provided of the biology of the species with proposals for the establishment and maintenance of reserves containing viable populations of the orchid. One recently discovered locality is suggested as a possible reserve for the orchid, using the gazetted status of the species as the means for creating an A class reserve at this locality.

1. INTRODUCTION: THE EARLY COLLECTIONS OF *RHIZANTHELLA GARDNERI*

Including the initial discovery and description of *Rhizanthella gardneri* in 1928 (Rogers 1928) all sightings up to 1979 of this highly unusual totally underground orchid were purely accidental, and resulted directly from clearing operations in the central wheatbelt. Unfortunately several of the earlier supposed sightings of the species were not accompanied by lodgement of herbarium voucher specimens, so these could easily have involved mistaken identity. For instance the 1914 sighting at Wubin, W.A., by the Rev. W.J. Thomson of Blackburn, Victoria of a structure later described as not unlike the flowering head of *Rhizanthella*, may well have been the stink-horn fungus, *Clathrus puscillus*, an earthstar fungus *Geastrum* ssp. or the parasitic angiosperm *Orobanche australiana*, all of which have been, and are still commonly confused with *R. gardneri*. Details of these early discoveries of the orchid are shown in Table 1.

TABLE 1 HISTORY OF *RHIZANTHELLA* DISCOVERIES, 1914-1982

Date	Month	Site of Discovery	Discovery*	No. Inflorescences Collected/Sighted
1914		WUBIN - NO SPECIMEN	A	?
1928	MAY	CORRIGIN - (TYPE SPECIMEN)	A	4
1928	JUNE	GOOMALLING	A	?(1)
1928	JUNE	SHACKLETON	A	?
1938	JUNE	MOONIGIN	A	1
1938	AUG	CORRIGIN	A	1
1940	?	CORRIGIN	A	?
1959	MAY	BABAKIN	A	1

*UP TO 1960 7 (8) SPECIMENS AT 5 LOCALITIES

1968 $100 Reward offered by John Trott

1978 SEPT PROJECT TO RESEARCH *RHIZANTHELLA* SUPPORTED BY WWF

1979	MAY	MUNGLINUP	A	11
1980	MAY	MUNGLINUP	D(R)	15
1980	MAY	BABAKIN	D	1

1981 JAN PROJECT WITH WWF STARTED

1981	JUN-AUG	BABAKIN	D	38
1981	JUN	SORENSON RESERVE	D	2
1981	JUL-OCT	CHEADANUP	D	6
1981	AUG-SEP	OLDFIELD LOCATION	D	5
1982	MAY-JUN	BABAKIN	D(R)	110
1982	MAY	SORENSON RESERVE	D(R)	4
1982	AUG	CHEADANUP	D(R)	4
1982	JUN	OLDFIELD LOCATION	D(R)	4

AV. MAN HOUR EFFORT/FIND (1979-1982): 9 HOURS

*A - Accidential discovery during agricultural operations

D - Purposeful discovery by scraping of litter around *M. uncinata*

D(R) - As D, revisit to established sites

WWF - World Wildlife Fund Australia

Despite the few specimens involved, early collectors were still able to provide reasonably acurate details on the subterranean habit of the orchid. The depth of the stem tuberous organ was shown by Trott (Serventy 1979) and Rogers (1928) to be between 7-10 cm, occasionally down to 25-31 cm, and both Trott and Gardner commented on the apparently monocarpic behaviour of the tuber in its production of inflorescences. The "saprophytic" nature of the orchid was mentioned in the original description by Rogers (1928), where the species was described as living close to decaying stumps of the broom honeymyrtle, *Melaleuca uncinata*. These stumps, he wrote, "were partially rotten through the action of a fungus, the mycelium of which formed dense masses of a violet colour ..... in the subsoil". Subsequent examination of partially cleared sites has shown that prolific growth of a fungus of similar characteristics to those described by Rogers (1928) commonly results from disturbance and disruption of soil profiles in clearing operations. This fungus shares no features in common with the form genus *Rhizoctonia*, the taxonomic grouping in which later workers have placed the fungal isolates from the vegetative organs of *Rhizanthella* (Pitman 1929, J. Warcup pers. comm.).

The recent phase of research on *R. gardneri* can be said to have dated from the chance discovery of a number of intact specimens in recently rolled, but still unploughed land in May 1979 by a farmer near the south coast town of Munglinup. The specimens were identified at the State Herbarium by Mr. A.S. George as the flowering heads of the Western Australian underground orchid, and subsequent examination of the site by George (1980) and later by ourselves, yielded several further plants in each of three subsequent seasons. From the flowering behaviour of these specimens a much clearer picture emerged of the biology of the species (see George 1980).

The initial aim of the study, as conceived in 1978 in consultation with World Wildlife Fund Australia, was to engage in a comprehensive, deliberate search for *R. gardneri*, hopefully to assess whether or not the species was extinct in its earlier recorded localities in the wheatbelt, and if not extinct, to determine the extent of its distribution and take active steps for its protection. With the 1979 discovery at Munglinup of one apparently viable but highly vulnerable population of the species, the possibility of discovering new natural populations outside private property was raised, thus giving great incentive to search areas of uncleared land, first in the vicinity of Munglinup and then in other general regions of the wheatbelt, especially close to where earlier discoveries had been reported. However

with the very exciting deliberate discovery by ourselves in May 1980 of a single specimen in *M. uncinata* thickets at Babakin, some 500 km from the Munglinup site, the future of the project became decidedly more optimistic, so that by the time when first funds from World Wildlife became available in January 1981, a much clearer picture of the specific aims of the project had been mapped out and embarked upon. Namely, it was proposed:-

1. to survey relic native vegetation in the vicinity of all earlier recorded localities of *Rhizanthella*, and to extend more general surveys to the remainder of the wheatbelt;
2. to develop non-destructive, widescale methods of surveying vegetation for *R. gardneri* and for assessing in greater detail its abundance in localities where it was eventually discovered;
3. to investigate the autecological requirements of the species as a basis for its management on reserves;
4. to recommend to the appropriate authorities the acquisition of a number of suitably sized reserves to preserve effectively as many as possible of the known localities of *Rhizanthella*.

Due to the supposed extreme rarity of the species, an initial undertaking was made from members of the survey team not to disturb or damage specimens in any way likely to endanger their survival, at least until such times as sufficient numbers of the species had been discovered to justify a special request to the Wildlife Authority for a single specimen or parts of specimens to be taken for strictly scientific purposes. While an obviously necessary precaution when dealing with an apparently extremely rare species, these obligations placed rigid limitations on the nature of the research that could be conducted during the course of the project, precluding, in particular, experimental studies on growth and nutrition of whole plants of the species intact *in situ* or following partial excavation.

2. METHODOLOGY OF THE SURVEYS FOR *RHIZANTHELLA*

2.1 Choice of Study Areas

By reference to flowering specimens discovered in 1979 near Munglinup, the authors were able to gain valuable first hand knowledge of the morphological characteristics and general positioning of live plants in their undisturbed state. Thus, of the 15 flowering plants discovered in 1979 all were located within 25 cm of the base of a broom honeymyrtle *(Melaleuca uncinata)*,

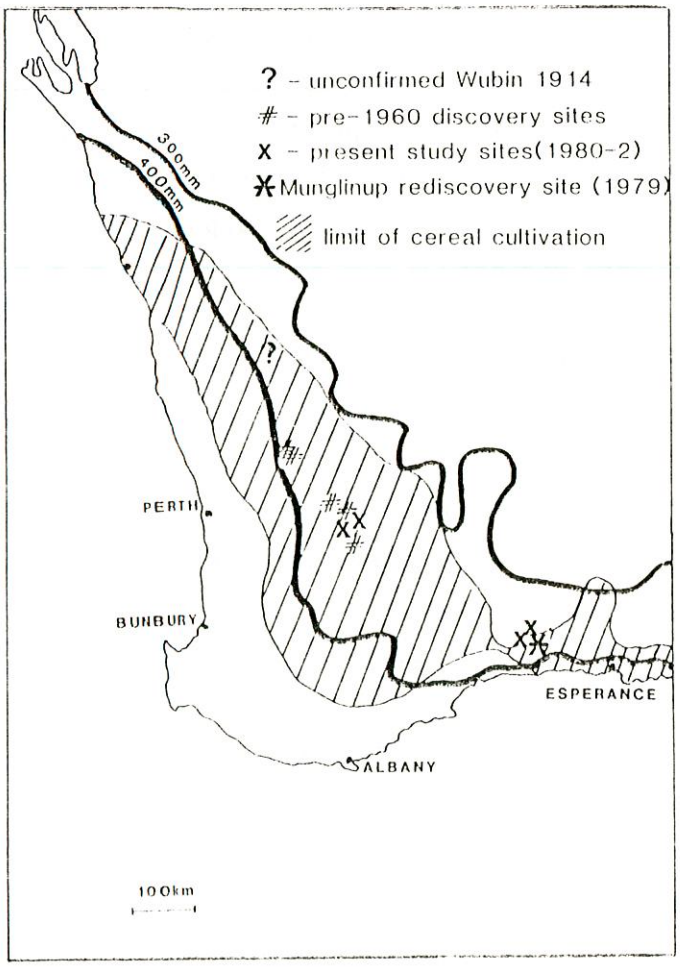

Fig. 1 Historical and current distribution of *Phizanthella gardneri* in relation to rainfall and cereal growing regions in the south-west.

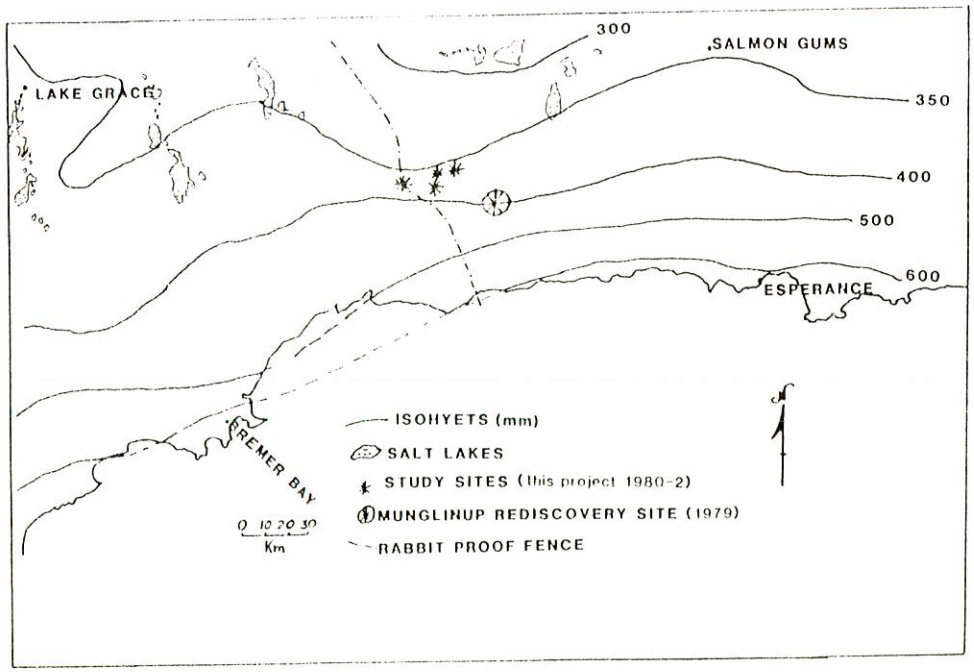

Fig. 2 Rainfall gradients for south coast locations of *Phizanthella gardneri*.

suggesting, were any degree of success to be assured, all initial searches should be restricted to stands of this species. The complex catina of soils within the discovery area gave the hope that the orchid might be quite broadly tolerant to soils ranging from lithosols to clay-loams over clay, to sandy-loams, provided of course, one would suppose, that its 'host' *Melaleuca uncinata* were present.

Since all six discoveries prior to 1979 occurred between the 300 mm and 400 mm isohyets (Fig. 1) it was decided to concentrate efforts initially on examining reserves and unvested, uncleared crown land within these confines. This range of isohyets broadly defines the major cereal growing areas of the state (such as the Munglinup area where the orchid was discovered in 1979), but excludes higher rainfall areas of the south coast some reasonably close to Munglinup (see Fig. 2). The rapid decline in rainfall from the coast inland for this portion of the state (50 mm decline for each 3.5 km of a northerly traverse to a minimum of 300 mm - local weather records, West Point Pastoral Co.) suggested a possible concentration of searches for the orchid to a coastal strip, north of the Ravensthorpe-Esperance Highway, up to and including the 300-400 mm isohyet. As will be seen, this decision was fortunate.

2.2 Mapping Procedures

The resource of uncleared crown and reserve land within the general region described above, and extending to the remainder of the sub-humid zone of Western Australia (Atlas of Australian Resources, 3rd Series, Vol. 1, 1980) was mapped onto a series of cadastral maps at 1" to 1 mile scale. This was achieved by:-

(a) plotting known flora and fauna reserves from sources within the Department of Fisheries and Wildlife and the Lands and Surveys Department, Western Australian Government;

(b) projecting enhanced LANDSAT images onto the cadastral maps, thereby allowing one to map uncleared private and crown land areas (as at early 1980), and obtain some indication of the type and condition of the vegetation and the recent fire history of the regions to be surveyed. In some instances the presence of extensive stands of *Melaleuca uncinata* could be surmised from the LANDSAT images, and appropriate follow-up engaged upon by ground surveys.

The mapping employed use of 15 cm x 15 cm LANDSAT transparencies generated from tapes held by either the Western Australian Lands and Surveys Department, or the EROS Data Centre, Sioux Falls, North Dakota, U.S.A. The transparent images were projected through an overhead projector onto a vertical glass screen. After alignment and adjustments for magnification cadastral maps on semi-transparent paper were attached to the screen and uncleared lands then mapped. Summer-scene LANDSAT images were found to provide the best differentiation of uncleared areas from cropped or cleared land, and to give best details on the quality and type of vegetation present.

Ground verification of data from the LANDSAT transparencies proved the technique to be reliable for 80% of the areas mapped; the remainder had either been recently cleared or burnt or, because of the wavelength spectrum selected to produce the enhanced images, contained elements such as samphire heath on salt pan soils which were initially confused with thickets of bushland possibly containing *Melaleuca uncinata*, and therefore potential hunting grounds for *Rhizanthella*.

2.3 Field Surveys

Areas in the central and southern wheatbelt (1970 Land Use Map of Western Australia, Department of Lands and Surveys, Perth, Western Australia) and along the south coast were divided roughly into 1^{o} lat. x 1^{o} long. grids, and then, using the earlier constructed cadastral maps and regional road maps, each 1^{o} lat. x 1^{o} long. grid square was systematically examined by vehicle for presence of stands of *Melaleuca uncinata*. An area was considered worthy of searching as a potential *Rhizanthella* habit, if the host shrub was present either as the dominant upper or second stratum within thicket, scrub or mallee formations (Muir 1977). Only those areas of *M. uncinata* greater than 500 m^{2} were deemed worthy of intensive investigation, since even if such areas were proved to contain the orchid, effective protection of such small sites would be improbable.

Following each initial survey, areas judged to be most promising were revisited and searches on foot then undertaken to determine whether flowering material of *Rhizanthella* could be discovered. The search method employed the use of the hand forks with curved tines, commonly used by Australian gardeners and not unlike the classic European "truffle-rake". The technique involved scraping litter from within and adjacent to the base of each of a

successive number of plants of *M. uncinata*, carefully disrupting the top few millimetres of soil beneath the litter at each successive scraping to look for emerging inflorescences. Were mature *Rhizanthella* flowering heads present it was considered that the tips of its involucral bracts would be exposed by this treatment. There was already therefore the possibility of superficial damage to the bracts in scraping before discovery, but our records eventually showed only two such cases in the 150-odd instances where a capitulum or groups of capitula had been discovered. Following examination of each plant of a *M. uncinata* the litter was replaced regardless of whether an orchid inflorescence had been found or not. Revisits to sites of initial discovery in subsequent years indicated that a previous year's examination had no apparent deleterious effects on either the *Melaleuca* or on the subsequent flowering of the orchid populations. Each orchid plant was tagged discreetly so that further observations could be made on later visits. Where a capitulum was sufficiently mature for its inside to be examined, the size and number of flowers in the capitulum and its distance to any nearby capitula were recorded. Soil samples collected from each orchid site were analyzed by atomic absorption spectrophotometry for a range of nutrient elements including sodium, calcium, phosphorus, potassium, nitrogen and a range of trace elements. Fungal materials (mycelia and fructifications) at the site were also collected for subsequent investigation.

2.4 Test of Relationship between *Melaleuca uncinata* and *Rhizanthella gardneri*

To examine the possibility that the orchid might be associated with species other than *M. uncinata* a series of 25 sites were selected and examined for presence of *Rhizanthella* both within *Melaleuca* thickets and in partner closely adjacent sites embracing other types of vegetation. A range of soil types was included in the study and most sites comprised one or other of the following vegetation types - woodland, tree-scrub, thicket, scrub and scrub-heath (Beard 1980). The majority (15 out of 25) of sample sites were within 1 km or less of confirmed habitats of the orchid and conformed to scrub with emergent mallee (Muir 1977). The rarity (apparent or real) of *Rhizanthella* and the problem of how to undertake searches for this subterranean species in vegetation other than *M. uncinata* thickets presented great difficulties when attempting to interpret results of the study. Nevertheless, no specimen of the orchid was ever found outside stands of *M. uncinata* or stands of mixed vegetation including clumps of *M. uncinata*.

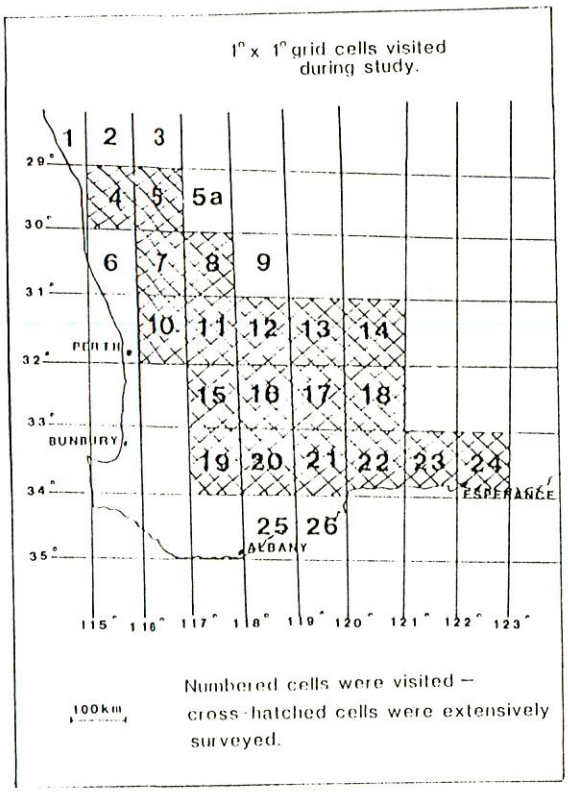

Fig. 3 1^{o} latitude x 1^{o} longitude grid cells visited during study (crosshatched). Grid cell numbers are referred to in Table 3.

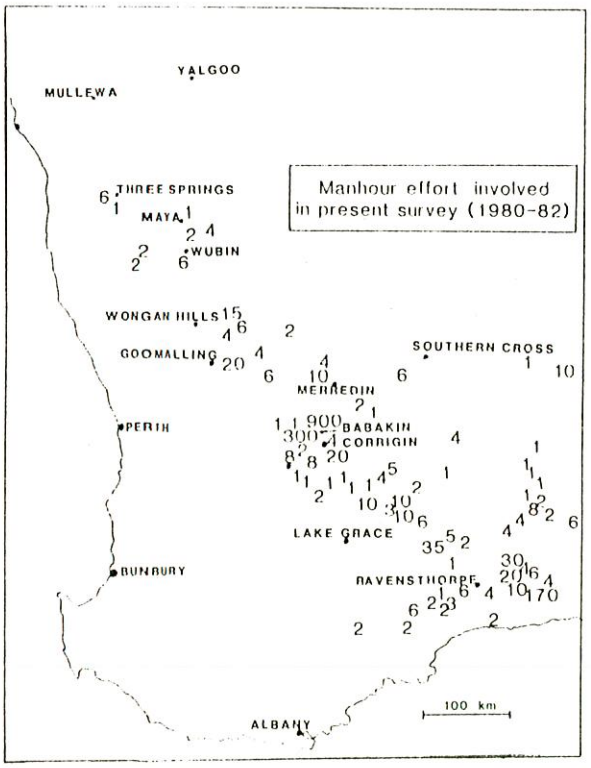

Fig. 4 Natural stands of vegetation visited during study with man hour effort involved in searching indicated.

2.5 Vegetation Surveys

Vegetation surveys based on the method of Pate, Dixon and Orshan (1984) and mapping of areas using the vegetation units suggested by Beard (1980) were undertaken to provide an indication of the likely range of vegetation types, species groupings, and growth and life form spectra of species neighbouring on or actually within the known *Rhizanthella* habitats.

Comprehensive collections were made of all flowering species and an herbarium of voucher specimens assembled to complement vegetation surveys. Checks were made of the presence in study areas of geographically-restricted or poorly-collected species (as listed by Marchant and Keighery 1979, Rye 1982). Apart from the scientific value of such studies, discovery of other endangered species within *Rhizanthella* habitats would obviously strengthen the case for such areas being assigned the highest reservation status.

3. RESULTS OF THE SURVEYS FOR *RHIZANTHELLA*

3.1 Survey Areas

Figure 1 shows the limits of cereal growing areas as defined in the Atlas of Australian Resources (Third Series, Vol. 1, 1980), while the cross-hatching of 1^{o} lat. x 1^{o} long. grid squares in Fig. 3 indicates which squares were comprehensively surveyed for the presence of *Melaleuca uncinata* and where deemed appropriate, examined by follow-up survey for *Rhizanthella gardneri*. Figure 4 illustrates those reserves and areas of undisturbed crown land visited during the study, indicating the approximate positions of the nature reserves or uncleared crown lands visited, and the number of man hours of time invested in searching each area for *Rhizanthella*.

The distribution of the two readily distinguishable variant forms of *M. uncinata* encountered during the survey is illustrated in Fig. 5. The variants may be described as follows:-

(a) A 'flat-leaved variant' which possesses leaves which are linear-lanceolate rather than terete. The single stems of this type are >2 m tall and arise from a basal mallee-type root stock, which unlike the typical type forms of *M. uncinata* shows little spherical development or swelling. Plant densities in thickets are typically 30-50 per $25m^2$.

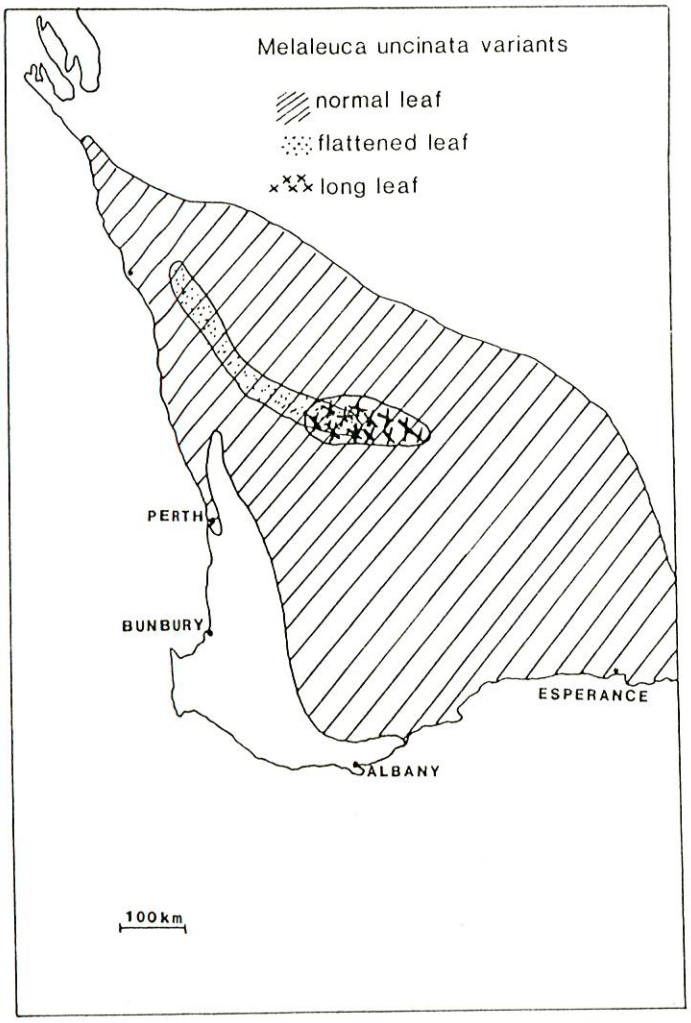

Fig. 5 Distribution of *Melaleuca uncinata* and its variants in the south-west of Western Australia.

(b) A 'long-leaved variant' form which resembles *M. uncinata sensu stricto* in possessing erect, multibranching stems to 2 m arising from a spherical swollen mallee-type root stock buried at or just below the soil. Leaves of this variant are 20-30 mm long *versus* 10-15 mm long in the usual form of *M. uncinata*. Plant densities of this form are highly variable.

Though these above two forms have long been recognised to exist by other workers, more exhaustive biological study is required to investigate what is clearly a large and complex pattern of variation within the species across its wide distribution range in southern Australia. Relevant to the present project is the fact that no occurrences of *Rhizanthella* were associated with either of these variants. Possibly they do not act as suitable hosts for the orchid.

The majority of areas visited could be grouped as containing (a) no *Melaleuca uncinata* at all, (b) *M. uncinata* as one or other of the variants listed above, or (c) *M. uncinata* in depauperate condition or growing in what was considered unsuitable terrain for *Rhizanthella*, i.e. rock or lithosols, swamps or semi-saline habitats. On these grounds, the habitat range and edaphic tolerances of *M. uncinata* are likely to be much more extensive and wider than those deemed suitable for *Rhizanthella*.

Table 2 indicates the number of reserves visited one or more times over the period 1980-82 and shows the very poor success of these visits in locating the orchid. Certain larger reserves and areas considered initially to be highly suitable habitats for *Rhizanthella* were visited many times without turning up the orchid (eg. Dragon Rocks Reserve - six visits; Lake King West- five visits). The quite enormous man hour effort involved is shown in Table 2, and largely reflects the considerable support provided to us by the members of the Western Australian Native Orchid Study and Conservation Group. In addition, local people from towns and farms frequently lent support as we searched for the orchid in their districts. Levels of enthusiasm rose dramatically once a first find of the orchid had been made and news of the discovery had spread in a particular locality.

Details of transects for the 100 areas surveyed are contained within the folio of 1 inch to 1 mile cadastral maps housed in the Botany Department, University of Western Australia (see Fig. 4). LANDSAT details (current to 1980) of uncleared private and crown land within the South-west Division mapped to a

resolution of 10 hectares are also housed at the same location.

TABLE 2 SITES VISITED DURING 1980-82 FOR SURVEY OF *RHIZANTHELLA GARDNERI*

	Number visited	Number with *Rhizanthella*	No. of Plants Found[3] (1980-82)	Search Time at Sites (Man hours)	Total time Searching (Man Hours)
Nature reserves vested in Dept. of Fisheries and Wildlife	47	2	19	1700	3200
Crown lands[2], not nature reserves (vested and unvested)	>50	2[1]	151		

NOTE: Records do not include the rediscovery site near Munglinup nor the plants found at that site.

[1]One of these sites (adjacent to the township of Babakin) is currently under consideration as an 'A' class flora and fauna reserve.

[2]Detailed descriptions of each of the four areas is given in a later section.

[3]Does not include repeat flowering of same plants in a subsequent season.

3.2 Identified Localities for Present Populations of *Rhizanthella gardneri*

A total of only four separate localities were found to contain *Rhizanthella* during the period 1980-82 (see Table 2). All were within 50 km of earlier discovery sites for the orchid. Grid cells visited during the study are listed in Table 3 together with those cells deemed worthy of closer inspection.

Sites where *Rhizanthella* had been sighted or recorded in the 1914-1958 period were relocated by ourselves wherever possible, but in each instance the search proved fruitless as it was found that the natural vegetation had long been cleared or was now so heavily grazed as there to be little likelihood of the orchid still surviving.

TABLE 3 IDENTITIES OF 1^{o} LAT. x 1^{o} LONG. GRID CELLS VISITED AND INVESTIGATED FOR SUITABLE STANDS OF *MELALEUCA UNCINATA* AND THE EXISTENCE OF *RHIZANTHELLA GARDNERI** (REFER TO FIG. 3 FOR LOCATION OF CELLS IN S.W. AUSTRALIA.)

Cells surveyed	Cells thoroughly examined for *M. uncinata*	Cells with extant *Rhizanthella* and historical sightings	Cells worthy of further examination	Cells known to contain good stands of *M. uncinata* but not investigated in current study
4,5,5a,7,8,10, 11,12,13,15, 16,17,18,19, 20,21,22,23, 24,25,26	4,7,8,10,11,12, 15,16,17,18,19, 20,21,22,24	16,22	5,13,23	1,2,9

*All pre-1979 localities for *Rhizanthella* (except dubious recording from Wubin 1914) have been cleared or the habitat has been irrevocably destroyed. In all instances no *Melaleuca uncinata* remains.

The distribution of extant populations of *Rhizanthella* (Fig. 1) shows two nodes of occurrence - one in the central wheatbelt, the other near the south coast. Whether these represent what have always been two distinct populations, or whether they are merely relics of what was once a larger continuous distribution range remains a matter of conjecture.

3.2.1 Central Wheatbelt Locations

The two localities involved both lie within the Shire of Bruce Rock.

RHIZANTHELLA LOCALITY 1 - BABAKIN TOWN RESERVE (cadastral map 4/80 Dept. of Lands and Surveys).

Situated 32 km north of Corrigin, $37^{o}7'S$, $118^{o}5'30"E$.

Background

Babakin was originally created as a regional centre for the shipment of grain and livestock in the early 1900's. Since then the importance of the town has declined steadily, as indicated by a marked drop in its population and facilities. Today all that remains of the town is a general store, primary school, hall and recreational facilities. The population of less than twenty persons consists of town-dwelling farmers, school teachers and the owners of the store.

The reserve, situated to the north and west of Babakin, was originally set aside to act as a reliable source of water via an earth dam and catchment, and to provide timber for domestic heating, town refuse facilities and, in earlier times, gravel for road building.

Physical Characteristics

The reserve has an area of approximately 250 ha. The highest points are on the northern and south western perimeters with a gentle slope towards an ephemeral water course which runs NW to W, crossing the Shackleton-Babakin Road on the western perimeter of the reserve. Topographic relief is gentle throughout, with granite outcrops rising to 2 m above the surrounding land along the western perimeter of the reserve.

The soils are lithosolic near granite rocks or where sub-surface rock occurs. Elsewhere they vary from white, leached, sandy-clay soils to red clays and loams - the latter in and adjacent to the drainage areas. Soils conform to categories Cd2 and Bb4 of Northcote (1971). Subsoils (>20 cm) are highly sodic and of low permeability resulting in seasonally perched water tables, with attendant saturation of upper soil profiles. General fertility is low with deficiencies in S, Mo, Cu, Zn and low levels of N, P, and K. Organic matter averages less than 5% of wet soil weight.

Five vegetational associations were recognised using the classificatory system of Muir (1977):-

(1) Wandoo Woodland: woodland of *Eucalyptus wandoo* with an intermittent and patchy understorey of broombush *(Melaleuca uncinata)*.

(2) Mallee Over Broombush Heath: open shrub mallee of *Eucalyptus cylindriflora* and *E. redunca* with scattered *E. loxophleba* over

broombush heath to 2 m tall with scattered *Melaleuca densa* and *Leptospermum erubescens*. Herb layer mainly consisting of *Borya nitida*.

(3) Broombush Heath: Heath A (Muir 1977), with scattered emergent mallees, *E. cylindriflora, E. redunca, E. foecunda*, understorey almost absent.

(4) Low Heath: equivalent to low heath 'c' (Muir 1977), containing a complex of species with scattered emergent *Acacia* spp., *Casuarina* spp., and rarely mallee *Eucalyptus*.

(5) Casuarina Heath: (= Tamma heath of Muir, unpubl.), dense heath of *Casuarina campestris* with scattered emergent *Acacia* spp. Understorey sparse except for patchy areas of *Borya nitida* and Restionaceae spp.

Plant Species

Some 87 higher plant species were recorded for the Babakin Reserve. One unusual find was the spider orchid *Caladenia multiclavia*, considerably outside the geographical range normally associated with this species. This orchid generally favours open heath in lithosol and lateritic-clays in *Casuarina campestris* heath. The orchid blooms at Babakin in September and is locally abundant. Flowering frequency is apparently linked to favourable winter rains.

Disturbance

Severe infestations by alien weed species, particularly *Briza* spp., *Arctotheca calendula* (capeweed), *Rhaphanus raphanistrum* (wild turnip) and *Trifolium* spp., were evident in areas surrounding granite rocks and in the semi-cleared areas towards the western margins of the reserve. The town dump, gravel quarry and moister areas along drainage channels were also prone to weed invasion. Spread of these alien species was directly related to the scratching and burrowing habits of the rabbit whose feeding on adjacent farmland introduces weed seeds to the parts of the bush reserve where they take refuge during the daytime. Sheet erosion and runoff, particularly from pasture lands upslope from the north and west of the reserve, appear to have contributed weed seeds and runoff of fertilizer to varying extent along all reserve margins. The western edges of the reserve are now so densely occupied by weed species that many native herbaceous and small shrub species have disappeared or are declining. Direct human disturbance from the small population of the town is now minimal and confined to tracks (which serve as

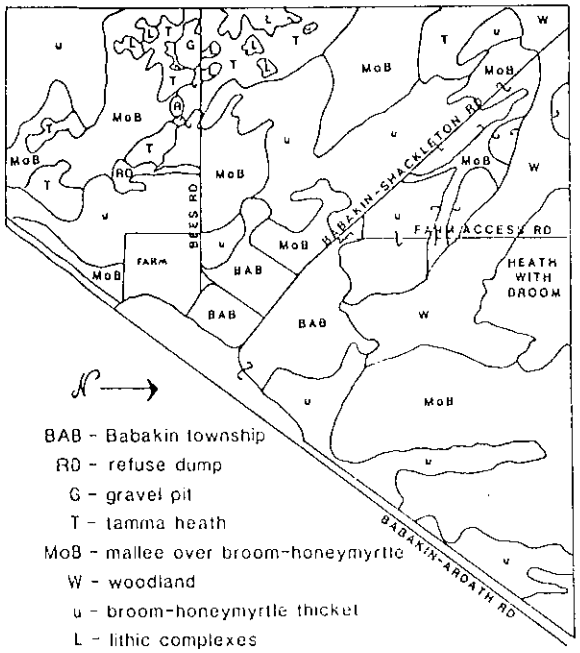

Fig. 6 Vegetation map for Babakin township reserve (see text for details).

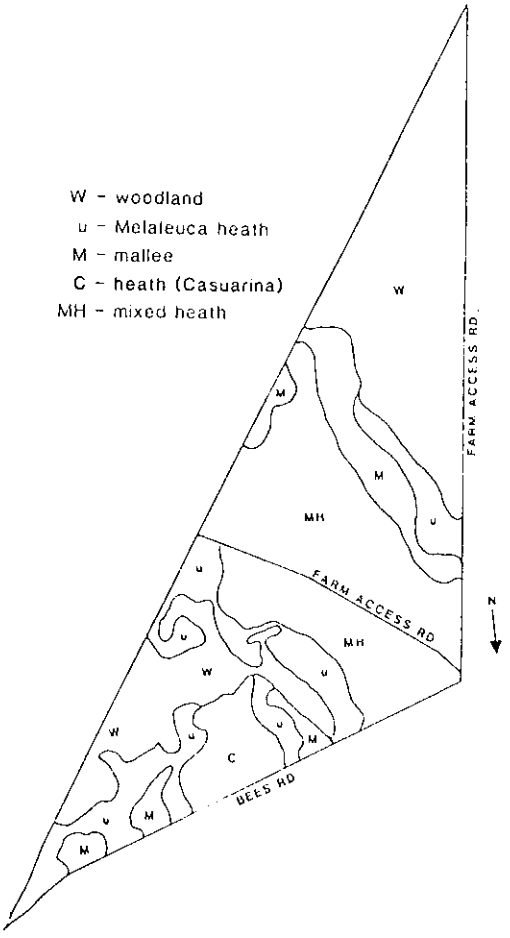

Fig. 7 Vegetation map for Sorenson's Reserve situated west of Babakin (see text for details).

fire breaks) and to the clear-scraped area established to extend the water catchment of the local dam. With the reduced population of the town, this catchment is no longer needed and native species are fortunately recolonising most of the area.

Adjacent Uncleared Land

The nearest other area of bush in any way near-pristine condition is that at Sorenson Reserve (No. 16104), some 8.5 km to the west of the Babakin town site. All privately owned land has been virtually completely cleared, possibly with a few remaining elements of the natural vegetation persisting around granite outcrops. Disturbance by sheep, cattle and rabbits is extensive in these lithic areas and vegetation accordingly damaged beyond repair.

TABLE 4 OCCURRENCE OF FLOWERING SPECIMENS OF *RHIZANTHELLA GARDNERI* IN BABAKIN TOWN RESERVE*.

Survey Dates	Area Surveyed (ha)	No. of Observers	No. of Plants Found	No. Reflowering	Field Man Hours Per Find
1980 May	1.5	2	1	-	6
1981 June	40	21	24	-	12
July	20	4	4	-	10
August	20	8	10	-	12
1982 May	150	23	109	10	3
June	2	4	1	Nil	4
		Mean man hour effort per find			8

*Subsequent surveys conducted in 1983 yielded only 2 flowering specimens. Annual surveys of this reserve will continue.

Occurrences of *Rhizanthella gardneri* (see Table 4)

Our discovery of a single flowering specimen of *Rhizanthella* in Babakin in

the drought season of 1980 was the first such find of the orchid in non-agricultural situations using deliberate litter searching by non-destructive means. The single specimen was located approximately 12 km away from a now cleared area of scrub where the orchid had previously last been unearthed during land clearing by a farmer (James Bee) in 1959. Subsequent visits to the Babakin town site in the much wetter seasons of 1981 and 1982, using the willing assistance of up to thirty members of the W.A. Native Orchid Study and Conservation Group, discovered a total of 140 plants - a truly outstanding effort in view of the physical endurance required in searching, the paucity of previous records of the plant, and the low densities of the plants at the sites in question. No other areas yet surveyed with comparable intensity of effort have approached the richness and density of *Rhizanthella* plants recorded for the Babakin town reserve. Considering that the vegetation consists of vast tracts of *M. uncinata* which are yet to be surveyed, it is reasonable to assume that considerably more *Rhizanthella* plants might exist in the reserve than have been currently recorded.

Vegetation Associations and Species Composition

For each of the five major types of vegetation within the reserve, brief descriptions were made in terms of dominant species and floristic composition. Taken together they should provide a virtually complete inventory of the total resource of the native flora in the reserve.

(1) Wandoo Woodland

Eucalyptus wandoo. The dominant upper storey trees are 10-20 m tall with 20-25% canopy cover. The lower tree canopy, particularly where soils are more loamy-clay, is dominated by *E. loxophleba.*

Other species recorded included:-

Billardiera coriacea (climber 1.5m)
Comesperma scoparia (shrub 1.0m)
Dodonaea bursarifolia (shrub 1.5m)
Eremophila scaberula (shrub 1.0m)
Eucalyptus cylindriflora (mallee 4.0m)
Gastrolobium spinosum (shrub 1.5m)
Goodenia affinis (procumbent herb)
Hakea lissocarpha (shrub 2.0m)
Lomandra effusa (herb 0.25m)
Loxocarya pubescens (herb 0.25m)
Melaleuca urceolaris (shrub 1.0m)
Olearia muelleri (shrub 0.5m)
O. rudis (shrub 0.5m)
Phebalium filifolium (shrub 0.75m)
P. microphyllum (shrub 0.75m)
Santalum acuminatum (tree 3m)

Leptospermum ellipticum (shrub 2.0m)

(2) Mallee Over Broombush Heath

Open mallee shrubs, *Eucalyptus foecunda, E. redunca, E. cylindriflora* and *E. calycogona* are co-dominants of the 3 m high upper stratum with 10-20% canopy cover. The second stratum is dominated by *Melaleuca uncinata* to 2 m with 40-60% canopy cover. Mallees predominate in drier soils whilst in wetter parts of depressions *M. uncinata* can assume upper stratum dominance.

Understorey biomass in this formation is relatively poor reflecting shading effects of the upper strata. Species list below represent major species, though their combined canopy cover is probably only 10-15%.

Acacia dielsii (shrub 1.0m)
Baeckea heteranthera (shrub 0.5m)
Brachyloma concolor (shrub 0.3m)
Cryptandra pungens (shrub 0.3m)
Ecdeiocolea monostachya (herb 0.2m)
Gahnia ancistrophylla (herb 0.3m)
Leptospermum erubescens (shrub 2m)
Lomandra effusa (herb 0.25m)
Loxocarya pubescens (herb 0.25m)
Melaleuca acuminata (shrub 2.5m)
M. adnata (shrub 2.5m)
M. densa (shrub 1.5m)
M. laterifolia (shrub 2.0m)
M. spathulata (shrub 1.5m)
M. undulata (shrub 1.5m)
Mesomelaena uncinata (herb 0.3)
Neurachne alopecuroidea (herb 0.2m)
Olearia muelleri (shrub 0.5m)
Santalum acuminatum (tree 3m)

(3) Broombush Heath

Melaleuca uncinata shrubs dominate; height to 2 m with a 50-80% canopy cover. Occasional emergent mallee *Eucalyptus*.

Suppression of understorey species by shading is again a significant factor in accounting for the low biomass of understorey species.

Species composition is similar to the mallee over broombush association except that the lower strata contribute less than 10% of canopy cover. Dominants in the lower stratum include:-
Loxocarya pubescens (herb 0.25m) and *Borya nitida* (herb 0.05 m)

Soils are typically deeper and moister than the surrounding mallee over

broombush association.

(4) Low Heath

A range of shrub species cohabit this heath with a 50-70% canopy cover and and average height of 0.5-1.0 m. Occasional emergents include *Acacia acuminata* (shrub 2.5m), mallee *Eucalyptus* (2.5 m) and *Melaleuca uncinata* (shrub 1.5m).

Other species recorded for the area include:-

Acacia dielsii (shrub 1.0m)
Borya nitida (herb 50mm)
Calothamnus quadrifidus (shrub 1.0m)
Calytrix brachyphylla (shrub 0.6m)
Casuarina campestris (shrub 1.0m)
C. microstachya (shrub 0.8m)
Dodonaea bursarifolia (shrub 1.0m)
Eucalyptus cylindriflora (shrub 2.5m)
E. redunca (shrub 2.5m)
Grevillea huegellii (shrub 1.2m)
Hakea trifurcata (shrub 1.5m)
Isopogon scabriusculus (shrub 0.5m)
Lepidosperma gracile (herb 0.5m)
Lomandra effusa (herb 0.25m)
Loxocarya pubescens (herb 0.25m)
Melaleuca densa (shrub 1.0m)
M. lateriflora (shrub 1.0m)
M. steedmanii (shrub 1.0m)
M. urceolaris (shrub 0.5m)
Oxylobium sp. (shrub 1.0m)
Phebalium filifolium (shrub 0.5m)
Psammamoya choretroides (shrub 0.8m)

Soils range from heavy clays in the low lying areas to lithosols on drier upland sites.

(5) Casuarina Heath

The dominant *Casuarina campestris* shrubs are 0.5-1.5 m tall, giving 25-60% canopy cover over mixed, sparse shrubs to 0.8 m tall. A low heath of mixed shrubs occurs in open areas (see 'low heath'). Occasional emergents are *Acacia* sp. and *Santalum acuminatum* to 3 m.

The species list for the vegetation type is:-

Acacia acanthoclada (shrub, 0.5m)
A. dielsii (shrub, 1.0m)
Anthotium rubrifolium (subshrub 0.25m)
Baeckea heteranthera (shrub 0.5m)
Hibbertia uncinata (shrub 0.4m)
Leucopogon dielsianus (shrub 0.3m)
Loxocarya fasciculata (herb 0.2m)
Melaleuca cordata (shrub 0.8m)

Borya nitida (herb 50mm)
Calothamnus quadrifidus (shrub 1.0m)
Comesperma scoparia (shrub 0.5m)
Cryptandra pungens (shrub 0.5m)
Dianella revoluta (herb 1.0m)
Dryandra cirsioides
Gastrolobium spinosum (shrub 0.5m)
Grevillea integrifolia (shrub 1.0m)
Hakea circumalata (shrub 0.8m)
M. spathulata (shrub 0.8m)
M. uncinata (shrub 1.0m)
Mesomelaena uncinata (herb 0.4m)
Persoonia striata (shrub 0.5m)
Petrophile drummondii (shrub 0.5m)
Psammamoya choretroides (shrub 0.5m)
Synaphea polymorpha (shrub 0.4m)
Verticordia chrysantha (shrub 0.4m)

Soils of type 5 vegetation vary from yellow clay-sands to lateritic sandy-clays.

Lithosol and granite rock vegetation associations (see Fig. 6) lying outside the five major vegetation types typically carry a suite of herbaceous and Semi-woody species, mostly adapted to the stresses of parched shallow soils during summer by acting as ephemerals or herbaceous perennial geophytes bearing corms or root tubers. Herbaceous plants in such areas show a 3-4 times greater diversity of species than any of the other habitats. Unfortunately these lithosol and outcrop sites face the greatest threat from rabbit activity and weed incursions. Control of these adverse influences is considered to be essential to preservation of species diversity and ultimately, protection of the *Melaleuca* thickets.

Species of lithosols on or adjacent to outcrops include:-
(All herbaceous)

Caladenia flava
C. gemmata
C. multiclavia
C. roei
Calandrinia corrigilioides
Chamaescilla corymbosa
C. spiralis
Crassula coloratum
Dichopogon strictus
Diuris longifolia
Drosera glanduligera
D. macrantha
D. stolonifera
Ophioglossum lusitanicum
Phylloglossum drummondii
Platysace maxwellii
Prasophyllum macrostachyum
P. fimbria
Stylidium breviscapum
S. bulbiferum
S. annual sp 1
S. annual sp 2
Thelymitra antennifera
Thysanotus patersonii
T. thrysoideus
Tribonanthes uniflora

D. sulphurea *T. variabilis*
Isoetes muelleri

Fire Influences

Burns have not occurred in the reserve area for at least 30 years, a fact attributable in part to the small size of the reserve, and its juxtaposition to the town of Babakin.

The high density of *M. uncinata* in many areas of the reserve would pose a significant threat to *Rhizanthella* populations were a canopy fire to spread from nearby wooded areas. However, the general lack of litter and understorey species in the *Melaleuca* thickets themselves would probably diminish the possibility of an underground orchid such as *Rhizanthella* suffering directly from fire.

Fauna

The following list of birds was compiled by Ken Wallace, Wildlife Authority District Officer, whose assistance is gratefully acknowledged in this and other respects.

BIRDS RECORDED ON RESERVES ADJOINING BABAKIN TOWNSITE
21.9.81 and 22.9.81

Common Name (as per RAOU Checklist)	Scientific Name
Port Lincoln Ringneck	*Barnardius zonarius*
Horsefield's Bronze Cuckoo	*Chrysococcyx basalis*
White-winged Triller	*Lalage sueutii*
Golden Whistler	*Pachycephala pectoralis*
Grey Shrike-Thrush (V)	*Colluricincla harmonica*
Grey Fantail	*Rhipidura fuliginosa*
White-browed Babbler	*Pomatostomus superciliosus*
Songlark	*Cinclorhamphus* sp
Western Gerygone	*Gerygone fusca*
Singing Honeyeater	*Lichenostomus virescens*
Brown Honeyeater (V)	*Lichmera indistincta*
White-fronted Honeyeater	*Phylidonyris albifrons*
Brown-headed Honeyeater	*Melithreptus brevirostris*

Striated Pardalote (V)	*Pardalotus striatus*

BIRDS RECORDED IN THE VICINITY OF THE RESERVES

Australian Magpie-lark	*Grallina cyanoleuca*
Australian Magpie	*Gymnorhina tibicen*
Black-faced Cuckoo-strike	*Coracina novae-hollandiea*
Crested Pigeon	*Ocyphaps lophotes*
Galah	*Cacatua roseicapilla*

(V) = identified by call

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RHIZANTHELLA LOCALITY 2 - SORENSON'S RESERVE (Reserve 16104)

This second locality in the central wheatbelt with a surviving colony of *Rhizanthella* is located approximately 8.5 km west of Babakin (lithograph 2433-1C2 Dept. of Lands and Surveys). Establishment of the reserve was recommended by B. Muir in his survey of wheatbelt vacant crown land. With discovery of *Rhizanthella* in the reserve in 1980 it was elevated to A Class status.

An unsealed track, Bees Road, running on the northern perimeter provides the only access to the reserve and is also used by nearby farmers as a service road to the adjoining areas of arable land.

Physical Characteristics

The reserve has an area of 108 ha and is surrounded on all three sides by farmland. Topographic relief is gentle with the highest points along the SE perimeter and sloping away to the west. No permanent or ephemeral water courses occur on the reserve. Rocky areas are restricted to a laterite plateau on the northern perimeter.

Soil types include coarse white sands to 30 cm overlying clays, loam clays (wandoo woodland), loamy clays with laterite pebbles and lithosols on the laterite exposures. Edaphic features are essentially similar to Babakin town reserve.

Occurrences of *Rhizanthella gardneri*

The exceptionally small size of the reserve and the restricted area of *Melaleuca uncinata* within it makes the Sorenson's location a most vulnerable locality of the orchid. Situated only 3-4 km from the 1959 discovery site (property of Charles Bee) the reserve has so far yielded a total of 6 plants from three visits (Table 5).

All specimens appeared healthy although the capitula were smaller and contained fewer flowers than specimens from the Babakin Reserve.

TABLE 5 SEARCH AREA AND MAN HOUR EFFORT IN RECOVERY OF *RHIZANTHELLA GARDNERI* ON SORENSON'S RESERVE, 1981-82.

Survey Dates	Area Surveyed (ha)	No. of Observers	No. of Plants Found	No. Reflowering	Field Man Hours Per Find
1981 June	4	18	2	-	18
August	10	2	0	-	-
1982 May	8	23	4	1	14
			Av. man hour effort per find		16

Plant Species

A total of 61 plant species were recorded for the reserve. A further range extension for the lazy spider orchid, *Caladenia multiclavia* was recorded for the reserve. Surprisingly, this uncommon species was found in abundance in both *Melaleuca uncinata* heath and *Casuarina* heath, where it was sympatric with other members of the genus viz. *Caladenia roei, C. filamentosa, C. gemmata* and *C. patersonii*. Hybrid swarms were evident between *C. roei* and *C. multiclavia*. Another uncommon species of *Caladenia* found on the reserve was the winter spider orchid *C. drummondii*. This species appears to prefer the sandy loams and sands in either the mallee or *Melaleuca* heath of the reserve.

The five associations of vegetation located within the reserve are as shown

below, the first four being essentially as conceived by Muir (1977). These are mapped in Fig. 7.

(1) Casuarina Heath (C) : *Casuarina campestris* as low heath or in a low heath of mixed shrubs.

(2) Melaleuca Heath (H) : *Melaleuca uncinata* (broombush) with *M. densa* and some *Leptospermum erubescens* all up to 2.0 m, understorey sparse.

(3) Mallee (M) : *Eucalyptus cylindriflora* with *E. redunca* and *E. calycogona*, understorey sparse.

(4) Woodland (W) : *Eucalyptus wandoo* low woodland with a variable though sparse understorey.

(5) Mixed Heath (MH) : A variety of species including *Casuarina* spp., *Melaleuca* spp., *Leptospermum erubescens*, *Hakea lissocarpha* to 1.0 m with scattered emergent mallee eucalypts to 2.0 m.

Species list with details of the life form of the principal vegetation elements were as follows:-

(1) Casuarina Heath

Casuarina campestris shrubs, mature, 1.0-1.5 m tall, 25-70% canopy cover over mixed shrubs 0.5 m tall with 10-30% canopy cover.

Other species recorded were:-

Acacia acanthoclada (shrub 0.5m)
A. dielsii (shrub 0.5m)
Baeckea heteranthera (shrub 0.5m)
Borya nitida (herb 35mm)
Calothamnus quadrifidus (shrub 1.0m)
Casuarina microstachya (shrub 0.8m)
Chamaexeros fimbriata (herb 70mm)
Choretrum glomeratum (shrub 1.0m)
Comesperma scoparia (shrub 0.5m)
Cryptandra pungens (shrub 0.5m)
Dryandra cirsioides (shrub 0.5m)
Gastrolobium spinosum (shrub 1.0m)
Grevillea integrifolia (shrub 1.0m)
Hakea circumalata (shrub 1.0m)
H. incrassata (shrub 1.0m)
Hibbertia uncinata (shrub 0.4m)
Leucopogon dielsianus (shrub 0.5m)
Loxocarya fasciculata (herb 20cm)
Melaleuca cordata (shrub 1.0m)
M. spathulata (shrub 1.0m)
M. uncinata (shrub 1.0m)
Mesomelaena uncinata (herb 30cm)
Persoonia striata (shrub 0.5m)
Petrophile drummondii (shrub 0.5m)
P. ericifolia (shrub 0.5m)
Synaphea polymorpha (shrub 30cm)
Verticordia chrysantha (shrub 40cm)
Xanthorrhoea nana (herb 40cm)

(2) Melaleuca Heath

Melaleuca uncinata, *M. densa* and *Leptospermum erubescens*, shrubs to 1.5 m tall with 30-70% canopy cover. Scattered *Eucalyptus calycogona*, *E. foecunda* and *E. redunca* mallee to 3 m tall.

The following species were also recorded:-

Acacia dielsii (shrub 0.5m)
Baeckea heteranthera (shrub 0.5m)
Borya nitida (herb 35mm)
Brachyloma concolor (shrub 0.4m)
Casuarina microstachya (shrub 0.5m)
Choretrum glomeratum (shrub 1.0m)
Cryptandra pungens (shrub 0.5m)
Dryandra cirsioides (shrub 0.5m)
Gastrolobium spinosum (shrub 1.0m)
Hakea circumalata (shrub 1.0m)
Loxocarya fasciculata (herb 20cm)
Melaleuca spathulata (shrub 1.0m)
Mesomelaena uncinata (herb 30cm)
Petrophile ericifolia (shrub 0.5m)

(3) Mallee

Eucalyptus cylindriflora, *E. redunca*, *E. calycogona* shrub mallee, maturing to 4-9 m tall with 30-70% canopy cover.

Acacia erinacea (shrub 0.5m)
A. orbifolia (shrub 0.5m)
Brachysema daviesioides (shrub 20cm)
Eucalyptus transcontinentalis (shrub 2.5m)
Lomandra effusa (herb 30cm)
Loxocarya pubescens (herb 20cm)
Melaleuca scabra var. tuberculata (shrub 0.5m)
M. uncinata (shrub 0.5m)
M. undulata (shrub 0.5m)
Olearia muelleri (shrub 0.5m)
Disphyma australe (ground cover 10cm)
Dodonaea bursarifolia (shrub 40cm)

(4) Woodland

Eucalyptus wandoo trees, mature, 8-14 m tall, with 10-30% canopy cover. Understorey virtually absent except for small localized patches of *Leptospermum erubescens* up to 10-30% canopy cover. Other plant species recorded were:-

Acacia glaberrima (shrub 0.5m)
Astroloma epacridis (shrub 0.5m)
Borya nitida (herb 35mm)
Casuarina acutivalvis (shrub 1.0m)
Comesperma scoparia (shrub 0.5m)
Daviesia teretifolia (shrub 0.5m)
Dianella revoluta (herb 0.8m)
Eucalyptus cylindriflora (shrub 3.0m)
Gastrolobium crassifolium (shrub 0.5m)
G. trilobum (shrub 0.5m)
Grevillea huegellii (shrub 1.0m)
Hakea lissocarpha (shrub 1.0m)
Lepidosperma gracile (herb 0.5m)
Lomandra effusa (herb 30cm)
Loxocarya pubescens (herb 20cm)
Melaleuca densa (shrub 0.5m)
Santalum acuminatum (tree 3m)
Stylidium breviscapum (herb 15cm)

(5) Mixed Heath

Casuarina campestris, C. acutivalvis, Melaleuca uncinata, M. densa, Leptospermum erubescens and Hakea lissocarpha were the dominant shrubs providing 40-70% canopy cover. Other shrubs (listed below) occurred as codominants at various sites.

Acacia acanthoclada (shrub 0.5m)
A. dielsii (shrub 0.5m)
Baeckea heteranthera (shrub 0.5m)
Calothamnus quadrifidus (shrub 0.5m)
Casuarina microstachya (shrub 0.5m)
Choretrum glomeratum (shrub 1.0m)
Cryptandra pungens (shrub 0.5m)
Dryandra cirsioides (shrub 0.5m)
Gastrolobium spinosum (shrub 1.0m)
Hakea incrassata (shrub 1.0m)
Leucopogon dielsianus (shrub 0.5m)
Melaleuca cordata (shrub 1.0m)
M. spathulata (shrub 1.0m)
Petrophile drummondii (shrub 0.5m)
P. ericifolia (shrub 0.5m)
Verticordia chrysantha (shrub 40cm)
Xanthorrhoea nana (herb 40cm)
X. reflexa (tree 2.0m)

A variety of native herbaceous species were scattered throughout the reserve contributing little to the overall biomass.

Caesia parviflora (Liliaceae)
Caladenia flava (Orchidaceae)
Chamaescilla spiralis (Liliaceae)
Dichopogon strictus (Liliaceae)
Diuris laxiflora (Orchidaceae)
D. longifolia (Orchidaceae)
Drosera macrantha (Droseraceae)
D. pycnoblasta (Droseraceae)
Elythranthera brunonis (Orchidaceae)
Isotoma hypercrateriformis (Lobeliaceae)
Pterostylis recurva (Orchidaceae)
P. sp nov. (Orchidaceae)
P. vittata (Orchidaceae)

Fauna

Muir (1977) describes the reserve as providing a valuable resting and feeding site for transient birds. He lists 6 species:-

Port Lincoln Ringneck	*Barnardius zonarius*
Galah	*Cacatua roseicapilla*
Tree Martin	*Hirundo nigricans*
Magpie-lark	*Grallina cyanoleuca*
Grey Butcher Bird	*Cracticus torquatus*
Australian Raven	*Corvus coronoides*

Exotic Fauna

The perimeter of the reserve showed evidence of disturbance by rabbit activity. As happens elsewhere in the wheatbelt, rabbits use the reserve for burrowing and as a daytime refuge between nightly feeding forays into adjacent agricultural land.

Fire Influences

The reserve shows no evidence of burning within the last 30-40 years. Highest risk areas are firstly the mixed heath and secondly the *Melaleuca* heath, though the most likely source of a fire would be from the grass verges and pastures bordering the reserve.

3.3.2 South Coast Locations for *Rhizanthella gardneri*

Three locations for the orchid are known for the south coast. These include the rediscovery site at Munglinup, re-examined by ourselves in 1980 and 1981 and two other sites discovered by ourselves during the course of the project. All occur in the Shire of Ravensthorpe. Since the 1979 site occurs on private property long-term measures to preserve the colonies there may prove impracticable unless the cooperation of the owner or future owners in halting clearing of the area is guaranteed. The new sites, however, at Cheadanup Reserve and near the Oldfield River are both on vacant crown land, and eminently suitable for declaration as Class A conservation areas. In view of their future promise these sites are selected for detailed evaluation

in the paragraphs which follow.

RHIZANTHELLA LOCALITY 3 - CHEADANUP RESERVE (Reserve No. 31754 33°33'S, 120°35'E)

Situated approximately 30km NW of Munglinup and covering an area of about 6813 ha, this reserve is vested in the Department of Fisheries and Wildlife for the purpose of conservation of flora and fauna. Largely because of its populations of *Rhizanthella* Cheadanup Reserve is being considered for "A" class status.

Due to previous land releases the reserve has irregular margins, with agricultural activity real or imminent on all but its extreme NW perimeter. Uncleared, vacant crown land with pristine bushland extends NW from the reserve.

Soils vary from leached white to grey tertiary sediment sands overlying a dense band of pre-ironstone over a compact mottled clay or loam in upland regions. These soils are represented by mallee heath and, where sand thickness increases, by scrub heath. Where mallee predominates the ironstone component is minimal with a pale grey sandy or silty horizon over clay. Beard (1973) describes the "Gilgai" or mounded surfaces found in the mallee lands on this reserve and further north as possibly resulting from expansion and contraction of the clay surfaces following cycles of wetting and drying. Valley soils are skeletal and often expose large expanses of rock. Vegetation is variable, consisting of dense thickets of *Melaleuca uncinata* and *Acacia* species with *Casuarina acutivalvis, C.campestris* and scattered mallee on flat bottomlands to dense mallee heath on valley sides.

The reserve is accessible from its southern (Rawlinson Road) and NW perimeter (extension of West Point Road) and is easily circumnavigable in summer using firebreaks. Gilgai country (mallee) however becomes notoriously boggy and inaccessible to vehicles during prolonged wet periods.

Occurrences of *Rhizanthella gardneri*

The data of Table 6 summarizes survey details for the Cheadanup Reserve.

TABLE 6 SEARCH AREA AND MAN HOUR EFFORT IN RECOVERY OF *RHIZANTHELLA GARDNERI* ON CHEADANUP RESERVE, 1981-82

Survey Dates	Area Surveyed (ha)	No.of Observers	No. of Plants Found	No. Reflowering	Field Man Hours Per Find
1981 July	10	6	5	-	5
August	3	4	0	-	-
Oct	4	2	1	-	4
1982 August	150	19	4	1	23
		Av. man hour effort per find			9

A preliminary survey indicated that potential sites for the orchid exist for approximately 2 km inwards from the southern boundary road. The condition of the *Melaleuca uncinata* under-storey then deteriorates, becoming noticeably less dense than in areas further south in the reserve. Unsuccessful searches for *Rhizanthella* in the north of the reserve revealed *M.uncinata* in a similarly depauperate condition, suggesting that the orchid may be restricted to an area much smaller than that of its host.

Areas of the reserve which are seasonally moister than surrounding country were found to contain reasonable stands of mallee, with isolated *M.uncinata* as understorey, but surveys of these pockets of the host species consistently failed to find evidence of *Rhizanthella gardneri*.

Inspection of isohyets for the region (Fig.2) indicates that the reserve lies close to the presumed 350 mm line, although the paucity of accurate rainfall data for this sparsely populated region leaves the exact location of the 350 and 300 mm isohyets in some doubt. Local observers in the area suggested that the 400-350-300 mm gradient may be considerably steeper than as indicated in published data (see Fig.2).

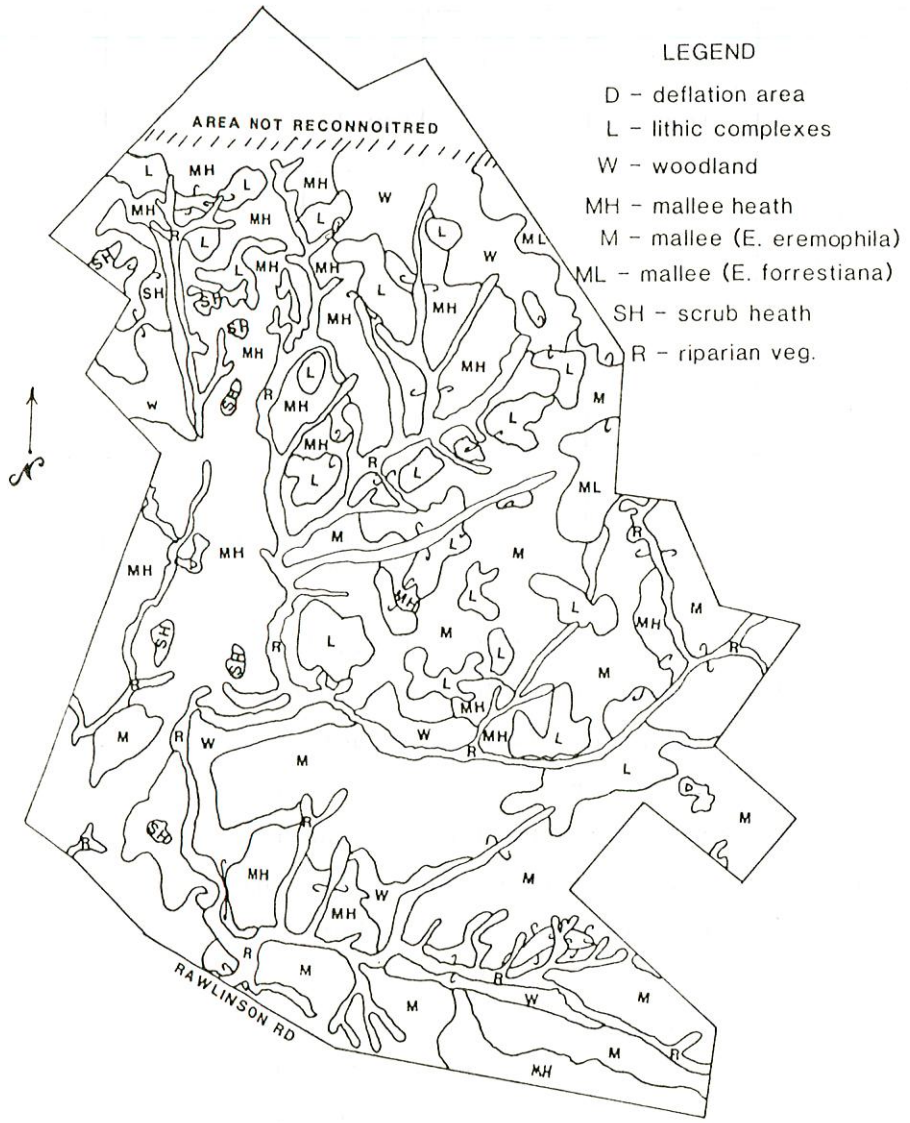


Fig. 8 Vegetation map for Cheadanup Reserve situated north-west of the south coast town of Munglinup (see text for details).

Vegetation

Over 75% of the reserve (southern portions) represents part of Beard's (1979) Oldfield vegetation system. This system is characterised by old land surfaces which are extensively and intensively dissected and incised by the upper courses of southward flowing river systems. Small feeder streams drain 85% of the area of the reserve carrying water south to a confluence with the Oldfield River some 10 km away. A small portion of land in the NE corner of the reserve is drained by a minor tributary of the Young River. All water courses are ephemeral except for rock holes or impounded ponds of brackish, often hypersaline water scattered along some of the larger sources. The remainder of the vegetation is considered part of the Lort System, as recognized by Beard (1979), although further study may show floristic characteristics intergrading with the Oldfield System.

Due to the large areas involved in the survey it is possible to list only the key species for each of the major vegetation types. However, the reader is referred to the more comprehensive species listing and discriptions based on growth form analysis given at the end of this section to gain a better picture of the flora of the region.

Six formations were recognised for the area and are listed below in order of total area that each occupies in the reserve (Fig. 8):-

(1) Mallee

This is the only vegetation type in the reserve known to contain *Rhizanthella*. The dominant mallee is *Eucalyptus eremophila*, 2-3 m when mature, with a canopy cover of 30-40%. In shallow soils over clay, dominance is shared with other mallee species - *E. redunca*, *E. oleosa and E. flocktoniae*. In the valleys *E. redunca* and *E. uncinata* are also present. The understorey is dominated by *Melaleuca uncinata*, 1.5-2.0 m tall when mature and providing 30-70% canopy cover when in mallee-type growth form. Lower understorey sparse and consisting of shrubs of *Daviesia teretifolia*, *Grevillea pectinata*, *Calytrix brachyphylla* and the herbs *Lepidosperma longitudinale*, *Ecdeiocolea monostachya* and *Neurachne alopecuroidea*.

(2) Mallee Heath

Blue mallee *(Eucalyptus tetragona)* is the dominant of this community, standing 1.5-2.5 m (4 m) with a 15-30% canopy cover. Other mallee eucalypts are *E. eremophila, E. redunca* and *E. gardneri*, these being found in isolated patches or as single plants and making insignificant contributions to canopy cover. The 0.5 m heath understorey is rich and diverse, providing the greatest contribution of species; for example the shrubs *Melaleuca pentagona, Lysinema ciliatum, Casuarina humilis, Grevillea pinaster, Isopogon scabriusculus, Calothamnus quadrifidus, C. gibbosus*. Larger species to 1.5 m high include *Hakea cinerea, H. corymbosa, H. nitida, Dryandra falcata, Leptospermum erubescens*, with occasional emergents such as *Nuytsia floribunda* (tree, 4 m) and *Santalum acuminatum* (tree, 3 m).

(3) Broombush Thicket

Where soils are thin and rocky this formation is dominated by *Casuarina campestris* and *C. acutivalvis*. When mature the average height is 1.5-2.0 m with 30-70% canopy cover. In other situations *C. campestris* assumes a sub-dominant role, especially where soils are sandy and deeper. Here *Melaleuca uncinata* (1.5-2.0 m high) may contribute 20-60% canopy cover. Species associated with broombush thicket include *Calothamnus quadrifidus* and *Melaleuca elliptica* overlying a herb layer consisting predominantly of *Lepidosperma longitudinale* and *Ecdeiocolea monostachya*.

Except for the complex of herbaceous species found on adjacent rock outcrops, the species diversity represented in broombush vegetation is relatively poor.

(4) Woodlands

These are confined to valley bottoms where the soil is deeper in parts, and ranges from coarse, to red, loamy sands. Essentially delimiting the drainage system of the reserve, these woodlands are of tall *Eucalyptus oleosa* and *E. redunca* (4 m) with denser, less tall stands of *E. platypus* and *E. annulata*. Yate Swamps *(E. occidentalis)* are not represented on the reserve, although this species is present on a small, 17 ha reserve (No. 31753) 2 km to the east of the reserve. The extent of low woodlands of Moort (*Eucalyptus platypus*) is indicated in Fig. 8.

Where valley bottoms are expansive and consist of deep loamy sands or loams, the above woodlands are replaced by thickets 2-4 m high, with 60-80% canopy cover and an upper stratum dominated by *Casuarina acutivalvis*, *Acacia ixiophylla*, *Melaleuca uncinata*, *Baeckea* species, occasional mallees, *Eucalyptus foecunda* and *E. redunca*. An understorey is virtually absent except for *Phebalium* sp. and scattered rushes and sedges.

(5) Mallee (Lort System)

This second distinct mallee form occurs in scattered patches in the extreme NW portion of the reserve. The surface is hummocky (Gilgai) and waterlogged in winter with the soils ranging from clay to sand on clay. Its upper stratum is dominated by *Eucalyptus eremophila* and *E. forrestiana*, 2-4 m high with occasional *E. redunca*, *E. uncinata*, *E. goniantha* and *E. flocktoniae*; canopy cover 20-30%. The understorey is rich in species varying in size from 0.5-1.0 m, with a canopy cover of 40-80% dominated by *Melaleuca uncinata*, *M. pungens* and *M. scabra*. Other species include *Grevillea pectinata*, *G. plurijuga*, *Cryptandra* sp., *Halgania integerrima*, *H. andromedifolia*, *Prostanthera microphylla*, *Melaleuca lateriflora*. *M. parviflora* forms dense stands in seasonally-wet swamps.

(6) Scrub Heath

This last and least common formation in the reserve is confined to isolated pockets usually adjacent to or surrounded by areas of mallee-heath. It is dominated by *Eucalyptus tetragona*. The formation favours deep sands of an infertile nature and consists of a relatively dense heath 0.5-1.0 m high, with 50-80% canopy cover. Predominantly proteaceous the major species include *Adenanthos cuneata*, *Isopogon trilobus*, *I. polycephalus*, *I. scabriusculus*, *Grevillea pinnatisecta*, *Grevillea nudiflora*, *Petrophile seminuda*, *Synaphea polymorpha*, *Dryandra falcata*, *Hakea corymbosa*, *H. cinerea*, *H. nitida* with a wide variety of supplementary species similar to those for the mallee-heath formation.

Fire Influences

There is no evidence of fires within the last 30 years on the NW perimeter though it is abundantly obvious that fires have frequently escaped from clearing operations on land adjoining the southern and eastern perimeter of

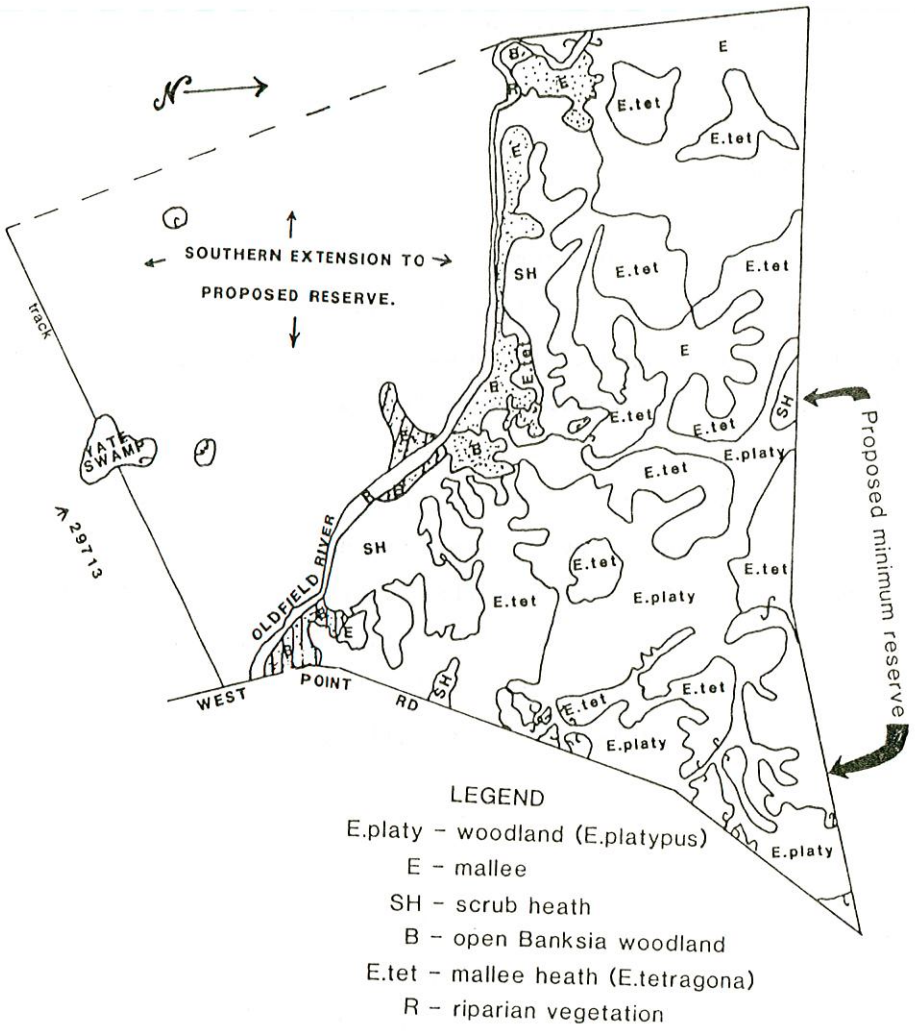


Fig. 9 Vegetation map for Oldfield location of *Rhizanthella gardneri* with boundaries indicated for proposed reserve including a possible annexure. Stippled areas contain stands of *Melaleuca uncinata* believed suitable to support *Rhizanthella gardneri* while cross-hatching indicates actual sites which were visited.

the reserve. The effects of fire on the mallee and scrub heath are minimal but careful preservation of the woodland areas from further devastating fires is considered imperative to maintain the physiognomy and species diversity of these areas. Beard (1973) states, "..... nearly all stands of larger trees in woodland formation, which formerly would not have been burnt at all due to the sparse (litter) undergrowth, have been ravaged and the trees killed. The regrowth of the present stage is indistinguishable from mallee."

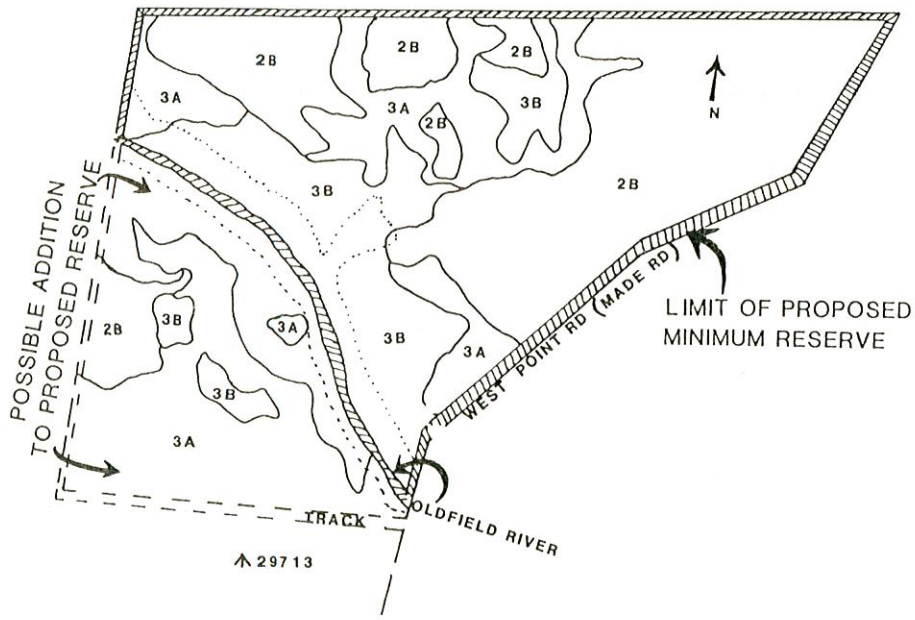
RHIZANTHELLA LOCALITY 4 - OLDFIELD LOCATION (Litho 404/80, unvested, vacant crown land; 33°32'S, 120°32')

Situated north of the crossing of West Point Road over the Oldfield River, this unreserved and relatively unspoilt tract of crown land contains probably the best situated populations of *Rhizanthella* from the viewpoint of long-term conservation of the species.

In determining boundaries for this proposed reserve (Fig. 9) we have taken the following points into consideration.

1. Any further agricultural development to the north and south of the reserve is likely to influence adversely the water quality and pattern of seasonal drainage into the Oldfield River. Accordingly, the proposed boundaries must include the Oldfield River itself (southern perimeter) and an adequate buffer zone - that is the area linking West Point Road near the intersection with Rawlinson Road. In effect this zone would create a northern sector of native vegetation embracing at least two water sheds in terms of protective distance between future agricultural developments and the known and probable habitats of *Rhizanthella*.

2. We suggest that for floristic reasons there should be included in the reserve viable tracts of each of the major vegetation formations described by Beard (1973) for the Oldfield System, particularly if the resource of any one or more of these unique formations is to be jeopardized by large-scale clearing of adjacent areas. As in the case of the Cheadanup Reserve, no Yate Swamp (*Eucalyptus occidentalis*) is present in the proposed reserve, but if inclusions of such swamps were deemed desirable, the proposed western perimeter of the reserve



(numbers refer to government
soil survey coding system-see text)

Fig. 10 Soil map for Oldfield location of *Rhizanthella gardneri*. Crosshatched border indicates limit of proposed minimum reserve. Limit of influence of Oldfield River indicated by dotted line.

would have to be extended southwards to meet the northern boundary of an existing A class flora and fauna reserve (No. 29713). A 25 ha Yate swamp would then be conserved, and, possibly more important, potential habitats for *Rhizanthella* would be considerably increased.

3. Except for a small sector of land on the northern section which might prove of interest to mining (grids for magnetic survey occur throughout this northern region), few conflicts are envisaged other than the ever-present threat of Government releases of land for agricultural purposes.

4. The proposed reserve would provide a contiguous extension to the existing river reserve 29715 adjacent to and including the Oldfield River south of its intersection with West Point Road.

TABLE 7 SEARCH AREA AND MAN HOUR EFFORT IN RECOVERY OF *RHIZANTHELLA GARDNERI* AT OLDFIELD LOCATION, 1981-82.

Survey Dates	Area Surveyed (ha)	No. of Observers	No. of Plants Found	No. Reflowering	Field Man Hours Per Find
1981 August	3	5	5	-	2
Sept.	4	2	0	-	-
1982 June	4	10	4	1	7
June	20	10	0	-	-
		Av. man hour effort per find			4

Soils of the Oldfield location are indicated in Fig. 10 and are coded as follows :-

2B - 2-30 cm of sand over sandy clay
3A - 15-45 cm of sand over gravel or 30-60cm of sand on sandy clay
3B - deep sand more than 80 cm
R - riparian deposits of a complex and variable nature often including exposed bedrock, brackish rock holes and coarse sandy alluvium.

Access into the reserve is limited to an overgrown bulldozed line along part of the northern perimeter. There is however an all-weather access track from West Point Road along the eastern perimeter via a 1 km long track leading to a picnic spot on the northern bank of the Oldfield River.

Occurrences of *R. gardneri* at the Oldfield Location

All discoveries were made in *Melaleuca uncinata* mixed thicket under *Banksia media* and *Eucalyptus eremophila*. Soil features are similar to the range of soils at the Cheadanup, Babakin and Sorenson's Reserve sites except that the sand layer is deeper (50 cm).

The data of Table 7 summarises survey and discovery details for the Oldfield location.

All specimens matched herbarium type material of *Rhizanthella gardneri*, although size of capitula, number and size of flowers tend to be less than for specimens from the Babakin locality. As elsewhere all capitula were observed within 30 cm of the base of a *Melaleuca uncinata*.

Vegetation near the Oldfield Location

This study area occurs within the Oldfield System of Beard (1973) with little evidence of the mounded Gilgai soils typical of the Lort System. All drainage is from the north with a variety of ephemeral streams, often merely a string of isolated, brackish pools, which may become seasonally interconnected and discharge into the Oldfield River.

Five vegetation formations were recognized and are listed below in order of the area each occupy within the proposed reserve. To avoid repetition, vegetation which is considered to be essentially similar to elements in the Cheadanup Reserve will not be detailed in length.

(1) Mallee Heath

This is essentially identical to that found on the Cheadanup Reserve. The soils consist of white, leached sands.

(2) Low Woodland

This contains 3-4 m tall specimens of moort (*Eucalyptus platypus*), often as

a dense monoculture of single-stemmed trees with a canopy cover of 60-80%. The understorey is sparse or totally absent, with *Melaleuca uncinata, M. scabra, M. pungens*, various Loranthaceae viz. *Leptomeria spinosa, L. pauciflora, Choretrum glomeratum* and various *Cassytha* spp. as the most frequent elements. The high density of parasitic species is of interest. *Eucalyptus nutans, E. eremophila, E. falcata* and *E. incrassata* form codominants with moort where the clay becomes more deeply buried beneath sand.

(3) Mallee

This shows similar physiognomy and floristics to mallee (Oldfield System) of the Cheadanup Reserve.

(4) Scrub Heath

Identical to that of the Cheadanup Reserve scrub heath, this type of vegetation occupies large flat sandplain areas adjacent to the Oldfield River and contains some scattered mallee *Eucalyptus*. Colonies of large *Nuytsia floribunda* trees (to 6 m) occur in the area, as do 1.5-2.0 m specimens of *Banksia elderana*.

(5) Woodland (open, with *Banksia media*)

Adjacent to the Oldfield River and forming on deep sands (>50 cm) over clays. This somewhat unusual association is dominated by *Banksia media*, which attains 2.5-5.0 m in height and develops 25-30% canopy cover, or even up to 45% canopy cover in reserve 29715. An alternative stratum for the woodland consists of a mixture of *Melaleuca uncinata, Eucalyptus foecunda, E. eremophila* and *E. gardneri*, with mature mallee forms reaching 1.5-2.0 m high and projecting 30-60% canopy cover. The shrub layer is generally sparse and consists of *Grevillea pectinata, G. pinnaster, G. pinnatisecta, Goodenia claytoniacea, Lysinema ciliatum, Daviesia teretifolia, Casuarina obesa* (near semi-saline water courses), *Daviesia paniculata, Hakea nitida, Lepidosperma longitudinale, Gahnia ancistrophylla, Ecdeiocolea monostachya, Platysace deflexa, P. maxwellii, Leptospermum erubescens, Calytrix decandra, C. brachyphylla, Acacia leptoneura, A. bidentata, A. saligna, Melaleuca pentagona, Gompholobium baxteri, Scaevola pulvinaris, Stackhousia huegelii, Micromyrtus imbricata, Dampiera linearis, Spyridium westringiifolium, Hibbertia rupicola* and herbaceous species *Chamaescilla corymbosa, C. spiralis, Corynotheca micrantha, Drosera pycnoblasta, Thysantous patersonii*. Orchidaceae were poorly represented in this formation.

All *Rhizanthella* sites on the Oldfield River so far occur only within this vegetational formation, which clearly represents a considerably different habitat from that previously associated with *Rhizanthella*. However in some respects the lower stratum of *M. uncinata* sedges and rushes has similarities with the lower strata of other *Rhizanthella* habitats, suggesting that localised associations of the orchid with these species on a site may be paramount, whereas the presence or absence of other woody or shrub species interspersed between the *Melaleuca* thickets may be of little consequence to the success or otherwise of the orchid.

Figure 11 shows by means of stippling those areas of *Banksia* woodland and mallee containing stands of *M. uncinata* which are regarded as potential habitats for the orchid. Since less than one-quarter of these areas have been thoroughly examined in the survey, there may well be a considerable resource of the orchid awaiting discovery in the proposed reserve area.

Weeds and Exotic Fauna

Little weed activity was observed although evidence of rabbit activity was abundant along all road verges adjacent to the proposed reserve.

Fire Influences

The area surveyed by ground traverses, aerial photographs and LANDSAT imagery showed no evidence of burning for probably at least the past thirty years, suggesting that the vegetation as a whole is not vulnerable to natural causes of ignition. However, as agricultural expansion moves closer to reserve areas a concomitant increase in wild or contrived fires can be expected.

Surveys for *Rhizanthella* in parts of Proposed Land Release Areas.

Attempts at finding *Rhizanthella* in these areas were unsuccessful. Detailed surveys were conducted in two areas proposed for land release and also in and close to reserve 29713 (see Fig. 11). Transects and areas surveyed are shown in Fig. 11 as shaded areas, with potential habitats for *Rhizanthella* indicated by cross hatching. Most of the sub-divisions in the centre of the release were severely burnt the previous summer thereby diminishing the chances of locating *Rhizanthella*. Reassessment of vegetation of this burnt area in the next few years would be of interest.

Reserve 29713 (area 2046 ha) (an A class flora and fauna reserve) contains stands of *Melaleuca uncinata* considered as potential *Rhizanthella* habitats.

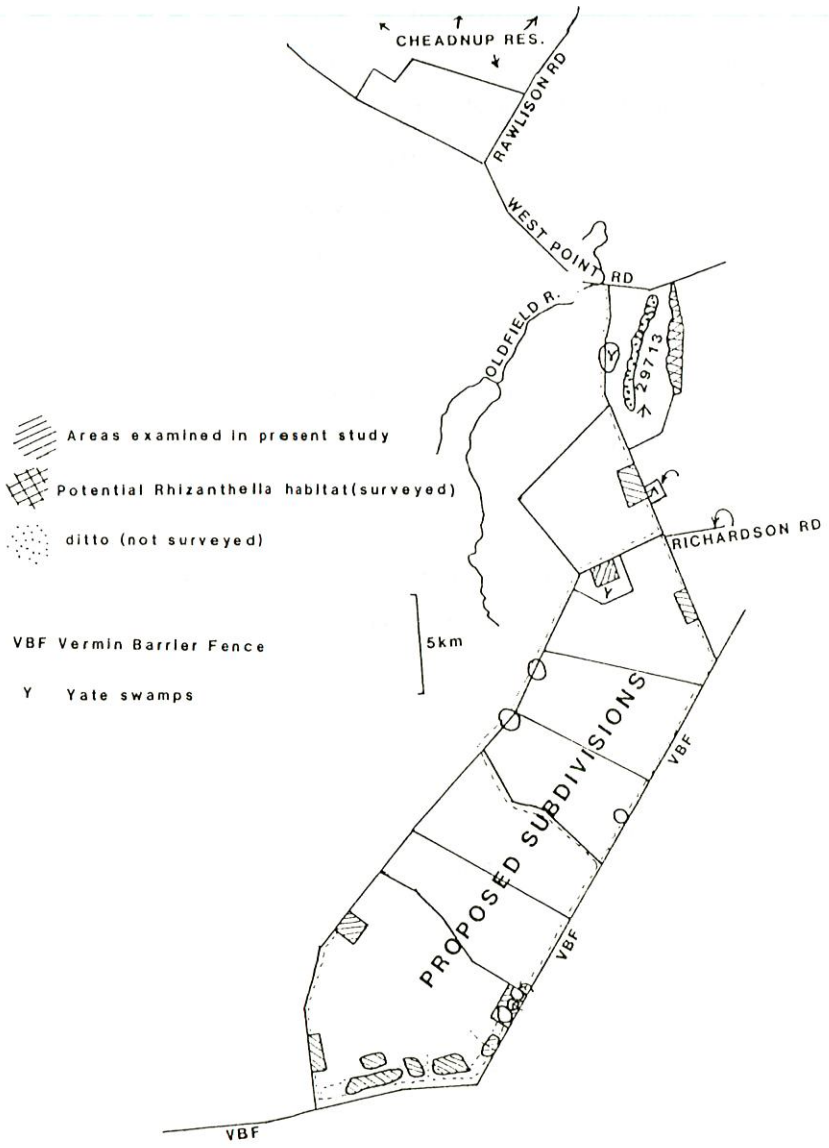


Fig. 11 Geographical relationship of South coast localities of *Rhizanthella gardneri* (excluding 1979 rediscovery site) including proposed land release subdivisions.

Such stands were confined to a thin strip along the southern perimeter of the reserve (Fig. 11). It was not possible to conduct a thorough examination of the interior of the reserve due to the lack of suitable access, but interpretations from aerial photographs indicate that *M. uncinata* also forms dense stands on the northern edge of the drainage basin of the reserve (stippled area Fig. 11), and that scattered *M. uncinata* interspersed with mallee *Eucalyptus* and broombush *(Casuarina campestris)* and tallerack (blue mallee) *(E. tetragona)* occurs frequently throughout the remainder of the reserve. In addition, the yate swamp, which is bisected by the road running along the northern perimeter of the reserve, is fringed by some *M. uncinata* associated with mallee *Eucalyptus* and moort *(E. platypus* and *E. nutans)*. Further examination of these areas of *M. uncinata* shrublands would be highly desirable especially if conducted during the months of June-August. The poor seasonal rainfall for the second consecutive year in the Oldfield area undoubtedly hampered the search for *Rhizanthella*, as indicated by the poor quality and low density of flowering in known sites of the orchid.

The most westerly portion of potential reserve situated adjacent to the Vermin Barrier Fence No. 1 was extensively surveyed for *Rhizanthella* on

TABLE 8 RAINFALL (MM) AND MEAN FOR BABAKIN.
1979-82 FIGURES ARE ADAPTED FROM THE READINGS FOR CORRIGIN

	N	D	J	F	M	A	M	J	J	A	S	O	PPT.[1] (mm)	Plants[2] Found	Freq.[3]
1958-59	-	-	15	27	6	4	14	119	19	45	11	18	278	1	?
1979-80	-	-	5	78	0	18	14	30	44	31	10	28	258	1	0.5
1980-81	3	5	3	45	3	17	74	47	39	39	15	15	305	38	1.2
1981-82	41	3	112	2	4	0	32	47	48	89	38	14	430	110	4.1
1982-83	20	1	4	0.4	7	5	5	123	103	32	53	7	360.4	2	0.1
Mean[4]	14	6	9	13	27	18	45	57	57	42	23	24			

1. Total rainfall for year
2. Total number *Rhizanthella* found
3. Plants found per observer
4. 99-year average

three occasions between July and September 1982. As indicated in Fig. 11 transects were generally confined to the perimeter of the reserve, though occasionally bisecting outwardly promising stands of *M. uncinata*.

Up to 20 field observers were used during these surveys covering an area slightly more than 400 ha and contributing an effort in excess of 450 man hours.

4. FACTORS POSSIBLY LIMITING THE DISTRIBUTION OF *RHIZANTHELLA GARDNERI*

The reliability of using present evidence and distribution to pinpoint the environmental parameters likely to be associated with success or failure of growth of *Rhizanthella* is obviously fraught with uncertainty, since only five locations containing a total of 150 plants are currently identified. However by examining these habitats it is possible at least to assemble the features which they appear to have in common and therefore, by inference, hope to identify at least some of the essential or preferred requirements of the orchid.

4.1 Soil Characteristics

Soils of all known *Rhizanthella* sites in native vegetation are generally sandy-clay to sandy-loam over white clay with a gritty texture and bleached white to grey colour. The farmland Munglinup site, however, is on sand-clay, brown, 2-3 cm, grading to brownish-yellow and yellow after 10cm.

Analysis of soil samples taken from sites near *Rhizanthella* plants showed < 5% organic matter (cf. 25-30% total organic matter in Jarrah forest soils, Forests Department, unpublished), low to trace levels of K, N, P, Zn and Cu and medium to high levels of Fe and Na. Nutrient values were generally regarded as typical of the majority of soils commonly farmed in the wheatbelt. Soil moisture showed great variability, a result not unexpected in view of the wide range of seasons and sites surveyed.

Besides the preference for sandy-based soils or, occasionally, clay-loams, the presence of an underlying clay base situated at no less than 20 cm depth seems an important criterion for *Rhizanthella*, possibly as a crucial element to the optimization of seasonal water relations for the species.

4.2 Rainfall

The average annual amount of rainfall per season probably determines generally where *Rhizanthella* will grow or whether it will be likely to succeed, while there is strong evidence for all sites that the periodicity and intensity of the falls of rain modulate the timing and overall success of flowering in any particular season. As stated earlier, all sites for the orchid occur between the 300 and 400 mm isohyets. Accordingly, in south coast localities (viz. Ravensthorpe-Esperance), the rapid decline in rainfall from the coast inland is likely to confine the orchid to a thin zone along the coast, probably only 70 km in width at its widest extent.

We conclude that the upper limit of rainfall may well coincide roughly with the limit of the zone where the host species *Melaleuca uncinata* coincides with mallee. However the vast majority of sites of this vegetation type were found not to contain *Rhizanthella* within the tenure of the current study.

Although George (1980) dismissed the commonly held belief that heavy summer rains were beneficial to flowering of *Rhizanthella* the current study has evidence which substantiates the earlier observation. The relevant data are found in Table 8 in which the monthly totals of rain (mm) are recorded for Babakin for each year recording a *Rhizanthella* discovery.

Unfortunately, only the figures for 1980-81-82 are strictly comparable in terms of number of observers and total effort in the field. Since *Rhizanthella* reaches anthesis at the start of winter rains in May, it might be argued that rainfall in the preceding summer, or indeed the preceding year, would have greatest effect on performance of the species. Thus, one might attribute the large number of plants present at the Babakin site in 81-82, to the exceptional falls of rain recorded in the previous November (41 mm) and January (112 mm). Conversely, the much poorer discoveries at the site per observer in 1980-81 might be attributed to the extremely dry summer of the 1979-80 period; when no rain at all occurred in November and December 1979, and only 5 mm in January 1980.

4.3 Association(s) Other Than With *M. uncinata*

Excavations have not shown any easily observable direct link between the

orchid and surrounding vegetation; indeed there is not even direct macroscopic or microscopic evidence of a common fungal link between the orchid and its presumed host *M. uncinata*.

Tests were made to see whether exceptions could be found to the supposedly invariable relationship between the orchid and *Melaleuca uncinata* by sampling for *Rhizanthella* in areas of bushland containing a variety of vegetation formations devoid of *M. uncinata* thickets.

The results of this study showed that in every instance where *Rhizanthella* was ever encountered it was associated with mallee heath, mallee scrub, or more rarely, with woodland and that all capitula found are within 30 cm of a *M. uncinata* stump. George (1980), however, reported finding *Rhizanthella*, 100 cm from a stump, but since the area in question had been recently rolled it was possible that the host plants in close proximity to the orchid had been uprooted or their shoots destroyed.

In all of the 150 *Rhizanthella* plants discovered in 1980-82 the nearby *M. uncinata* were mature and of a mallee form each with from 3-8 erect stems to 1.5-2.3m high arising from an irregular (± globoid) subterranean, lignotuber, 15-30 cm wide, buried at or just below soil surface. Numerous persistent papery coverings or periderms ensheath the tough, woody, root stock, the centre of which often becomes charred and burnt-out, leaving a periphery of living tissue with stems attached. The orchid is frequently in intimate association with such old root stocks, flowering heads of the orchid having even been observed to have squeezed between convolutions of the lignotuber of a *M. uncinata* or appearing in the burnt-out centres of its mallee-type root stock.

Root stock of the host *M. uncinata* (Fig. 12) involves seasonal extension and secondary thickening of a large perennial root stock, which often extends many metres in depth in well-drained situations. At the same time, annual regrowth or additions to a near surface (within 50cm) mat of fine fibrous feeding roots takes place, these remaining active, it would appear, only as long as soil moisture remains high in the vicinity of the roots. Were nourishment to be derived by *Rhizanthella* from *M. uncinata* mycorrhizal attachments these ephemeral feeding roots of the host would be the most

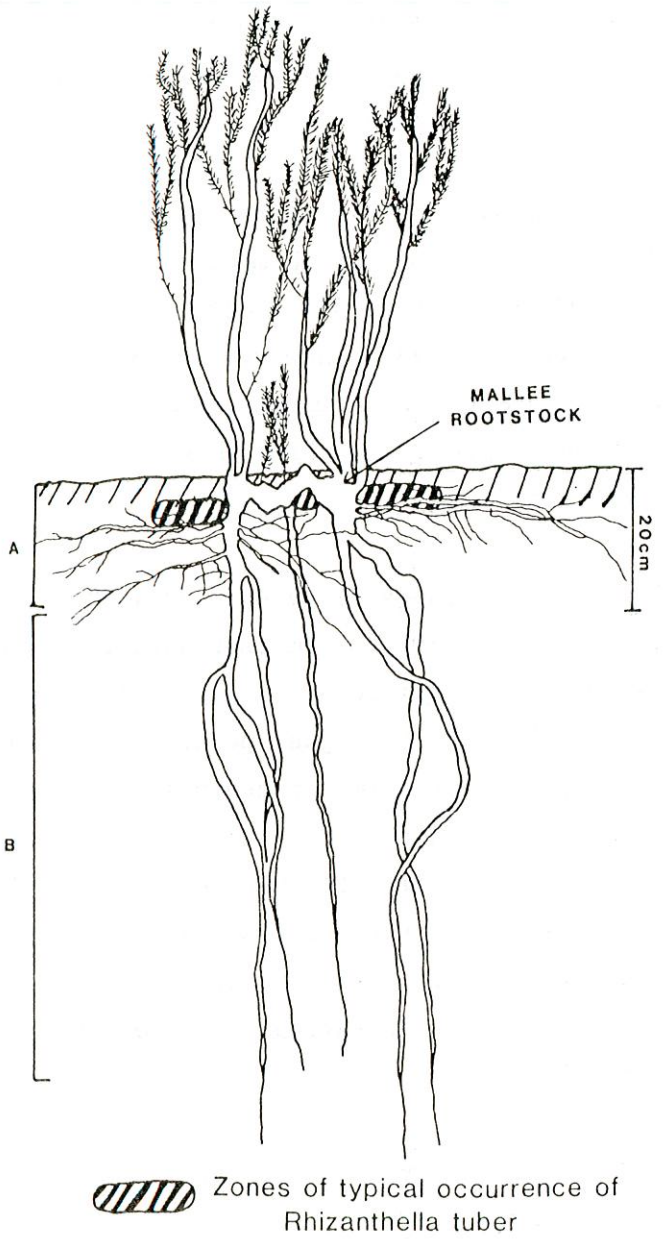


Fig. 12 Schematic reconstruction of typical *Melaleuca uncinata* root system indicating (A) zone of active lateral root production; (B) zone of depth-seeking tap root-like roots with minimal lateral root development.

likely source of supply. Indeed the zone 3-15 cm below soil surface, where maximum concentration of ephemeral *M. uncinata* roots and maximum mycorrhizal activity is recorded (J. Warcup, pers. comm.) is the very region in which the tubers of the orchid are normally encountered.

Estimates of the density of *M. uncinata* in *Rhizanthella* sites were made by taking a series of 25 m^2 sample quadrats at each of the sites where the orchid was recorded (see data below).

	No. *M. uncinata*/25 m^2
Babakin Town Reserve	38
Sorenson's Reserve	39
Cheadanup Reserve	15
Oldfield River Location	20

Only mature non-senescent plants of *M. uncinata* were considered when scoring plant density. Similar densities were recorded at many other sites where *Rhizanthella* was not observed.

Significantly, no other species are consistently associated with *M. uncinata* at the *Rhizanthella* sites. However near-neighbour species frequently found in the vicinity of *Rhizanthella* sites were *Melaleuca scabra*, mallee *Eucalyptus* spp., Cyperaceae species, *Gahnia ancistrophylla* and *Lepidosperma longitudinale*, and an as yet unidentified Restionaceae (aff. *Loxocarya*). The latter species was associated with the orchid in 60% of the *Rhizanthella* localities.

5. MANAGEMENT PROPOSALS FOR RESERVES CONTAINING *RHIZANTHELLA*

The great difficulties in finding *Rhizanthella* plants, let alone the difficulty of monitoring season by season changes in the vegetative activity or vigour of individuals of different populations will undoubtedly present major problems in management of the species. However, it can be generally hoped that by maintaining the *Melaleuca uncinata* associate of the orchid in a suitably healthy state one might confer continued benefits to the *Rhizanthella*. In other words management of the orchid translates to successful management of the whole vegetational system which supports the thickets of *M. uncinata* in which *Rhizanthella* is known or suspected

to reside.

5.1 Danger from Fire

In all habitats possessing the orchid, fire is likely to be a less frequent natural event than it would be in adjacent heathlands or sandplain floras. Studies of dense *Melaleuca uncinata* populations following hot fires indicated that:-

(a) up to 20% of adult individuals may perish.
(b) regrowth is slow and confined largely to below-ground sprouting from the mallee-type root.
(c) flowering and seed set of coppice does not occur until 4 years after burning.
(d) recruitment by means of seedlings is generally poor, as to be expected of a long-lived sprouter species.
(e) tender *M. uncinata* coppice attracts foraging by kangaroos, rabbits and invertebrates.

Cyperaceae and Restionaceae understorey species of the *Melaleuca* thickets, and the range of geophytes found in these areas, fare well after fire due to the reserve of stored materials and buried buds of these species. These floristic components are therefore likely to be predominant following repeated burning, though their interaction with *Rhizanthella* is not known. However, it would appear to be impossible for the delicate capitulum of the orchid to emerge from directly beneath the dense tufted root stocks of monocotyledonous species.

Tight fire control in *Rhizanthella* habitats seems a highly judicious course, and even if well maintained fire breaks exist surrounding a reserve, strict controls need to be placed on land owners wishing to commence burning operations close to reserves of the orchid. This is particularly urgent near the south coast (eg. close to the proposed Oldfield Reserve) where each year fires spreading from agricultural land are seen to burn out-of-control for great distances through habitats where *Rhizanthella* may well exist.

5.2 Effects of Runoff and Weed Influences

Nutrient rich water flowing onto reserves from adjacent farmland is particularly evident in the older central wheatbelt localities of the orchid. The impact of this progressive eutrophication is insidious, progressively altering the species composition of affected areas through the introduction of a variety of pasture weed species, and encouraging growth of certain native species to the exclusion of others.

The Babakin town reserve, for example, is under a pressing threat of weed invasion along parts of the western perimeter. This can best be alleviated by cutting a drainage channel along this perimeter to divert fertilizer residues away from the reserve.

Incursions of weeds into Sorenson's Reserve is confined to road and farm margins and open areas in wandoo woodland, but the reserve is clearly too small to be considered seriously as a significant genetic resource of the orchid. The two south coast localities are under no immediate threat from weeds although runoff patterns should be closely monitored in areas downslope from agricultural land. It is to be hoped that the siting of the proposed reserve at the Oldfield location will take into consideration local watersheds and potential influences from runoff, along the lines suggested in this research note.

5.3 Effects of Rabbit Activity

All colonies of *Rhizanthella* in Babakin town reserve showed marked evidence of rabbit activity, particularly in the NW sector, where several extensive warrens were located. In one instance a *Rhizanthella* capitulum and part of its parent tuber were found to have been excavated by rabbits. The damaged but uneaten orchid capitulum was recovered in rabbit scrapings in clumps of *Neurachne alopecuroidea* (Poaceae) and *Loxocarya* sp. (Restionaceae) - the latter species attracting rabbits with its somewhat fleshy young roots. It would be highly desirable that rabbits be totally eliminated from at least the presently-known locations of the orchid at Babakin and that the locations then be surrounded by rabbit proof fencing. We regard rabbits as the greatest existing threat to *Rhizanthella* at Babakin.

By contrast, rabbit activity at Sorenson's Reserve and at the south coast sites is negligible although there is evidence of roadside scratchings adjacent to farmland. Nevertheless the situation should be monitored closely at this site in view of the great seasonal variation that can exist in rabbit populations. The coastal sites, where rabbit activity is not at present of alarming proportions in *Rhizanthella* areas, should be similarly monitored and appropriate action taken if necessary.

5.4 The Ultimate Goal of Management: Maintenance of Genetic Diversity

Provided no catastrophic event endangers existing 'clones' of the orchid, the species might be expected to maintain itself at least by vegetative reproduction, as evidenced by its ability to produce daughter tubers.

Input of new sexually-derived genotypes, however, is probably likely to remain a remote event in view of the small numbers of remaining plants, their poor natural seed set, and the fact that probable agents of long distance seed disperal (bettongs, bandicoots, hopping mice) are all but extinct in the known areas possessing *Rhizanthella*.

Understanding the processes involved in seed dispersal and germination and in formation of daughter tubers on current clones of the species are essential before more precise management proposals can be formulated. The high rate of seed set following hand pollination (K.W. Dixon and J.S. Pate, unpublished) would provide a means for producing stocks of seed, were establishment of the species in new reserves to be envisaged.

5.5 Dangers from Human Interference

Since 1980, five capitula of *Rhizanthella* are known to have been illegally removed from the Babakin colonies, four within 5 m of the road and the other from a colony some 100 m from the nearest road. The nature and purpose behind the thefts was unclear, but such action highlights the vulnerability of *Rhizanthella*, at least in the Babakin town reserve. Unfortunately, through press releases and publicity due to local enthusiasts, the location of the Babakin Reserve is now well known.

Indeed, the publicity surrounding the orchid is providing residents of the Babakin area with an additional source of income from tourist stops to view *Rhizanthella* and purchase a locally-crafted souvenir of the orchid. Reaching a compromise between preserving plants, while providing the public with a glimpse of the plant, has already proved difficult for Babakin residents, although this has been partially overcome by the involvement of local people as 'honorary wardens' for the reserve.

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BIBLIOGRAPHY

Beard, J.S. (1972-80). Vegetation Survey of Western Australia. 1:250 000 Series. Vegmap Publications, 6 Fraser Road, Applecross, W.A.

George, A.S. (1980). *Rhizanthella gardneri* Rogers - The underground orchid of Western Australia. Am. Orchid Soc. Bull. 49: 631-646.

Marchant, N.G. and Keighery, G.J. (1979). Poorly collected and presumably rare vascular plants of Western Australia. King's Park Res. Notes No. 5.

Muir, B.G. (1977). Vegetation and Habitat of Bendering Reserve. Biological survey of the Western Australian wheatbelt, Part 2. Rec. West. Aust. Mus. Suppl. No. 3.

Northcote, K.H. (1971). A Factual Key for the Recognition of Australian Soils. Rellim Technical Publications, Glenside, S.A.

Pate, J.S., Dixon, K.W. and Orshan, G. (1984). Growth and life form characteristics of kwongan species. In Kwongan - Plant Life of the Sandplain. (Eds J.S. Pate and J.S. Beard). Univ. of W.A. Press, Nedlands.

Pitman, H.A. (1929). Note on the morphology and endophytic mycorrhiza of *Rhizanthella gardneri* Rogers and certain other Western Australian orchids. J. Roy. Soc. West. Aust. 15: 71-79.

Plumb, T. (1980). Atlas of Australian Resources: Soils and Land Use. Series 3, Vol. 1. Division of National Mapping, Canberra.

Rogers, R.S. (1928). A new genus of Australian orchid. J. Roy. Soc. West. Aust. 15: 1-8.

Rye, B.L. (1982). Geographically restricted plants of southern Western Australia. Dept. Fish. and Wildl. Rept. No. 49.

Serventy, D.L. (1979). Obituary: John Trott (1903-1978). West. Aust. Nat. 14: 165-168.