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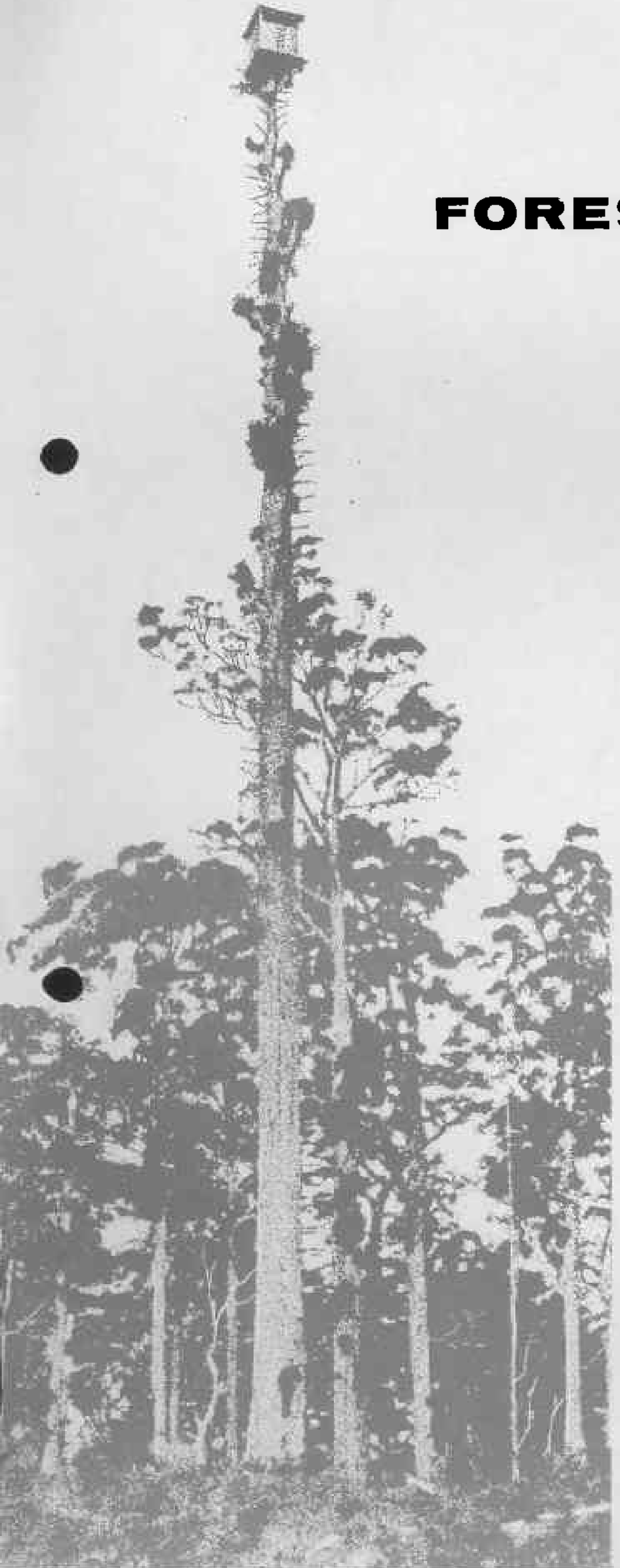

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THE ROOT SYSTEM OF JARRAH *(Eucalyptus marginata)*

by

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SUMMARY

The root system of jarrah (*Eucalyptus marginata* Sm.) was investigated by soil excavation. It was found to consist of a dense lateral and feeder root system in the top 0.9 m of soil, with a secondary dense layer of feeder roots at considerable depth near the water table. The two systems were connected by vertical sinker roots with little branching. The deep feeder root system maintained supplies of moisture to the tree in the dry summer period. It is suggested that the secondary feeder root system is unlikely to be affected by the pathogen *Phytophthora cinnamomi* Rands because of its depth, and that mortality in jarrah attacked by this organism is therefore not due to a drought effect.

INTRODUCTION

The purpose of this study was to further the knowledge of the root system of jarrah (*Eucalyptus marginata* Sm.). Jarrah has been the subject of several eco-physiological studies. Doley (1967) investigated the water relationships of a single vigorous jarrah pole under forest conditions in late spring and summer. He concluded that healthy jarrah trees in lateritic soils suffered diurnal moisture stress due to high transpiration potential rather than to the depletion of soil water. Grieve and Hellmuth (1968) classed jarrah and marri (*Eucalpytus calophylla* R.Br.) among species having a well developed taproot. The same authors found that jarrah does not have the ability to restrict transpiration in time of water stress. Grieve (1956), investigating the transpiration of Western Australian sclerophyllous plants, concluded that jarrah was prodigal in its use of water and showed a high rate of water usage in summer. He considered adequate water to be available to jarrah even in late summer because of its deep root system.

Further evidence that the species has a very deep root system came from soil moisture measurements around pole stands in the Dwellingup area (88 km south-south-east of Perth). Moisture in the upper 0.5 m of soil in these stands reached wilting point by later December or early January. The same stage of depletion was reached at 5 m by late March. The trees in the study area showed no visible signs of stress under these conditions, despite the evidence that they were likely to be transpiring freely.

The studies cited above were used in predicting the type of root system likely to be found in jarrah. The investigation was carried out in the most common soil type of the northern jarrah forest, the pisolitic gravel of lateritic origin. The complete soil profile is varied, but the general profile description in Table 1 indicates the rooting medium for jarrah.

TABLE 1

Profile of Typical Jarrah Forest Lateritic Soil

Depth (Metres)	Soil Type
0 – 0.07	Very dark grey gravelly sand. Gravel 60%.
0.07 – 1.2	Yellow-brown gravelly, sandy loam. Gravel 80%. Occasional laterite boulders at lower depths.
1.2 – 2.5	Massive laterite rock (duricrust), frequently fissured, or as massive boulders a few metres in diameter.
2.5 – 3.3	Yellowish clayey sand.
3.3 – 12	Yellowish sandy clay, becoming mottled at depth.
12+	White kaolinitic clay.

The white kaolinitic clay layer may reach great depths, but root extension would be limited by the water table level. The depth from soil surface to water table varies considerably; the only data available are from a gully head at Dwellingup, showing a depth of 20 m, and a kaolinite pit in a valley at Jarrahdale, with a depth of approximately 15 m.

All the soil horizons appear permeable to roots, including the massive laterite layer which is generally fissured.

METHOD

As evidence pointed to a very deep root system, excavation of the complete roots of an individual tree was considered impracticable.

Three different sites were investigated by excavation and sampled to cover the range of soil depth.

Site 1 was 11 km south-east of Dwellingup, where three jarrah poles in deep lateritic soil on fairly steep slopes were selected. The top 1.2 m of soil were removed to form a trench on the downhill side of each tree. Excavation was extensive enough to allow a side view of the top one metre of the major root system. During excavation 30 x 30 x 7.5 cm soil samples were taken in a vertical sequence.

Site 2 was 10 km west of Dwellingup. The exposed root systems of two windthrown jarrah trees, formerly embedded in shallow soil overlying clay, were measured and sketched to show the distribution of the sinker roots.

Site 3 was the Jarrahdale open-cut bauxite mine, 48 km south-east of Perth. To allow sampling of the 1.2 to 4.3 m level, a grid with 0.61 x 0.75 m spacing was laid out on the vertical face and samples, each with a volume of 9,400 cm^3, were taken at the intercepts. Further samples were obtained from the kaolinite zone in a deep pit on the mine site. The bottom of the pit was water filled. The 30 x 30 x 2.5 cm samples were taken at 0.3 m intervals vertically and 0.6 m intervals horizontally, on the vertical face.

Roots were extracted from all the soil samples and grouped into two classes – those with diameters less than, and those with diameters greater than, 3 mm. They were over dried and then weighed. All root weights were expressed in kilograms per cubic metre of soil. The results are shown in Table 2.

RESULTS

The results indicate that jarrah has a dense lateral root system confined to the gravel zone above the massive laterite layer. Beneath this a well-developed sinker root system penetrates to considerable depths and develops into a secondary fine root system in the clay immediately above the water table. Figure 1 shows this arrangement diagrammatically, but only a small proportion of the feeder roots are shown.

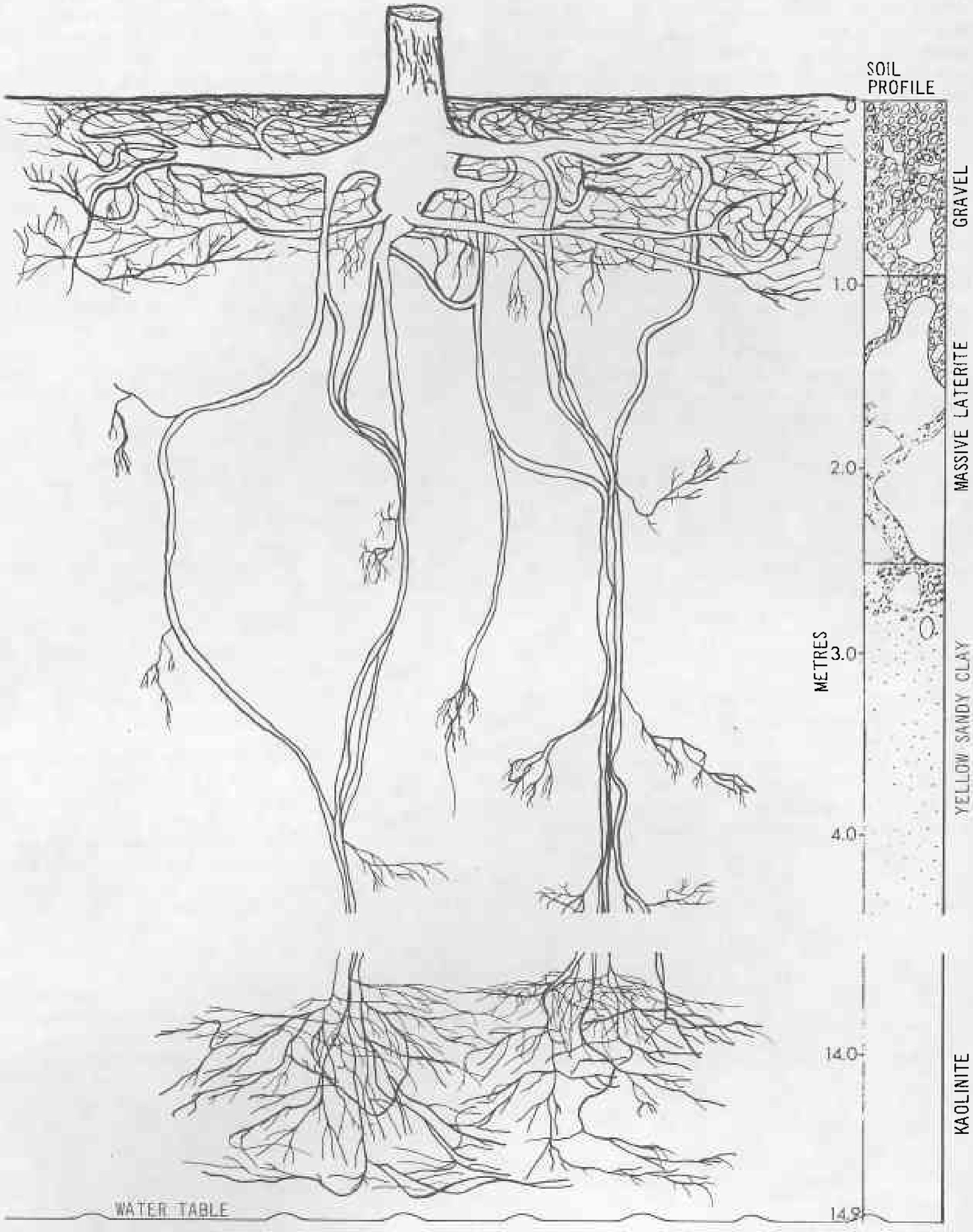

FIGURE 1: *Diagram of a jarrah root system.*

TABLE 2

Root Distribution with Soil Depth

Depth (metres)		Soil Type	Oven-dry Root Weight (kg/m^3)		No. of Samples
			<3mm	>3mm	
0	0.3	Gravel	0.755	5.235	10
0.3	0.6	Gravel	0.406	6.047	14
0.6	0.9	Gravel	0.222	1.267	10
0.9 -	1.2	Massive laterite	0.046	0.272	9
1.8		Massive laterite	0.064	0.441	11
2.4		Massive laterite	0.039	0.522	12
3.0		Yellow clay-sand	0.039	0.812	12
3.6		Yellow sand-clay	0.018	0.042	12
4.2		Yellow sand-clay	0.060	0.911	11
13.7		Kaolinitic clay	0.261*	7.304**	3
14.0		Kaolinitic clay	0.332*	10.226**	5
14.3		Kaolinitic clay	0.134*	0.102**	5
14.6		Kaolinitic clay	0.078*	0.604**	5
Water table at 15 metres					

* The surface of the excavation was exposed some years ago and many fine roots had undoubtedly rotted away, so these results may be low.

** All roots were less than 12 mm diameter.

Dense concentrations of fine feeder roots in the top 0.9 m of gravel, and in the few metres of clay above the water table, were evident. These two absorbing root masses were linked by the sinker roots, through a zone which had a much poorer development of fine feeder roots.

The Surface Root System

Figure 2 illustrates the larger roots of the four jarrah poles investigated. They exhibited a variety of forms which were probably due to the influence of steep slopes, boulders in the soil, and a shallow gravel layer. The tendency for the larger lateral roots to extend to one side of the rootstock in Figures 2a, b and c was due to slope, the larger roots occurring on the uphill side of the tree. The generally flattened nature of the lateral system in Figure 2d was due to shallowness of soil.

Two main types of root occurred in all four trees. The large lateral roots left the rootstock and continued almost parallel to the soil surface. The smaller sinker roots (up to 4 cm diameter) descended vertically into the soil. Differentiation into laterals and sinkers was most obvious in the tree growing over heavy clay at shallow depth (Figure 2d). The lateral roots were restricted to the top 0.5 m of gravel. At this depth a rapid change to white kaolinitic clay took place. Numerous sinker roots entered the clay, but no laterals did.

Sinker roots appeared limited in their distribution. They were generally located within one metre of the rootstock; the most distant was 3 m, but this appeared to be unusual. The fine feeder roots were most numerous in the top 0.3 m of gravel, decreasing rapidly with depth to 1.2 m. Below this the number remained fairly uniform, being approximately 5% of that found in the top 0.3 m.

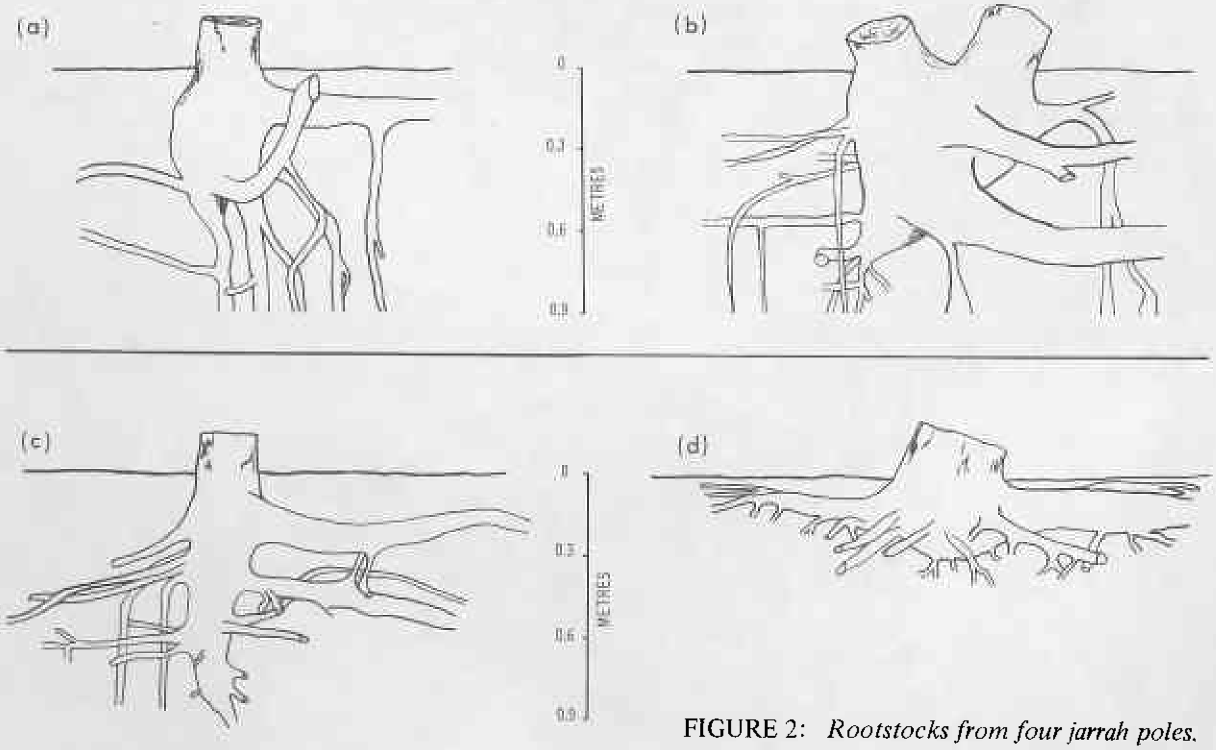

FIGURE 2: *Rootstocks from four jarrah poles.*

The Intermediate Root System.

The intermediate root system extended from a depth of about one metre (equivalent to the top of the massive laterite layer) to the secondary feeder roots, a few metres above the water table. It was primarily a downward extension of the sinker roots. The main sinkers were between 6 and 12 mm diameter and passed through fissures in the massive laterite layer. Several roots were frequently found using one fissure, resulting in a clumping of root distribution which persisted with depth. Samples collected in this zone were consequently very variable and nearly half contained few or no roots.

The Deep Root System

A proliferation of the sinker roots into a secondary fine root system at considerable depth is shown by the results in Table 2. This system was only found near the presumed water table. The area sampled had been exposed for a number of years and the roots were extensively rotted. It is thus likely that estimates of weight were low, particularly for the finer roots.

The larger roots (over 3 mm diameter) were well distributed throughout the samples. The fine roots were concentrated in flattened masses in cracks in the massive kaolinitic clay. Sampling was confined to a zone between water level and 1.2 m above. Maximum root development was found 0.6 to 0.9 m above water level and decreased rapidly above and below this level.

DISCUSSION

The importance of the secondary fine root system found near the water table becomes apparent when the rapid decline in moisture to wilting point in the surface soil in early summer is considered. It is this secondary root system on which the tree relies for its summer moisture supply and which permits jarrah to transpire relatively freely, even during periods of high temperature and low humidity.

The sparse and uneven distribution of fine roots in the zone between the surface and secondary systems suggests that this region is a relatively unimportant moisture source to the tree.

Certain implications arise from this study with respect to the effects of *Phytophthora cinnamomi* on jarrah. It is the surface feeder root system which is destroyed by the pathogen. These roots appear relatively unimportant for moisture uptake during the period of greatest demand. The assumption that infected jarrah dies from drought is therefore questionable. The possibility of the deep root system becoming infected by *P. cinnamomi* is extremely remote. Soil temperatures at the depths to which the secondary root system extends are likely to be below those necessary for active fungal growth. In two years measurements at Dwellingup the soil temperature at 5.2 m never exceeded 15°C. The lower critical temperatures for mycelial growth and sporangial production of *P. cinnamomi* are 12°C and 15°C respectively.

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