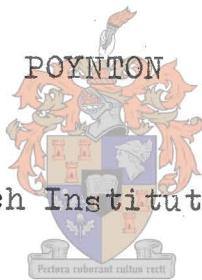


TREES FOR THE WESTERN TRANSVAAL  
SELECTED ON THE BASIS OF ARBORETUM TRIALS

R.J. POYNTON

(Forest Research Institute, Pretoria)



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## SYNOPSIS.

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Trees are needed on the semi-arid Highveld of the western Transvaal for shelterbelts, woodlots, fodder, honey, shade and ornament.

A brief history of tree planting in the area, more particularly at Lichtenburg and Potchefstroom, is given.

Relatively few species can be grown successfully in the western Transvaal because <sup>of</sup> the unfavourable climate. Hot, dry winds blow almost continuously off the Kalahari between August and October before the first, spring rains; cold winds and frosts are experienced in winter, although the summers are hot; the rainfall is erratic and low, averaging about 600 mm. a year and occurring mainly in the form of heavy thunderstorms during summer; hail is common.

The geology of the area is complex. In the north-west an overburden of wind-transported sand obscures the underlying formations. The soils are mostly of a light, sandy or loamy consistency, with a fairly high base-saturation value. Concretions, sometimes forming a continuous hardpan, are characteristic of certain types.

Various indigenous trees are found in some localities. These are small, and are mainly confined to rocky hillsides and stream banks. In the past they have been much exploited for rough building timber, fence posts and firewood. Their growth is very slow, and exotics have proved to be more vigorous as well as more useful in cultivation.

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Possible adaptations of trees to dry climates are discussed. It is concluded that apparent adaptations observed in the field are of little value in selecting trees for dry areas. No practical alternative therefore exists at this stage to the introduction of species from areas with a similar climate and testing these under local conditions. Parts of the world having a climate similar to that of the western Transvaal are indicated.

Summarised results of species trials in the western Transvaal are given in tabular form, and recommendations for tree planting in the area are made.

In an appendix, trials of 89 species in arboreta at Lichtenburg and Potchefstroom are fully described and discussed.

#### ACKNOWLEDGEMENTS.

The writer records his indebtedness to the South African Department of Forestry for permission to draw on official sources of information in the preparation of this thesis, to his promotor, Prof. C.L. Wicht of the Faculty of Forestry, University of Stellenbosch, for helpful criticism of the text, to Mr. B.R. Schulze for placing at his disposal calculations of the moisture balance at Lichtenburg and Potchefstroom and to Mr. W.J. van der Bank for detailed information on the soils of the Lichtenburg area.

## INTRODUCTION

The semi-arid, highveld regions of South Africa, as exemplified by the gently undulating plains of the Western Transvaal, are climatically unsuitable for commercial afforestation. Nevertheless, tree planting in this almost treeless area is a pressing need, particularly for the purpose of arresting wind erosion.

Selective grazing and the destruction of trees over a period of more than a century have seriously depleted the natural, vegetal cover of the soil. Arable land has been rendered less stable by persistent maize monoculture. As a result, hot, dry winds blowing off the Kalahari before the first spring rains heap the light, sandy soil into incipient dunes and bear it away as dense clouds of dust. Severe dust storms occur with increasing frequency, and dust-bowl conditions must develop unless the retrogression is halted.

Of the various means by which wind erosion can be checked, tree planting is one of the most effective. Another important use of trees in exposed, featureless areas is to provide shelter for crops and livestock. The efficacy of trees planted in the form of shelter-belts as a means of ameliorating the micro-climate is widely recognised, and has received much study in recent years (Caborn, 1957). In dry areas, where wood is relatively scarce and expensive, trees can also be planted with advantage for the production of rough building timber, posts, droppers and fuel to meet local needs. Trees supply fodder for stock in times of scarcity and provide nectar and pollen for bees. In streets, parks and

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gardens they afford welcome shade, From an aesthetic point of view, they afford one of the most effective means of transforming an otherwise drab and featureless landscape.

A study of site factors in the western Transvaal has suggested ~~the~~ certain criteria by which the suitability of trees for planting in the area may be assessed. Existing trials of 89 species in Arboreta at Lichtenburg and Potchefstroom have been critically examined in the light of this study, and an attempt has been made to lay a sound foundation for future tree planting in the area.

## Chapter I.

HISTORY OF TREE PLANTING IN THE WESTERN  
TRANSVAAL.

Relatively little is known of either the character or the extent of the woody vegetation which existed in the western Transvaal when the area was first occupied by white settlers from the Cape Colony a century and a quarter ago. However, such forest resources as may once have existed were rapidly depleted, and by 1900 the scene differed little from that which meets the eye to-day. Steps were therefore taken at an early stage by the settlers to introduce various hardy and easily propagated exotic trees from the Cape.

Alexander Struben in his diary (Marsh, 1951) writes that in 1863 the town now known as Potchefstroom was "buried in a mass of magnificent willow trees." Other exotics had almost certainly become established by that time, including the English or Common Oak (Quercus robur Linn.), the Blue Gum (Eucalyptus globulus Labill.) and the Churchyard Cypress (Cupressus sempervirens Linn. var. stricta Ait.) D.E. Hutchins (1903), in his celebrated "Transvaal Forest Report", records the names of a great many exotics found in the territory at the end of the Anglo-Boer War (1899-1902). This list reflects substantial progress in the way of tree planting, but it was not until 1903 that afforestation in the true sense of the word, and with it the systematic introduction and trial of tree species on a scientific basis, was first attempted in the Transvaal.

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In the Report already referred to, Hutchins presented a list of suggested species for experimental planting in the Colony. This was remarkable alike for its comprehensiveness and for the insight which it reveals into fundamental, silvicultural principles. Under the sub-title: "The Tree Fitted to the Climate", Hutchins formulated an approach far in advance of his times when he wrote: "Climatic fitness is the crux of the list, and on that every care has been bestowed".

The foundations of a sound forest administration in the Transvaal were also laid by Hutchins, who at the time held the post of Conservator of Forests at Cape Town. The newly-formed Transvaal Division of Forestry adopted a policy of establishing plantations and forest tree nurseries in close proximity to all the larger centres of population. In accordance with this policy, suitable sites were selected near Lichtenburg and Potchefstroom in 1903, and preparations were immediately put in hand for raising transplants to meet official requirements and for sale to the public.

In the Annual Report of the Division of Forestry for the year 1903-04, the Conservator of Forests enlarged as follows on current proposals to establish plantations and to stimulate tree planting generally in the Lichtenburg and Potchefstroom districts:

"Lichtenburg is one of the chief centres in the south-western Transvaal, a division of the country through which it is possible to drive for hours on end (by wagon) without coming across a single tree. At wide intervals groves of thorns occur, but the greater portion of the

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District is bare, exposed and treeless.

"It is recognised that, without the shelter and other benefits to be derived from extensive tree-planting, farming in this District, as in other treeless parts of the Transvaal, will never make the strides of progress it might, and it is largely with the object of demonstrating to the at present sceptical population that it is possible to grow trees without irrigation in this semi-arid part of the country, and at the same time supplying young trees to the local farmers, that the nursery and plantation were opened.....

"From the Plantation itself such large yields as would be obtained in more favourable localities is not to be looked for, but, nevertheless, remunerative returns can be expected from the sale of fencing poles, firewood and smaller sized timber.

"Only trees accustomed to very dry climates will be planted out here. Such are *Euc. hemiphloia*, *Eus. polyanthemos*, the red and grey box of inland East Australia; *Euc. salmonophloia*, the salmon barked Gum of Coolgardie; *Euc. salubris* and *Euc. microtheca*, trees which grow in the hot, arid interior of Australia; the Cypress pines, *Callitris calcarata* and *Callitris verrucosa*; the various Acacias - all from Australia; *Pinus halepensis* from the Mediterranean region; *Cupressus sempervirens* from Asia Minor and Northern Persia; and *Prosopis* and other dry country trees from Texas, California and Mexico .....

"(At Potchefstroom) the same class of tree that is being grown at Lichtenburg is also being planted ..... The rainfall at the two places differs very

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little, and will only suffice to produce trees accustomed to a comparatively dry climate."

Hutchins' strictures on the matter of "climatic fitness" had not, it seems, been taken fully to heart, for species from the Mediterranean region and California were not entirely excluded. Nevertheless, a new orientation is apparent in the phrase "only trees accustomed to very dry climates will be planted out here" (i.e. at Lichtenburg).

Hutchins' views on the prospects of establishing a successful plantation at Lichtenburg were not optimistic, for in his Report (ibid.) he writes:-

"The rainfall here is not known. It is probably not above 20 inches, and may be less, so that it will be necessary to proceed with caution, planting only dry country trees, such as Callitricises, Ironbarks, Eucalyptus polyanthemos, E. tereticornis, E. rostrata etc. It must be borne in mind that though 20 inches may be enough for avenue trees and scattered trees, it is too little for trees in mases .....

"If the rainfall be below 20 inches, as seems possible, in view of the nearness of Lichtenburg to the Bechuanaland (Botswana) frontier, it will be prudent to reduce the work to a distributing nursery, and such planting as may be necessary for arboretum purposes ....."

Despite misgivings, preparations proceeded apace, and the following year a significant step forward was taken when an Arboretum was laid out at Lichtenburg Plantation. Thus, for the first time in the history

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of the western Transvaal, experimental plantings of timber tree species were placed on a comparative basis. Similar developments followed shortly at Potchefstroom.

An interesting record of the early history of the Arboretum at Lichtenburg can be gleaned from successive Annual Reports of the Conservator of Forests, the salient points of which are given in the following pages. Unfortunately, these same Reports throw no light on the progress of the Arboretum at Potchefstroom, the only source of information in this case being the accounts of individual species trials contained in the Arboretum Book.

Early History of Lichtenburg Arboretum.

In the Annual Report of the Conservator of Forests for the year 1904-05, we read that: "An Arboretum, 10 acres in extent, has been fenced and laid out into plots one-tenth of an acre in size. Sixteen of these plots have been planted with different varieties of trees to test their adaptability to the district.

"It has been established that *Euc. bicolor* and *Euc. microtheca* (an error for *E. camaldulensis* Dehn.) are very hardy against frost, while *Euc. salmonophloia* and *Euc. salubris* are much less so."

Further progress was made during the course of the following year, for in the Annual Report for 1905-06 it is recorded that: "The Arboretum has been extended by the planting of 10 additional plots, so that there are now 26 blocks of different kinds of trees

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growing side by side under ordinary veld conditions. More plots will be planted from time to time as material becomes available. The local indigenous veld trees are not being neglected, blocks having been set aside for white stinkwood (*Celtis rhamnifolia* - now *C. africana* Burm.), karree (*Rhus viminalis* - actually *R. lancea* L.f.), the ordinary sweet thorn (*Ac. sp.* - *Acacia karroo* Hayne)."

The harsh climate of Lichtenburg was soon to take its toll of the newly established arboretum plots, however. The story is told in the Annual Report for the following year, 1906-07, which states: "The weather during the winter was extremely severe and occasioned heavy loss not only in the nursery but also among the trees planted out. The main damage was done between the 27th and 30th of May, when a bitterly cold wind blew from the south. The effect was the more deadly because up to that date the trees were growing vigorously after the abnormally wet summer."

The last reference to the Arboretum at Lichtenburg is contained in the Annual Report for 1908-09, in which certain preliminary conclusions are drawn <sup>with</sup> regard to the hardiness of various species in the western Transvaal. Some of these conclusions cannot be supported to-day in the light of further experience, drawing attention to the dangers inherent in judging the success of trials after the lapse of too short an interval of time.

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## CHAPTER II.

DESCRIPTION OF AREA.

The semi-arid, highveld region of the western Transvaal is not isolated by natural, physiographic barriers which cause its climate to differ appreciably from that of the country <sup>(see Topographical Map of the Western Transvaal)</sup> surrounding it. To the south it is separated from the Orange Free State by the Vaal River. The boundary with Botswana to the west is political rather than climatic, while in the north and east the region merges by imperceptible degrees with the warm, dry valley of the Limpopo River and its tributaries and with the cool, sub-humid, gently rising plateau of the eastern Transvaal highveld. A line drawn roughly from Parys on the Vaal River, through Zeerust and on to the (Botswana) Border (corresponding with the boundary between Silvicultural Zones C ' ' ' 2 and B ' ' ' 2 of the Map) delineates the region from areas to the north and east. While there is a gradual diminution in the rainfall from east to west and while the winters become progressively more severe <sup>from</sup> north to south, the change is nowhere abrupt. The results of the species trials conducted at Lichtenburg (26°09'S, 26°10'E) and Potchefstroom (26°43'S, 27°06'E) are therefore to some extent valid not only for the whole of the western Transvaal but for a wide area beyond its boundaries.

The relationship of the climate of the western Transvaal to that of the rest of South Africa is illustrated by the Silvicultural Map. In this map, the parameters of the different humidity and temperature



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zones are not mathematically related in any systematic way, nor do they accord closely with those of other, previously published, climatic classifications. The zones are empirical ones and were suggested by the observed limits of hardiness to frost and drought of representative tree species.

#### CLIMATE.

The climate of the western Transvaal can be classed as temperate, semi-arid, with a markedly seasonal <sup>rainfall</sup> occurring almost entirely during the summer months. It is further characterised by periodic, cold winds in winter, which blow unimpeded across the plains from the south and are sometimes accompanied by light falls of snow or sleet. Severe frost may be experienced during several months of the year, the effect of which upon vegetation is frequently accentuated by high winds. In spring and early summer, warm, dry winds of considerable force and long duration sweep across the rainless countryside off the Kalahari desert and dry out the vegetation at the end of the long, winter drought. Mute testimony to the strength and persistence of these westerly winds is borne by the inclined stems and lopsided crowns of evergreen trees exposed to their influence. "Set-in" rains, although sometimes experienced, do not account for a large proportion of the total, annual rainfall, which is received mainly in the form of short, sharp thunder storms.

A marked similarity exists between the climates of Lichtenburg and Potchefstroom. Both centres

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fall within the same silvicultural zone (Zone C ' ' ' 2 of the Map) and are thus comparable in terms of moisture balance and mean, minimum temperature - two factors critical to the survival and growth of trees.

Rainfall.

Since 1904, when systematic tree planting commenced in the western Transvaal, the mean annual rainfall recorded at Lichtenburg and Potchefstroom has been 598 mm. and 618 mm., respectively. The closeness of these averages is to be noted, the more so because a decade or so ago they were practically indential. The annual totals for each centre are given in the following Table:-

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TABLE I.

## ANNUAL RAINFALL RECORDED AT LICHTENBURG AND POTCHEFSTROOM

Year	Rainfall (mm.)	
	Lichtenburg	Potchefstroom
1904	596	664
1905	480	496
1906	523	485
1907	731	900
1908	480	522
1909	909	783
1910	551	528
1911	594	504
1912	622	671
1913	649	618
1914	533	600
1915	560	684
1916	448	518
1917	699	734
1918	942	788
1919	442	409
1920	442	557
1921	748	808
1922	437	556
1923	774	491
1924	625	692
1925	652	665
1926	495	554
1927	505	504
1928	753	573
1929	565	939
1930	525	525
1931	539	650
1932	556	428
1933	470	478
1934	964	530
1935	397	459
1936	655	803
1937	458	371
1938	429	502
1939	904	725
1940	729	587
1941	482	380
1942	709	704
1943	840	959
1944	806	821
1945	485	395
1946	589	616
1947	661	544
1948	395	591
1949	583	530
1950	752	685
1951	495	645
1952	639	716
1953	465	629
1954	539	595
1955	400	728
1956	533	500
1957	869	767
1958	518	595
1959	439	616
1960	535	803
1961	646	670
1962	547	662
Mean	598	618

The above data are presented graphically in Figures 1 and 2.

The variability of the rainfall in the western Transvaal is apparent. However, wet and dry years frequently coincide at the two centres, notwithstanding the erratic behaviour of convection storms. This is illustrated in Figure 3, where the two sets of data are plotted over one-another.

Of especial importance from the point of view of tree planting, since most species have a life-span extending over several decades, is the question of weather cycles or trends. Such trends have been demonstrated by Schumann and Thompson (1934) and Wicht (1949), who fitted smoothed curves to rainfall data. The method of analysis employed involves weighting observed annual rainfall totals proportionately to the values of the normal frequency distribution, using the following set of equations:-

# LICHTENBURG.

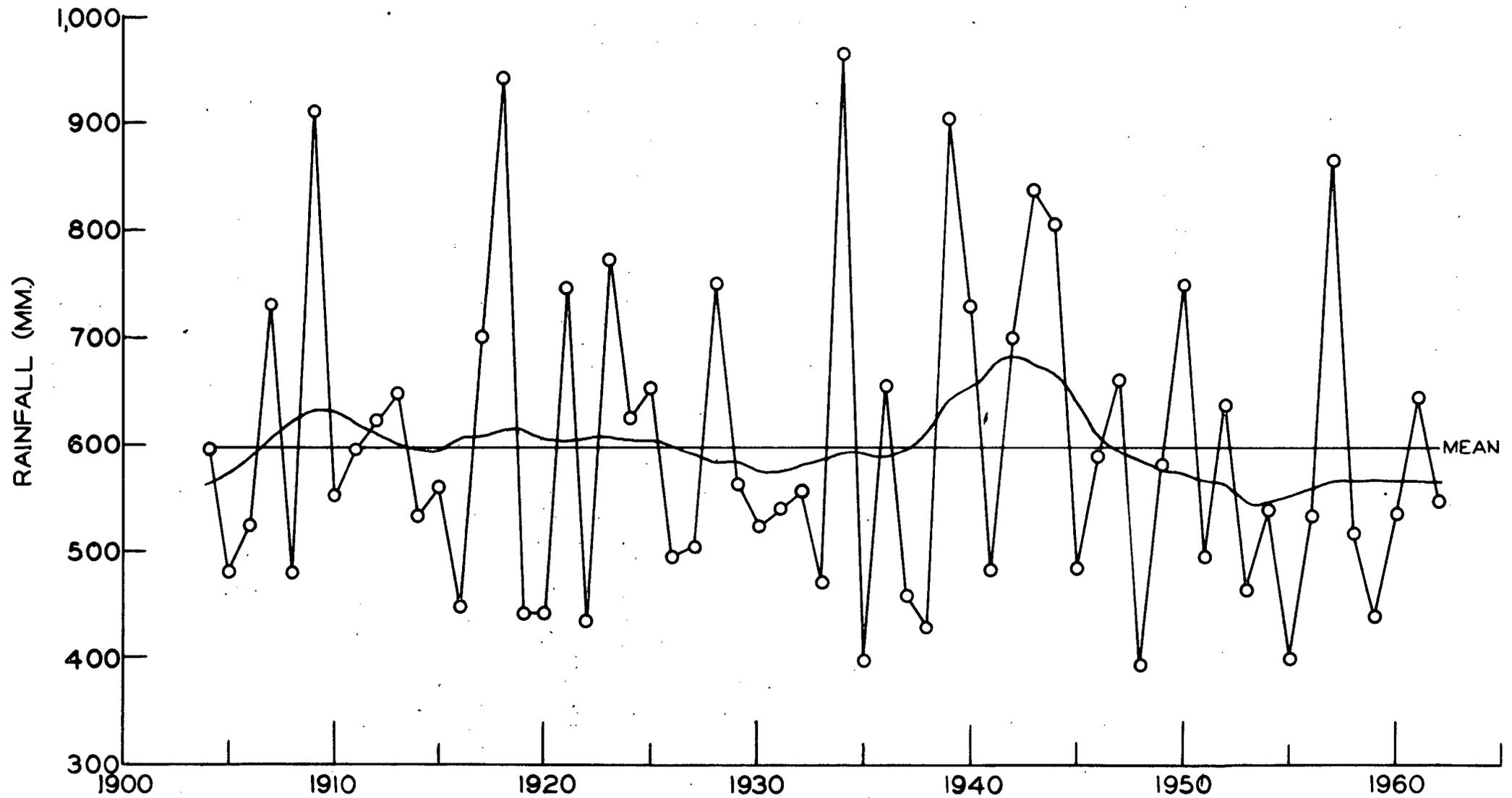


Fig. 1. Annual, cyclic and mean rainfall: Lichtenburg.

# POTCHEFSTROOM.

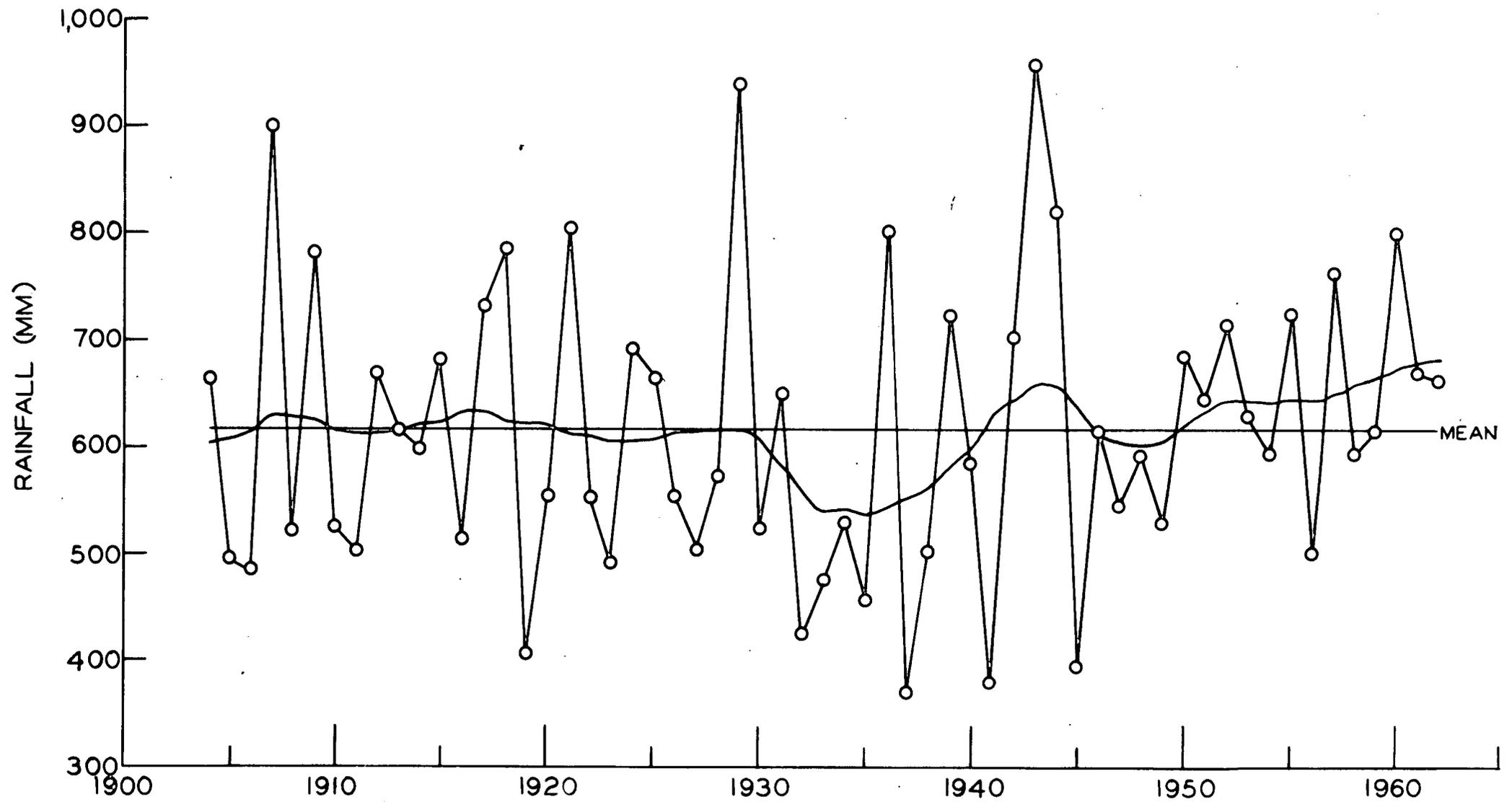


Fig. 2. Annual, cyclic and mean rainfall: Potchefstroom.

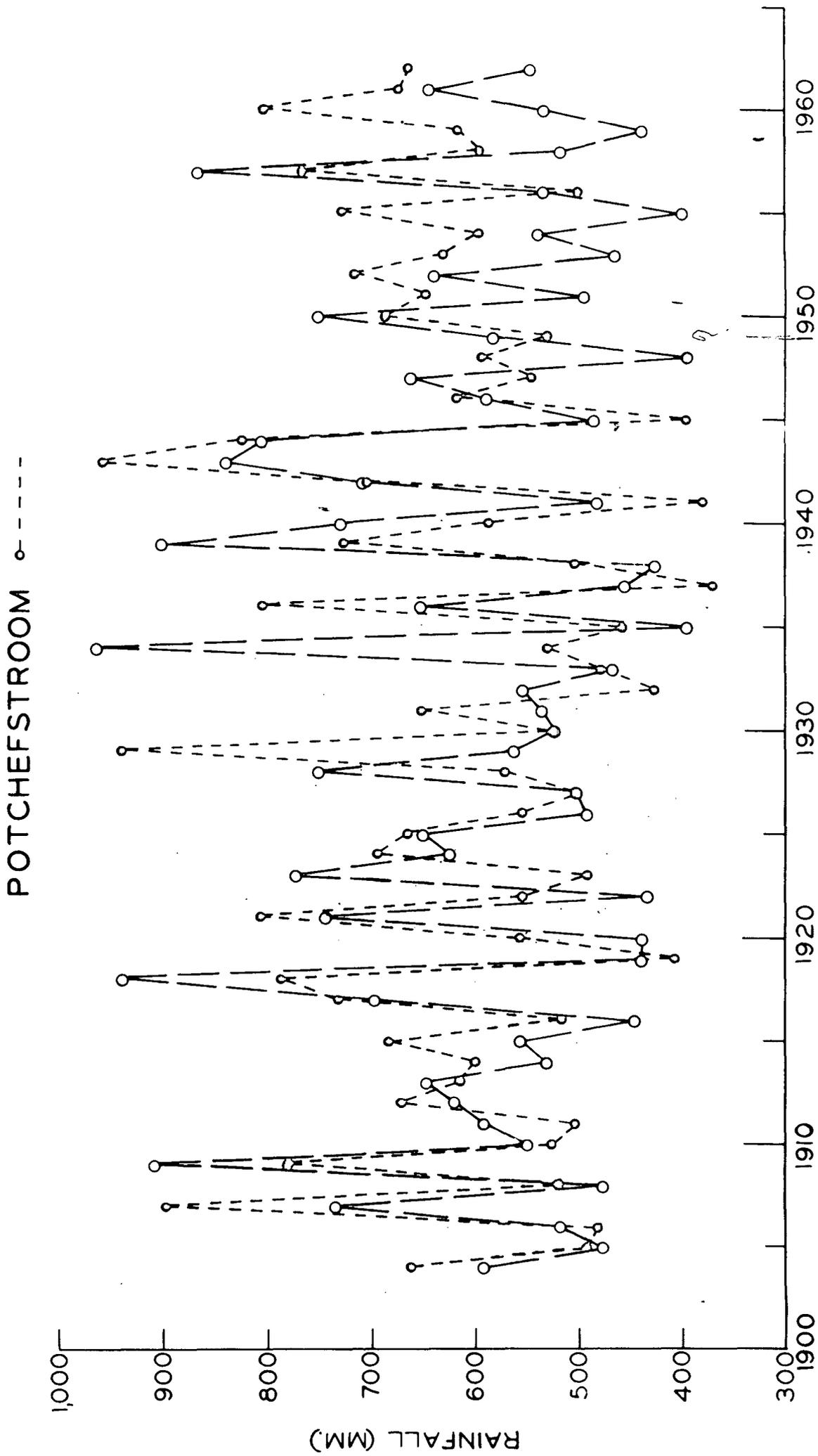


Fig. 3. Annual rainfall: Lichtenburg and Potchefstroom.

$$B_1 = .325A_1 + .270A_2 + .195A_3 + .115A_4 + .060A_5 + .025A_6 + .010A_7$$

$$B_2 = .270A_1 + .245A_2 + .195A_3 + .135A_4 + .085A_5 + .045A_6 + .025A_7$$

$$B_3 = .192A_1 + .195A_2 + .190A_3 + .160A_4 + .120A_5 + .075A_6 + .040A_7 + .025A_8$$

$$B_4 = .120A_1 + .135A_2 + .160A_3 + .170A_4 + .155A_5 + .120A_6 + .075A_7 + .040A_8 + .025A_9$$

$$B_5 = .060A_1 + .080A_2 + .120A_3 + .155A_4 + .170A_5 + .155A_6 + .120A_7 + .075A_8 + .040A_9 + .025A_{10}$$

$$B_6 = .025A_1 + .040A_2 + .075A_3 + .120A_4 + .155A_5 + .170A_6 + .155A_7 + .120A_8 + .075A_9 + .040A_{10} + .025A_{11}$$

$$B_7 = .025A_2 + .040A_3 + .075A_4 + .120A_5 + .155A_6 + .170A_7 + .155A_8 + .120A_9 + .075A_{10} + .040A_{11} + .025A_{12}$$

$$B_{n-5} = .025A_{n-10} + .040A_{n-9} + .075A_{n-8} + .120A_{n-7} + .155A_{n-6} + .170A_{n-5} + .155A_{n-4} + .120A_{n-3} + .075A_{n-2} + .040A_{n-1} + .025A_n$$

$$B_{n-4} = .025A_{n-9} + .040A_{n-8} + .075A_{n-7} + .120A_{n-6} + .155A_{n-5} + .170A_{n-4} + .155A_{n-3} + .120A_{n-2} + .080A_{n-1} + .060A_n$$

$$B_{n-3} = .025A_{n-8} + .040A_{n-7} + .075A_{n-6} + .120A_{n-5} + .155A_{n-4} + .170A_{n-3} + .160A_{n-2} + .135A_{n-1} + .120A_n$$

$$B_{n-2} = .025A_{n-7} + .040A_{n-6} + .075A_{n-5} + .120A_{n-4} + .160A_{n-3} + .190A_{n-2} + .195A_{n-1} + .192A_n$$

$$B_{n-1} = .025A_{n-6} + .045A_{n-5} + .085A_{n-4} + .135A_{n-3} + .195A_{n-2} + .245A_{n-1} + .270A_n$$

$$B_n = .010A_{n-6} + .025A_{n-5} + .060A_{n-4} + .115A_{n-3} + .195A_{n-2} + .270A_{n-1} + .325A_n$$

Where  $A_1 - A_n$  are successive values of the observed, annual rainfall and  $B_1 - B_n$  are successiver points on the smoothed curve.

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The values of  $B_1 - B_n$  calculated for Lichtenburg and Potchefstroom by means of the above equations are shown in Figures 1 and 2 by continuous, smooth curves. The arithmetic, mean rainfall for the period under consideration is indicated by a straight line drawn parallel with the abscissa.

Inspection of the smooth curves in Figures 1 and 2 does not reveal any definite rhythm or trend in the rainfall, although dry periods are seen to alternate with moister ones. This is consistent with the findings of various authors who have attempted, unsuccessfully, to demonstrate rainfall cycles (such as one associated with the 11.2-year sun-spot cycle). Similarly, no clear indication is given by these smooth curves of any long-term increase or decrease in the annual rainfall over the whole period under review. This aspect of the matter can, however, be subjected to further analysis.

Schumann and Thompson (ibid.) point out that "it is tacitly assumed that there is a fixed normal or average value of rainfall, which may be determined from a sufficiently lengthy series of observations", but cast doubt on this assumption, stating that "..... there is also the possibility that no such thing as a fixed, average rainfall exists, and that the so-called average itself is subject to variations." They refer to the findings of Dean A. Pack, which seem to lend weight to such an hypotheses, concluding that, "instead of referring to 'normal' rainfall as though it were a fixed average, it would be more correct scientifically to employ the term 'floating average'".

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If this floating average is computed progressively year by year and plotted over time, a smoother curve can be expected than that obtained by the method of Schumann and Thompson or Wicht, i.e. one less influenced by transitory droughts and periods of higher rainfall. Such a curve, while of no value as a means of showing weather cycles, would give a clearer indication of long-term changes in the annual rainfall.

The calculation of the floating or progressive average involves the following set of equations:-

$$M_1 = \frac{A_1}{1}$$

$$M_2 = \frac{A_1 + A_2}{2}$$

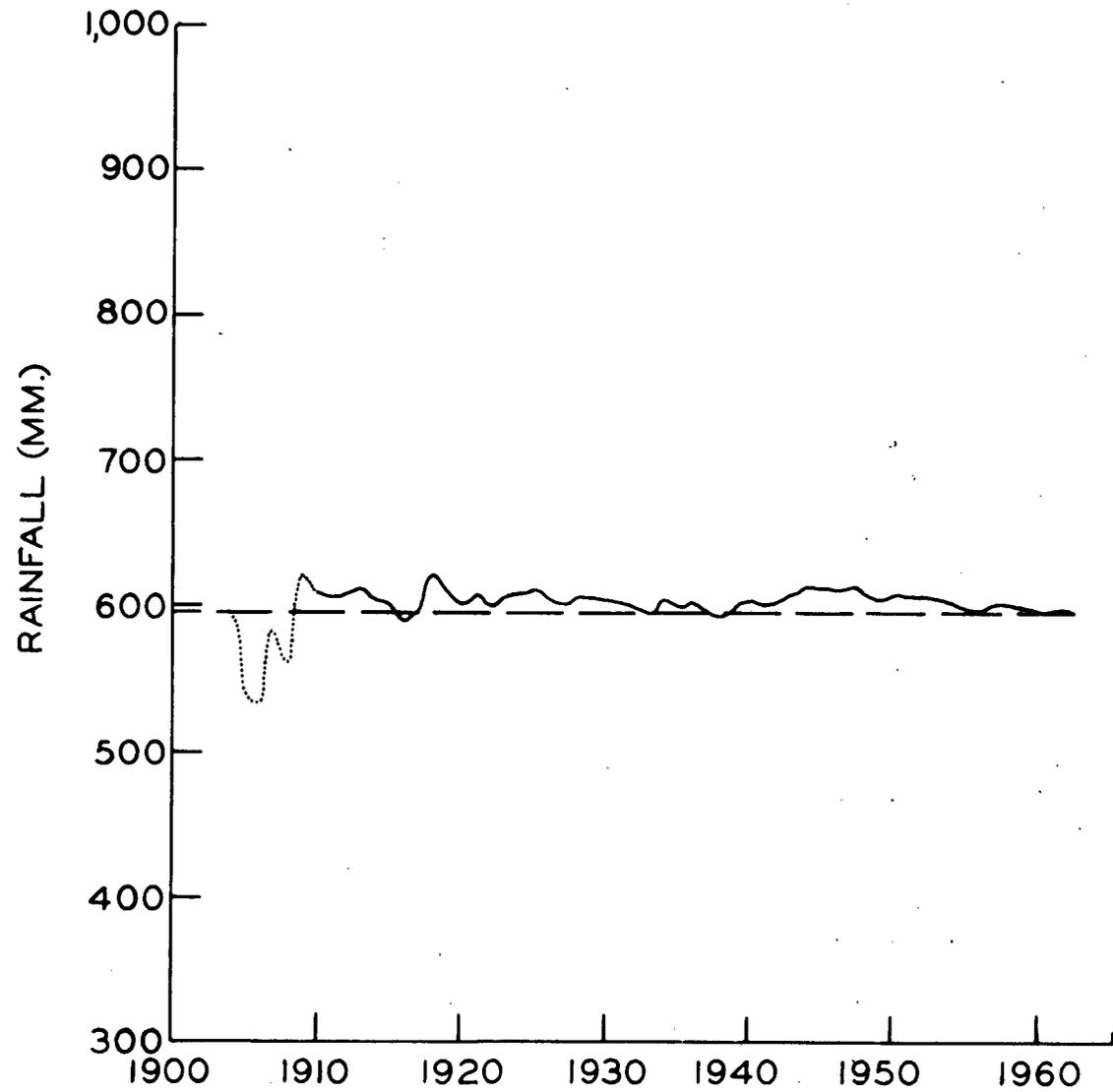
$$M_n = \frac{A_1 + A_2 + \dots + A_n}{n}$$

where  $A_1 - A_n$  are, as before, successive values of the observed, annual rainfall and  $M_1 - M_n$  are successive levels of the progressive mean.

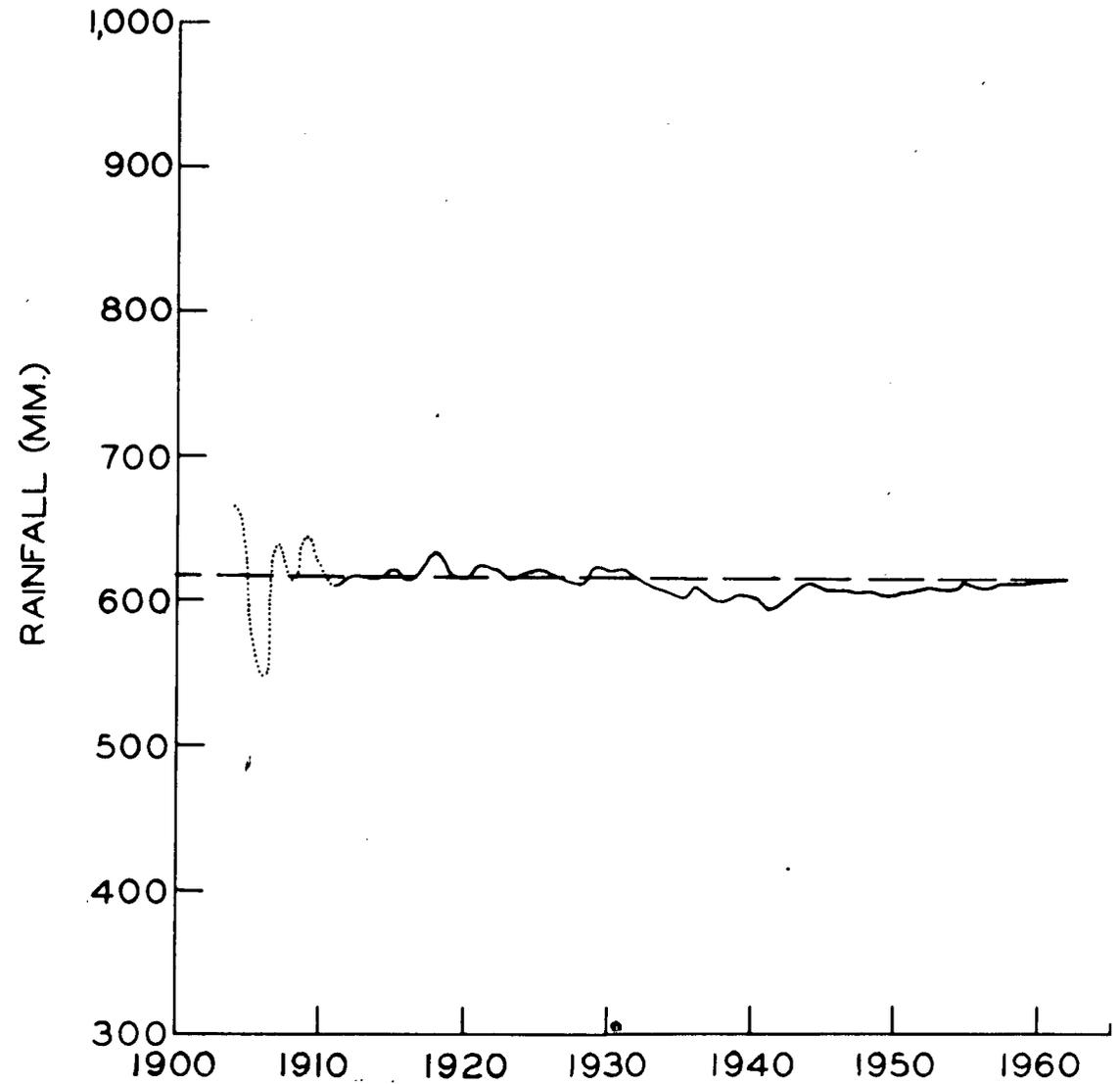
The values of  $M_1 - M_n$  calculated by means of these equations are presented graphically in Figures 4 and 5, in which the ordinates are drawn to the same scale as in Figures 1, 2 and 3 but the scale of the abscissae is reduced by one half. These data indicate that the mean annual rainfall at Lichtenburg in 1962 stood at a lower level than at any time since 1938. Only on three occasions since 1909 has the figure dropped below the most recently calculated level. On the other hand, the position with regard to Potchefstroom is reversed, for the mean annual rainfall has not stood so high since 1931 and has only risen above the most recently calculated level twelve times since 1911.

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# LICHTENBURG.



# POTCHEFSTROOM.



Figs. 4 and 5. Progressive average annual rainfall: Lichtenburg and Potchefstroom.

These results seem slightly contradictory, yet double-mass analysis shows no inconsistency of the records, and it must be concluded that, over the western Transvaal as a whole, there has been no progressive change of practical~~y~~ significance in the annual rainfall during the period under review.

Another feature of the rainfall in the western Transvaal is that the precipitation is confined to relatively few days in the year, the average <sup>number</sup> of rainy days per annum at Lichtenburg being 56.7 days and at Potchefstroom 58.0. On the other hand, the percentage of the total annual rainfall which is liable to occur within a single, 24-hour period is not unduly high. The maximum, 24-hour, rainfall expectancy at Lichtenburg and Potchefstroom for spans of from 5 to 100 years is given in the table below,

TABLE 2  
MAXIMUM 24-HOUR RAINFALL EXPECTANCY FOR PERIODS RANGING FROM 5 TO 100 YEARS.

Centre	Percentage of Average Annual Rainfall								
	5 Years	10 Years	15 Years	20 Years	30 Years	40 Years	60 Years	80 Years	100 Years
Lichtenburg	11	13	15	15	17	17	18	19	20
Potchefstroom	11	13	14	15	16	17	18	19	19

The maximum rainfall actually recorded in a single, 24-hour period at Lichtenburg and Potchefstroom is 97 mm. and 140 mm., respectively, that at the former centre having been registered in April, 1945, and that at the latter in December, 1943.

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The average, maximum and minimum rainfall recorded at Lichtenburg and Potchefstroom for each month of the year is given in Table 3, below:-

TABLE 3  
MONTHLY RAINFALL

Month	Rainfall (mm.)					
	Lichtenburg			Potchefstroom		
	Mean	Maximum	Minimum	Mean	Maximum	Minimum
January	114	282	24	106	240	29
February	91	265	13	95	227	22
March	99	200	8	84	276	11
April	38	127	0	34	135	0
May	17	73	0	19	99	0
June	6	111	0	8	104	0
July	6	70	0	8	83	0
August	5	92	0	10	100	0
September	15	86	0	18	93	0
October	45	138	5	46	171	1
November	71	184	3	78	170	10
December	97	309	9	102	237	21

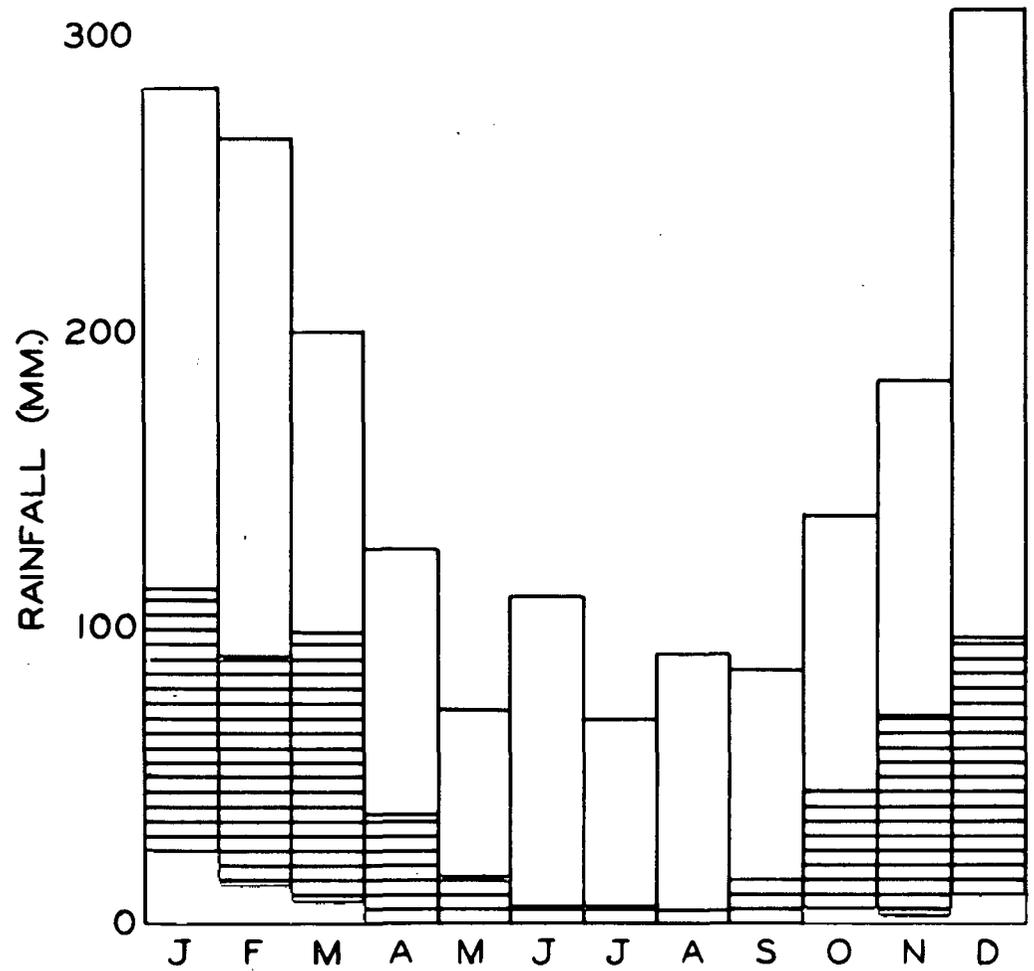
The above data are represented diagrammatically by means of histograms in Figures 6 and 7.

The markedly seasonal distribution of the rainfall is apparent. At both centres there are 6 consecutive months in each year during which no rain at all may be experienced, while the average monthly rainfall over the period May-August, inclusive, is no more than 10 mm. This long, practically rainless period lasting almost the entire winter is of great significance to plant life and more particularly to evergreen trees. Into this category fall the eucalypts and all the conifers of any importance in the western Transvaal.

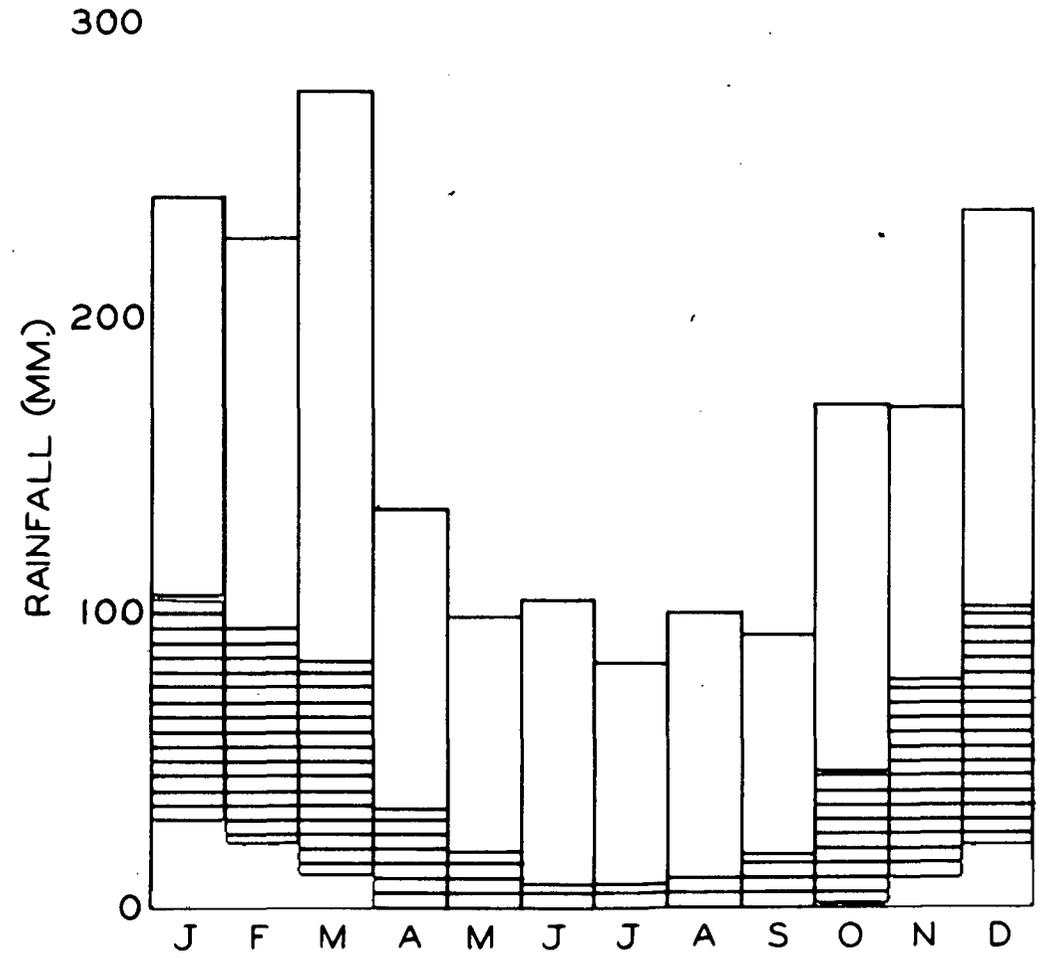
It might be argued, and plausibly, that the effect of the seasonal drought would be even more severe

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### LICHTENBURG.



### POTCHEFSTROOM.



Figs. 6 and 7. Average, maximum and minimum rainfall: Lichtenburg and Potchefstroom.

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if it occurred at the height of the summer, growing season instead of in winter. Any such consideration is, however, offset by the fact that the loss of moisture through evaporation to the atmosphere after rain is both greater and more rapid at the higher temperatures which prevail in summer. Consequently, a smaller proportion of the rainfall penetrates the soil. Hence it is that economic afforestation is possible in the winter rainfall area in localities where the mean, annual precipitation is less than that necessary in the summer rainfall area unless the summers are particularly cool.

The effectiveness of the annual rainfall, having due regard for seasonal distribution and for mean, monthly temperatures throughout the year, has been critically examined by Thornthwaite (1948). In discussing the rôle of evaporation, Thornthwaite states: "We cannot tell whether a climate is moist or dry by knowing the precipitation alone. We must know whether precipitation is greater or less than the water needed for evaporation and transpiration." The combined effect of evaporation and transpiration Thornthwaite terms "evapotranspiration", continuing: "Since precipitation and evapotranspiration are due to different meteorological causes, they are not often the same either in amount or in distribution through the year. In some places more rain falls month after month than evaporates or than the vegetation uses. The surplus moves through the ground and over it to form streams and rivers and flows back to the sea. In other places, month after month, there is less water in the soil than the vegetation would use

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if it were available. There is no excess of precipitation and no runoff, except locally where the soil is impervious and cannot absorb the rain on the rare occasions when it falls. Consequently, there are no permanent rivers, and there is no drainage to the ocean. In still other areas the rainfall is deficient in one season and excessive in another, so that a period of drought is followed by one with runoff. The march of precipitation through the year almost never coincides with the changing demands for water."

The rational approach to the classification of climate evolved by Thornwaite is based on the balance between available moisture (as expressed by precipitation and the water storage capacity of the soil) and potential evapotranspiration (defined by him elsewhere as "the amount of moisture that would be transferred from a vegetationcovered soil to the atmosphere by evaporation and transpiration, if it were constantly available in optimum quantity"). In calculating the water balance, Thornthwaite assumes that the amount of stored moisture available to plants with fully developed root systems does not deviate substantially from a mean value equivalent to 100 mm. of rain. He then devises an empirical method of computing potential evapotranspiration (which is actually an index of solar, thermal efficiency) based on latitude and mean, monthly temperatures throughout the year. For this, specially prepared tables and a nomogram are used, and a final adjustment is made for the number of days in the month.

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The computed data for potential evapotranspiration are next compared with the mean rainfall for the corresponding month, carrying forward surplus moisture stored in the soil (if any) from one month to the next. A measure is thereby obtained of the moisture surplus or deficit for each month and so, in turn, for the whole year. A possible refinement to the method would be the introduction of a factor for the average interval between rainy spells in each month, since, as Thornthwaite himself observes, "drought does not begin immediately when rainfall drops below water need" but sets in only when evapotranspiration has accounted for all the moisture stored in the soil.

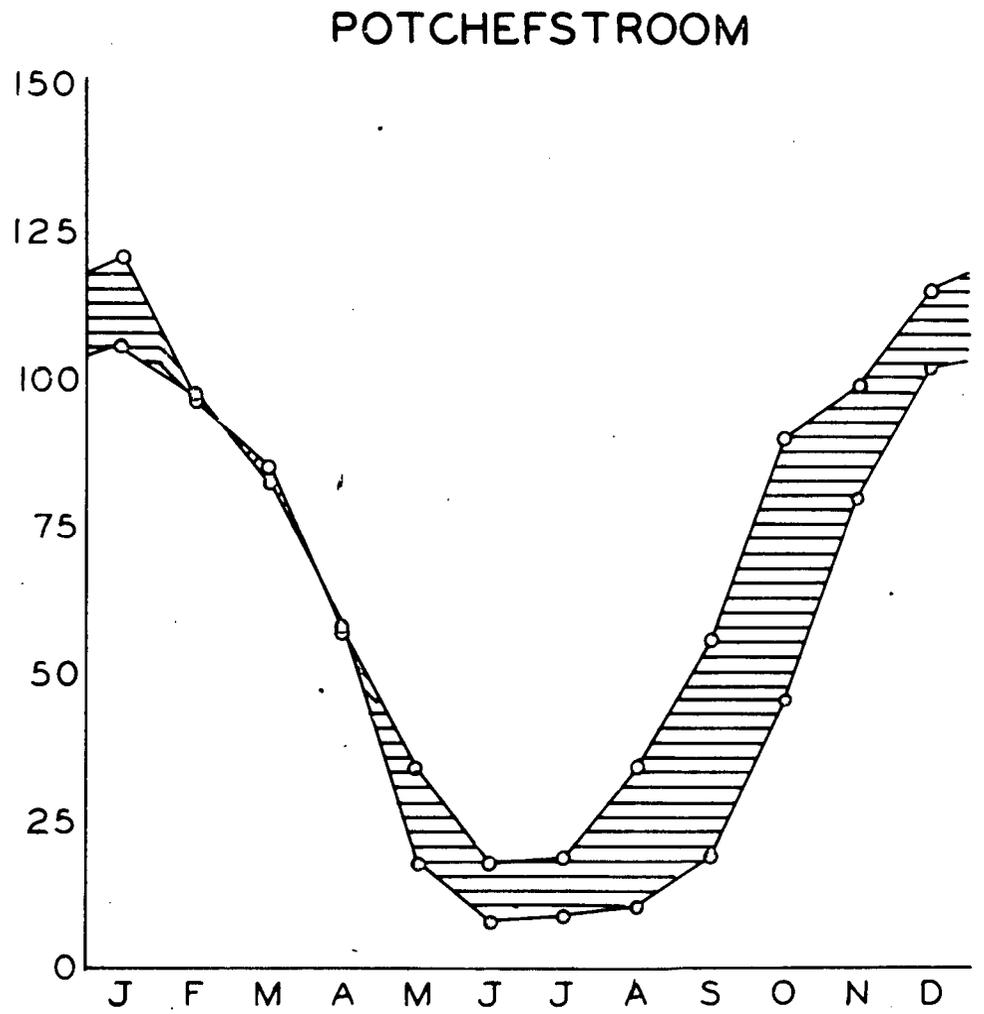
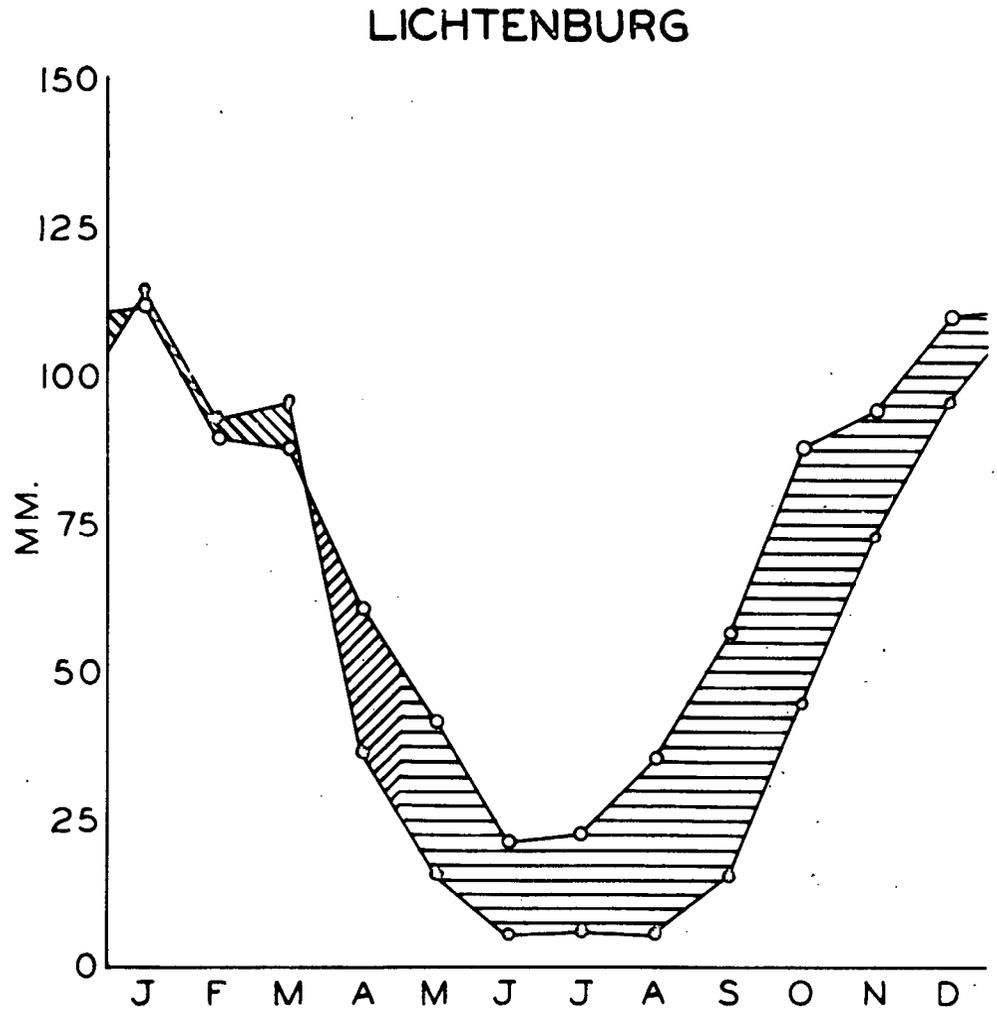
Schulze (1947), in preparing a paper on the climate of South Africa using the method proposed by Thornthwaite, computed the water balance of over 400 stations distributed throughout South Africa, South West Africa and the three High Commission Territories. The writer is indebted to him for permission to draw upon these valuable data to describe more fully the climate of the western Transvaal.

In Figures 8 and 9, data for precipitation, evapotranspiration, <sup>water deficit and</sup> water surplus are presented graphically for Lichtenburg and Potchefstroom.

These data reveal that at Lichtenburg and Potchefstroom there is no seasonal water surplus, i.e. there is no month during the year when the supply of moisture in the soil is more than can be exhausted by the combined action of evaporation and transpiration. On the contrary, throughout the greater part of the year these two centres experience a water deficit.

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Soil Moisture Depletion  
Water Deficit



Figs. 8 and 9. Precipitation, evapotranspiration, water deficit and water surplus:  
Lichtenburg and Potchefstroom.

In view of the chronic water shortage which exists at Lichtenburg and Potchefstroom, moisture is necessarily a critical factor in the survival and growth of vegetation. Hence a capacity for resisting prolonged drought is among the essential attributes to be looked for in any tree species when assessing its suitability for trial in the area.

#### Temperature.

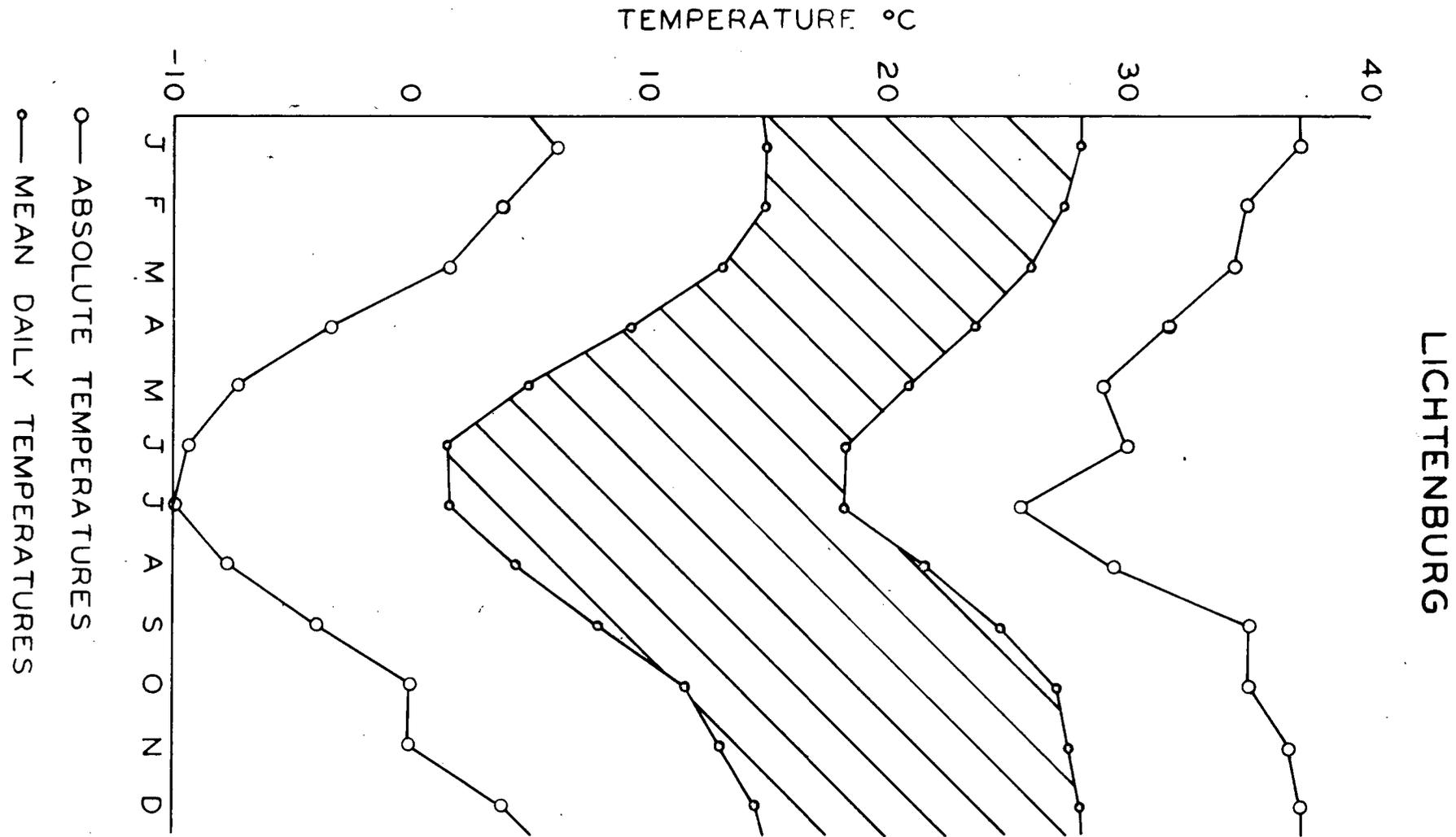
The effect of temperature on rate of evaporation and transpiration has been discussed in relation to water balance. It only remains, therefore, to give a more detailed account of actual temperatures experienced in the western Transvaal and of their bearing upon tree planting there.

In Figures 10 and 11, the absolute maximum, mean daily maximum, absolute minimum and mean daily minimum temperatures recorded at Lichtenburg and Potchefstroom during each month of the year are presented graphically after the method of Deasy (1941). Perusal of these data shows that, as in the case of rainfall, a close similarity exists between conditions at the two centres.

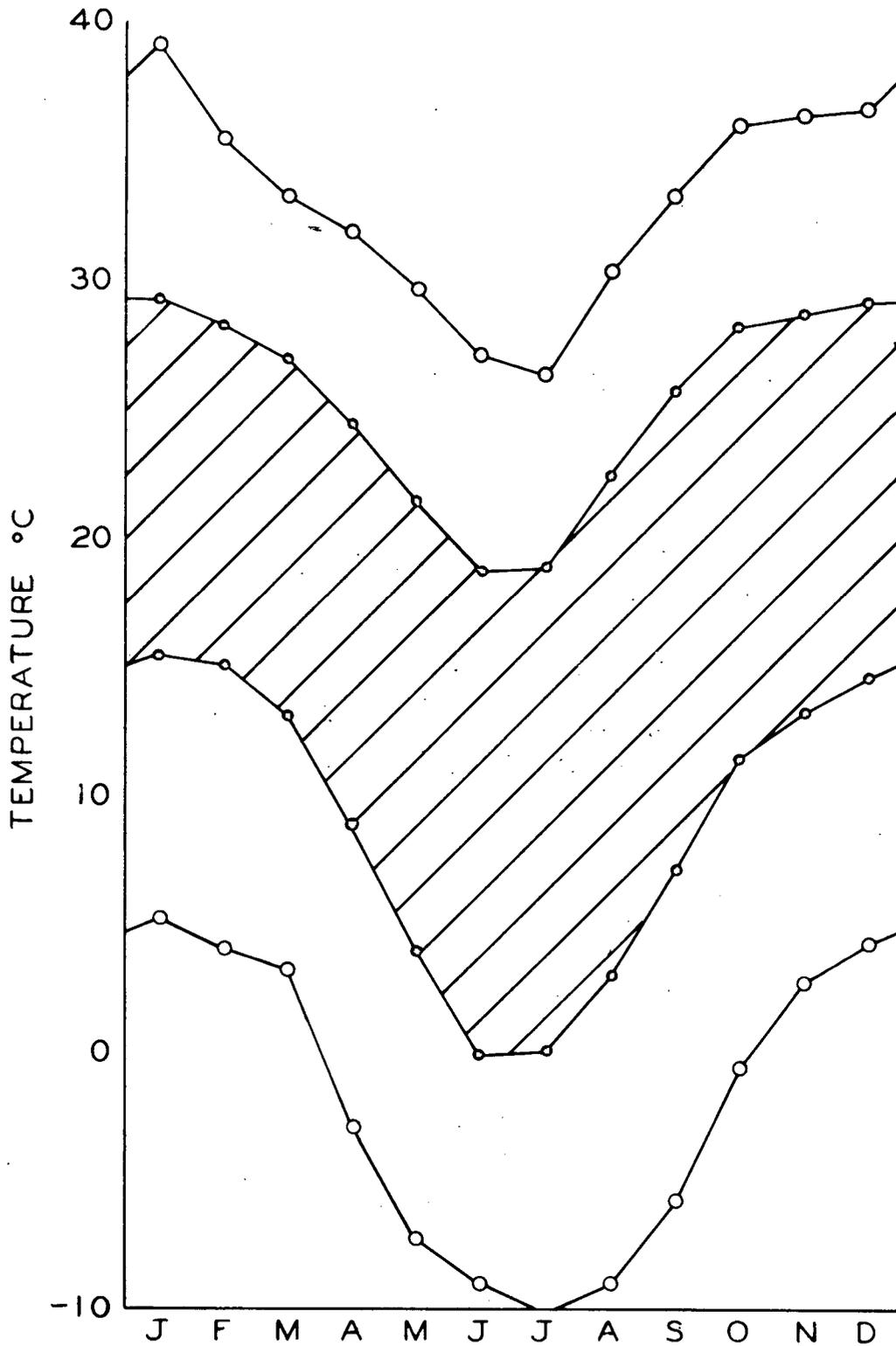
In the diagrammatic method of presentation developed by Deasy the annual temperature range is shown by the overall interval between the four curves. The shaded space between the mean (daily) maximum and mean (daily) minimum curves represents the average or 'normal' diurnal temperature range during the different months of the year. Extreme temperatures, which may be limiting factors for plant and animal life, are reflected by the absolute maximum and absolute minimum curves. The distance of the extreme curves from the mean curves indicates

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Fig. 10. Absolute maximum, mean daily maximum, absolute minimum and mean daily minimum temperature for each month: Lichtenburg.



### POTCHEFSTROOM



○ — ABSOLUTE TEMPERATURES  
● — MEAN DAILY TEMPERATURES

FIG. 11. ABSOLUTE MAXIMUM, MEAN DAILY MAXIMUM, ABSOLUTE MINIMUM AND MEAN DAILY MINIMUM temperature for each month: Potchefstroom.

the daily temperature irregularity for different months, though imperfectly, for no account is taken of absolute lowest maximum or absolute highest minimum temperatures.

The data for Lichtenburg and Potchefstroom are noteworthy, firstly, for the exceptionally wide overall temperature range which they embrace; secondly, for the very large fluctuation in absolute maximum and absolute minimum temperatures according to the season of the year; thirdly, for the great difference which exists between the mean, daily maximum and mean, daily minimum temperature in any one month. The range in absolute temperature experienced at Lichtenburg is 47.2°C and at Potchefstroom 49.4°C. Hot days, with the temperature rising above 27°C or 80°F, can occur at either centre in any month except July, while cold nights, with the temperature dropping to or below freezing, have been recorded in every month except November (Potchefstroom only), December, January, February and March. Frosts are frequent between May and September, and occur, on an average, 25.9 times a year at Lichtenburg and 43.2 times a year at Potchefstroom; yet, for about 5 months in the year, both the absolute maximum and daily maximum temperatures rise above the corresponding levels for many centres in the sub-tropics. These facts, taken collectively, underline the essentially "continental" character of the climate in the western Transvaal.

The conclusion to be drawn from the above data is that the climate of the western Transvaal is unsuitable for economic, large-scale afforestation. The rainfall is low and undependable; temperatures vary between wide extremes.

Not only is the growth of trees in the area slow, but the climate imposes sever restrictions on the number

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of species which can be brought successfully to maturity

### GEOLOGY AND SOILS

#### Geology.

The geology of the western Transvaal is a good deal more complex than the flat or gently undulating topography of the area would suggest. A detailed account of the several geological systems represented in this relatively small tract of country would add unduly to the length of the present paper. Moreover, the subject has been adequately dealt with, not only in such general works of reference as those of du Toit (1954) and King (1942), but also in the more specialised and exhaustive treatise of von Backström, Schumann, le Roux, Kent and du Toit (1953), Nel, Truter, Williams and Mellior (1939) and others.

The intricacies of the various formations found in the western Transvaal are most easily understood if considered in relation to the geological history of the area, as revealed by the evidence of the rocks themselves.

Underlying the entire sub-continent of Southern Africa are the rocks of the Swaziland System. These consist of highly metamorphosed schists and gneisses derived from lavas and sedimentary deposits, into which were intruded massive batholiths of "Old Granite". This basement complex is of the greatest antiquity, belonging to the Archaeozoic Era and dating from a period about 2,000 million years ago. Although apparently continuous at depth, the Swaziland System is covered by younger formations of varying thickness over the greater part of

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its area. Its occurrence in the western Transvaal is confined to "windows", through which it emerges when the overlying mantle of more recent strata is stripped by erosion. The most famous of these windows is the remarkable "Vredefort Dome", across which the Vaal River now cuts as it flows to meet the Orange, pursuing a course which it presumably followed whilst the granite was still covered by superimposed strata.

Following the igneous activity which marked the close of the archaic epoch there occurred a period of erosion during which the landscape was reduced to one of low relief, though not to a perfectly plane surface. This phase was succeeded, about 1,100 million years ago in the Proterozoic Era, by a period of active deposition, which gave rise to the sediments of the Witwatersrand System.

The Witwatersrand System is best known from the southern Transvaal, where its rocks reach a total thickness of 25,000 feet in places. Lying unconformably on the Old Granite, with its associated schists and gneisses, it comprises a succession of fairly well defined formations, including volcanic lavas, quartzites, shales and an auriferous conglomerate. The quartzites have left their mark on the topography of the western Transvaal, giving rise to the characteristic, rocky ridges of the Kroonstad and Parys districts.

Later Witwatersrand time saw a renewal of volcanic activity, which reached such proportions that the resultant lavas, with interspersed sediments, have come to be regarded as a separate system, called the Ventersdorp System. This consists, in the Transvaal, of two series - the Lower Division and Upper Division Series - totalling

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about 6,000 feet in thickness. The Ventersdorp System is of importance because its rocks at present occupy the greater part of the land surface of the western Transvaal, having been exposed through erosion of more recent formations.

The volcanic eruptions of the Ventersdorp System were followed by a long period of renewed erosion, which came to an end only when the greater part of what is now South Africa subsided beneath the ocean. This sub-marine phase was marked by the deposition of calcareous rocks and shales which, together with beds that seem to have been laid down as continental conditions were gradually restored, make up the Transvaal System.

The Transvaal System comprises three, well-defined series, namely the Black Reef, the Dolomite and the Pretoria Series. The first of these is represented in the western Transvaal only by a band of dark, hard quartzite with associated shales and conglomerates some 20 to 50 feet thick. Of more importance locally is the Dolomite, which covers a considerable area immediately to the north of Lichtenburg and almost encircles Potchefstroom. This calcareous formation is well known for its caves and sinkholes, which owe their existence to its slightly soluble nature. The Pretoria Series comprises, in all, three, broad, typically argillaceous stages and three narrower, quartzitic ones, the latter, in particular, heavily invaded by thick sheets of diabase. In the western Transvaal it occurs only as concentric bands to either side of Potchefstroom associated with the Vredefort Dome.

With the closing stages in the deposition of the Transvaal System there commences a great hiatus in the geological history of South Africa, during which a prolonged

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period of erosion seems again to have set in. The sea once more encroached on the eastern and southern parts of the sub-continent, resulting in the local accumulation of marine deposits. The next formation found in the western Transvaal, namely the Karroo System, is, however, terrestrial in origin and dates from about 350 to 135 million years ago (i.e the Palaeozoic Eras).

At the base of the Karroo System lies the Dwyka Series, of which the most characteristic component is the celebrated glacial tillite - a quasi-conglomerate comprising mud-stone and striated boulders of various sizes deposited as the ice retreated. This formation is poorly developed and erratic in its occurrence in the western Transvaal, partly as a result of having been laid down on an uneven surface. However, it is exposed to view immediately to the south and east of Lichtenburg and is the parent rock upon which the Arboretum there is situated (cf. stone line in soil profile).

Following conformably on the Dwyka Series are the shales and sandstones of the Ecca Series. These, like the former, are not widely represented in the western Transvaal, occurring at the surface only over limited areas to the east of Schweizer Reneke and Klerksdorp. The succeeding formations of the Karroo System are totally wanting in the Transvaal.

Subsequent to the accumulation of the sediments and lavas of the Karroo System there occurred again a period of erosion, in the course of which an exceptionally

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flat peneplane developed over a wide area. This vast plane has been partially obscured during Tertiary and Quaternary (recent) times by an even mantle of windblown deposits known as the Kalahari Beds. Enormous tracts today lie covered by transported sand, including parts of the western Transvaal to the north-west of Lichtenburg. Deposits of recent geological date occur as well in the Potchefstroom area, and upon these the Arboretum at that centre is located.

The importance of the geology of an area in the forestry context<sup>x</sup> lies in the influence of the rock formation upon topography and upon the depth, texture and fertility of the soil. The lengthy period of erosion which followed the deposition of the Karroo System reduced the topography of the western Transvaal to an almost featureless<sup>e</sup> plain. Only in the vicinity of Parys and Kroonstad did the more resistant quartzites of the Witwatersrand System withstand the levelling forces of erosion to any marked extent. The rugged hills and ridges formed by this inert, massive rock are of extraordinary antiquity, ~~and~~ constituting a fossil landscape which once lay buried under the sediments of later systems but which have<sup>s</sup> now been laid bare again by erosion.

### Soils.

The characteristics of a soil are determined by the nature of the rock from which it was derived and by the climate under which it evolved. Neither of these pedogenetic factors is universally dominant, but in regions with a uniform climate, such as the western Transvaal,

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variations in soil depth, texture and fertility are usually associated with changes in the parent material.

Under the climatic conditions of the western Transvaal, acid, plutonic, igneous rocks such as granites and pegmatites give rise to somewhat gritty, sandy loams of rather low fertility. Basic lavas, on weathering, produce a more fertile loam or clay-loam. Soils derived from quartzites, although of fine texture, are very siliceous, inclined to be shallow and depend largely for their fertility upon included organic matter. The dolomitic areas are characterised by deep, friable, loamy soils of good quality which, however, frequently contain boulders of chert. The soil derived from the Dwyka tillite is chiefly remarkable for the stone line or stone horizon deposited as the ice melted.

Throughout the western Transvaal the intensity of chemical weathering and leaching is relatively low, chiefly because of the deficient rainfall. The soils, consequently, tend to have a high base-saturation value.

The first major contribution to the classification of South African soils along modern, pedological lines is that of van der Merwe (1941), who recognised two distinct soil groups in the western Transvaal, namely: Kalahari Sand on Lime and Brown to Reddish Brown Ferruginous Lateritic Soils. The former group occurs principally to the west of Lichtenburg and is made up of a layer of Kalahari Sand superimposed on formations belonging to some older geological system (such as the Swaziland or Karroo System) from which basic, mineral salts have been leached upwards. The latter group is chiefly characterised by ferruginous and mangiferous concretions in the lower

horizons, though it is sometimes also associated with an overburden of wind-blown sand or diamondiferous gravel, resulting in a porous upper horizon. The ferro-manganese concretions are deposited by moisture which percolates down through the soil after rain but dries up before reaching the water table. Under certain conditions these concretions become cemented together to form an impervious hardpan, which may interfere to a marked extent with the penetration of tree roots. The Arboreta at both Lichtenburg and Potchefstroom are sited on soils of this group.

A more intensive survey of the soils of the Lichtenburg district has recently been completed by the Soil Research Institute (W.J. van der Bank, report in preparation). The soil type upon which the Arboretum there is located has been named the Rietgat Series, and is made up of aeolian sand of varying depth overlying tillite and shales of the Karroo System. The morphology of this soil type is characteristically as follows: the topsoil, which measures 6 to 12 inches in thickness, is a sandy loam, but gives way to a more heavily-textured soil with increasing depth, passing through clay-loam to clay; the stone line marks a sharp transition in the profile, and is underlain by a heavy-structured clay. The occurrence of concretions is typical, their quantity usually increasing with depth. Mottles are also characteristic, becoming more numerous and distinctive as the depth increases. The stone line is common though not universal, and its position may vary from the surface to a depth of 4 or 5 feet. Generally speaking, the soil may be classed as moderately well drained.

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The writer is grateful to Mr. van der Bank for permission to reproduce the descriptions of two profiles (see Tables 4 and 5), both observed at no great distance from the Arboretum at Lichtenburg. These convey an excellent impression of the soil type as well as giving an indication of the variation which may occur over a small area.

For the following description of the soil in the Arboretum at Potchefstroom, based on three test pits, the writer is indebted to the Director, Highveld Region, College of Agriculture, Potchefstroom:

"0-14" brown, sandy clay-loam with a poorly developed, fragmental structure; open and friable. Plenty fine and large roots. Some fine oukclip nodules.

14"-18" light, yellowish-brown clay, structure as above. Plenty oukclip nodules.

18-45" yellow clay; well developed fragmental structure; fairly open; friable. Abundant oukclip nodules and small concretions - only  $\pm$  30% soil.

Roots penetrate to  $\pm$  36".

pH of soil is 5.9-6.0.

The soil is residual and is developed from shales and quartzites of the Pretoria Series. Resistant stones may be present on the surface or anywhere in the profile.

In one profile, partially decomposed shale rubble occurred from 14" down".

TABLE 4

## RIETGAT SERIES, REPRESENTATIVE PROFILE

Depth (in).	Moisture	Colour	Mottles	Texture	Consistency	Structure	Concretions	Stones	Roots
0/10	Dry	Brown	Nil	Fine, sandy loam	Slightly hard	Very weak: medium, sub-angular, blocky	Very rare, Fe/Mn.	Nil	Absent
10/18	Dry	Yellowish-red	Nil	Clay loam	Slightly hard	Weak: medium, sub-angular, blocky	Very rare, Fe/Mn.	Nil	Frequent
26/32	Dry	-	Few, distinct, strong brown	Clay	Hard	Weak: medium, sub-angular, blocky	Frequent Fe/Mn.	Frequent, 2-100 mm.	Rare
32 +	Dry	Yellowish-brown	Common, strong	Clay	Very hard	Compound-Moderate; medium prismatic and moderate; medium, angular, blocky			

TABLE 5  
RIETGAT SERIES, REPRESENTATIVE PROFILE

Depth (in).	Moisture	Colour	Mottles	Texture	Consistency	Structure	Concretions	Stones	Roots
0/12	Dry	Brown	Nil	Fine, sandy loam to clay-loam	Slightly hard	Very weak; medium, sub-angular, blocky	Rare Fe/Mn.	Nil	Absent
12/20	Dry	Yellow- ish-brown	Clay	Common, distinct, strong brown	Hard	Moderate; Medium, sub-angular, blocky	Rare to frequent, Fe/Mn.	Nil	Frequent
20/32	Dry	Variegated	Many, diffuse strong brown	Clay	Very hard	Moderate; medium, angular, blocky	Rare, Fe/Mn.	Nil	Rare

32 VEGETATION

The botanical exploration of the western Transvaal goes back little more than 60 years, despite the fact that the greater part of South Africa had been fairly well covered by collecting expeditions by 1900. The reasons for this are largely a matter of conjecture, but the unspectacular and even monotonous character of the vegetation and the hostility of the local Boers undoubtedly contributed to the position. Thus, notwithstanding the tremendous strides made in the fields of botanical exploration and taxonomic research during the Nineteenth Century in the Cape, the western Transvaal remained virtually terra incognita up to the time when the Arboreta at Lichtenburg and Potchefstroom were established early in the present century. Even at the time of writing, the western Transvaal has been less thoroughly collected than most parts of South Africa, although sufficient progress has been made to enable the main vegetation types to be described and mapped.

By far the most detailed classification of the vegetation of South Africa published to date is that of Acocks (1953), who recognises five different veld types in the western transvaal. These may be summarised as follows:-

1) In the far west and south, but extending eastwards in the form of a bulge to take in the country round Schweizer Reneke, is the Kalahari Thornveld - a rather open savanna formation of which the most characteristic tree species is Acacia giraffae Burch. Associated with the Giraffe Thorns and often grouped beneath their crowns are the shrubs Grewia flava DC. and Diospyros pallens (thunb.) F. White. The grasses which make up

the other characteristic element of this veld type are those of the Dry Cymbopogon - Themeda type noted below.

2) North of the Kalahari Thornveld, in the region of Mafeking, occurs the Sour, Mixed Bushveld. This veld type is also characteristically a rather open savanna, with Acacia caffra (Thunb.) Willd. the dominant tree. Other woody species found are A.gerrardii Benth., A. heteracantha Burch., A. karroo Hayne, A. robusta Burch., Burkea africana Hook., Combretum zeyheri Sond., Dichrostachys glomerata Hutch. et Dalz., Dombeya rotundifolia (Hochst.) Harv., Grewia spp., Pappea capensis E. et Z. var. radlkoferi Schinz, Peltophorum africanum Vogel, Sclerocarya caffra Sond. and Ziziphus mucronata Willd. As before, the grasses are those of the Dry Cymbopogon - Themeda veld type.

3) West of the Kalahari Thornveld lies an irregular belt of Dry Cymbopogon - Themeda Veld, which stretches north-eastwards as far as Lichtenburg and forms a deep wedge into the previous type southwest of Schweizer Reneke. Floristically, this veld-type is composed almost entirely of grasses, small shrubs and herbs, though stunted specimens of Grewia flava and Diospyros pallens occur where it merges into the Kalahari Thornveld. The Lichtenburg Arboretum is situated in the transition zone where this type passes over into;

4) The Cymbopogon - Themeda Veld proper, which occupies the slightly moister country to the east as far as Ventersdorp, and sends out a tongue in the south to include the country round Potchefstroom. A great many of the species which occur in this veld type are those which go to make up the Dry Cymbopogon - Themeda Veld. Trees are

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conspicuous by their absence.

5) West of Ventersdorp and north of Potchefstroom, sending out a spur to the north-west above Lichtenburg, lies the so-called Banken Veld. This is regarded by Acocks as a false, grass veld type because it is probably transitional between Cymbopogon - Themeda Veld and Sour, Mixed Bushveld, <sup>Arbo-</sup> <sup>species,</sup> /real/ dominated by Acacia caffra, are now virtually confined to hills and rocky outcrops.

Acocks is carefully to note, in discussing these Veld Types, that his object has been not to give an account of the veld as it is today after many years of "grazing mismanagement" but to describe it as it could be in its "most useful form". Thus, in the case of the Kalahari Thornveld, the graceful Giraffe Thorns, which are described as forming an open savanna, have been all but exterminated in the western Transvaal. It is necessary to cross the border into Botswana, where the land has been withheld from white farmers, to see this Veld Type in a relating undisturbed state.

CHAPTER IIISELECTION OF TREESAdaptations of Trees to Severe Climates.

Plants may become specially adapted for survival in cold or dry climates. Such adaptations can be morphological, anatomical or physiological, and are often complementary. It is theoretically possible, therefore, to determine the suitability of <sup>trees for</sup> planting in semi-arid areas with cool winters by investigating the extent of their adaptation to these conditions.

The mechanisms of frost- and drought-resistance are to some extent analogous. Miller (1938) cites certain authors in support of the contention that freezing, by causing the formation of ice crystals, results in the withdrawal of water from the protoplasm. This "de-natures" the protoplasm so that, upon thawing, the original colloidal system is not re-formed. The dormant condition achieved by certain hardy forms appears to involve fundamental changes in the colloidal condition of the protoplasm which results in a marked retention of water against the force of dehydration. Hence, frost-resistant tissues have a considerable degree of drought-resistance.

Maximov (1929) concludes from investigations into the nature of drought-hardiness that xerophytes have certain recognisable characteristics. Anatomically and morphologically, these consist of a reduction in the size of all cells (including stomata), a thickening of the cell walls, strong development of palisade mesophyll, an increase in the number of stomata per unit area, a denser

network of veins and smaller leaves. Physiologically there is an increase in the intensity of transpiration and assimilation, in the osmotic pressure of the cell contents and in the capacity of the plant to endure wilting. He warns, however, against the dangers inherent in attempting to select varieties for drought-hardiness on the grounds merely that they possess peculiarities reminiscent of various kinds of xerophytes.

Kramer and Kozlowski (1960) point out that numerous factors may play a part in drought-hardiness. These include some which reduce the rate of dehydration of the plant, such as efficiency of the water absorbing and conducting tissues, leaf area and structure, stomatal behaviour and osmotic pressure; they also include others which enable the plant to survive dehydration, such as cell size and shape and protoplasmic characteristics. They consider that most drought-resistant trees have a capacity for enduring dehydration as well as possessing morphological and anatomical characteristics which retard the loss of water. No single factor is solely accountable for drought-resistance in any particular tree. However, one or more factors may predominate in some species and different factors in other species.

An attempt has been made to recognise morphological adaptations to climates such as that of the western Transvaal. This attempt was not successful, although there is some indication that species which exhibit several characteristics suggestive of resistance to drought or frost are hardier than those which display few such characteristics. The characteristics considered were those which can be readily observed in the field, and are as follows : -

/ .....

- (1) The deciduous habit.
- (2) The replacement of leaves by
  - (a) phyllodes, (b) cladodes.
- (3) The reduction of leaves to (a) needles, (b) scales.
- (4) Various other leaf modifications, eg. leaves
  - (a) coriaceous, (b) tomentose, (c) glaucous.
- (5) Mode of presenting leaves to the sun, i.e.
  - leaves (a) isobilateral, (b) dorsiventral.
- (6) Semi-succulence <sup>of</sup> stem and branches.
- (7) Depth of rooting.

While it is not suggested that all deciduous trees are drought-hardy, the deciduous habit was deemed to improve the chances of survival in the Western Transvaal, where winter and early spring are the driest seasons.

The replacement of leaves by phyllodes or cladodes is usually interpreted as an adaptation to dry conditions, yet not one of the phyllodineous Acacias has proved successful in the western Transvaal. The reason for this lies to some extent, however, in the fact that species like Acacia cyanophylla were repeatedly cut back by frost. The Casuarinas have proved unsatisfactory in the dry interior unless planted in moist situations.

The reduction of leaves to needles or scales is not, in itself, a criterion of drought-hardiness, physiological factors apparently outweighing the morphological adaptation in many instances. In the pines, length of needle also provides little or no indication of drought-hardiness.

Modifications in the texture, indumentum and colour of leaves, while apparently contributing to the drought-hardiness of many species, are not always effective; neither is the device of exposing the margin instead of the broad blade of the leaf to the direct rays of the overhead sun an infallible indication of drought-hardiness.

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Only one of the species tried, Brachychiton populneum, was considered to have a semi-succulent stem. This tree is very drought-hardy, though somewhat liable to injury by cold winds.

Depth of rooting is apparently inoperative as a factor promoting drought-resistance in the Lichtenburg arboretum, where the presence of hardpan over much of the area interferes with root penetration. Species like Acacia karroo and Prosopis juliflora, which tend to develop strong taproots, have grown very poorly under these conditions.

The failure of the characteristics discussed above to serve in the field as reliable criteria for selecting drought-hardy species leads to the conclusion that there is, at least for the present, no practical alternative to introducing trees from areas experiencing a similar climate and observing their performance under local conditions.

Geographical Regions of the World from which trees might be introduced into the Western Transvaal.

Hutchins (1903) first emphasised the need, when afforesting treeless areas, of concentrating upon the introduction and trial of species from regions of the world with similar climates. His view, now supported, by a wealth of evidence, was that the species most likely to thrive and grow to maturity in a particular area are those which are naturally suited to the locally prevailing conditions. This be termed "climatic fitness".

Thorntwaite (1933), in classifying the climates of the earth, places the western Transvaal in his zone DB'd (semi-arid, meso-thermal, rainfall deficient in all seasons). The distribution of this zone throughout the world is as follows:-

Africa: widespread in Southern Africa from Cape

Agulhas to Angola and Moçambique, embracing much of the area known as the Kalahari Desert; also <sup>f</sup>ound in Morecco.

America: in South America present as a narrow belt of country lying in the rain shadow east of the Andes in Argentina, and found also in the valley of the Colorado River; in Central and North America it occurs along the west coast of the Gulf of Mexico, extending thence northwards through Texas and Oklahoma to Kansas in the U.S.A. and reappearing to the east on the central plateau of Northern Mexico.

Asia: fairly extensively represented along the eastern shores of the Mediterranean and Black seas, and found throughout the greater part of Iran, Afghanistan and south-eastern Russia.

Australia: occurs in a belt along the lower, western slopes of the Dividing Range in Queensland and New South Wales.

Europe: confined to the basins of the Spanish meseta.

In the classification of climate proposed by Köppen (1931) ~~with~~ the western Transvaal falls within zone BSkw (arid, hot steppe with dry season in winter). The distribution of this zone corresponds fairly closely with that of Thornthwaite's zone DB'd, the main points of difference being the following:-

Africa: besides embracing much of the central part of southern Africa, occurs as a belt stretching across North Africa south of the Sahara from Senegal to the Sudan and thence southwards through Kenya to Tanganyika.

Asia: absent from Iran, Afghanistan and Russia but found in West Pakistan and in the eastern and southern parts of the Indian Peninsula.

America: slightly more extensive in South America.

of temperature regimes by the temperature limits of certain agricultural crops, while humidity regimes are based on the relation between rainfall and evapo-transpiration (i.e. "the water requirements of plants"). The temperature regimes he proposes are: (1) equatorial, (2) tropical, (3) frostless highland, (4) non-frostless, (5) tropical highland, (6) Andine, (7) subtropical, (8) marine, (9) temperate, (10) Pampean-Patagonian, (11) continental, (12) polar and (13) Alpine. The proposed humidity regimes are: (1) humid, (2) Mediterranean, (3) monsoon, (4) Steppe and (5) desert. The classification is, to some extent, an empirical one, and lends itself to adaptation to forestry on the lines of the Silvicultural Map prepared for South Africa by Poynton in collaboration with Vowinckel (1962-63).

Various other climatic classifications have been suggested by different authors. Several of these are outlined by Champion and Brasnett (1958). The methodology of Thornthwaites rational approach to climatic classification has already been discussed in some detail (see Chapter II).

Reverting to the global classifications of Thornthwaite (1933) and Köppen (1931), it may be noted that among the most successful trees planted at Lichtenburg and Potchefstroom are species of Callitris, Cedrus, Cupressus, Eucalyptus and Pinus introduced from localities falling within the same zones in America, Asia and Australia.

Global classifications such as those of Thornthwaite and Köppen are necessarily broad in concept, and individual zones are susceptible of further sub-division. This has been done, along lines suggested by Thornthwaite, for South Africa by Schulze (1947) and Poynton in collaboration with Vowinckel (1962-63) - vide Silvicultural Map re-issued with the present paper. It might be supposed that a global classification is too superficial to be of practical value in selecting trees for trial on the basis of climatic fitness. Unquestionably, more precise information about the climate in which an exotic tree occurs naturally

is desirable for the purpose of selecting one or more localities in which to undertake trials. Even more comprehensive data are necessary, not only in respect of climate but also of other environmental factors such as soil, when introducing a particular geographical or physiological race. Such exactitude is not, however, essential in the search for new species, where latitude must be given for other bionomic factors and for the inherent adaptability of trees as living organisms.

In Thornthwaite's global classification, Zone DB'd embraces much of the drier territory between Cape Agulhas, Angola and Mocambique. Reference to the Silvicultural Map of South Africa reveals that this Zone embraces both a summer and a winter rainfall climate as well as a certain range in water balance and temperature. Notwithstanding this, it is noteworthy that one of the few trees indigenous to the western Transvaal, Acacia karroo, occurs over most of the Zone in Southern Africa.

With regard to the selection of exotic trees for trial, it must be borne in mind that the distribution of a species is not governed solely by water balance and temperature, but that geographical isolation, soil characteristics, various biological factors - including competition from other vegetation and the depredations of insects and fungi - and the influence of fire can be decisive. Champion and Brasnett (1958) draw attention to the effect of wind upon vegetation. Troup (1932) cautions that "although a knowledge of the climatic and soil requirements of a species is of great assistance in determining the conditions under which it is likely to succeed if introduced into a new home, its ultimate success or failure, particularly for plantations, cannot be determined without trial." When these considerations are taken into account, it is evident that a climatic classification can conceivably err in being over-elaborate, as a result of which potentially useful introductions might be overlooked. As a general

indication of the adaptability of tree species, it is noteworthy that, of fifty-six species recommended by the Department of Forestry for planting in the western Transvaal (Poynton 1962-63), fifty-four are recommended also for the Robertson district of the winter rainfall area. Only three of the species recommended for the Robertson district are not also recommended for the western Transvaal. A considerable overlap is found also in the species recommended for other Zones.

#### Summarised Results of Species Trials and Recommendations for Tree Planting.

A detailed account of species trials carried out in the arboreta at Lichtenburg and Potchefstroom is given as an appendix hereto. The results of these trials serve as an invaluable guide to tree planting in the western Transvaal. Nevertheless, they are open to criticism in certain respects, and for this reason discretion is called for in interpreting them. Other sources of information, such as the environment in which the trees occur naturally and the results of trials elsewhere in Southern Africa, must also be drawn on if the facts are to be correctly presented.

One of the most serious criticisms which must be levelled against the trials carried out in the Lichtenburg and Potchefstroom arboreta attaches to the smallness of the plots. This fault is common to most pilot trials at the arboretum level. At Lichtenburg the area of the majority of plots is 0.1 acre; at Potchefstroom it is only 0.09 acre. The statistical data yielded by plots of this size are of limited value since they relate neither to single trees nor to more extensive stands. The "edge effect" is not eliminated, neither is competition from adjacent and possibly older or more vigorous plots buffered by a surround.

Another shortcoming of the trials is the lack of repetition in many instances. Most of the species were tried in one arboretum only, and the results might well have been influenced unduly by localised variations in soil or exposure. In an environment where

trees are tested almost as much for survival as for rate of growth, the replication of trials in time, as well as in space is also very desirable. The success or failure of a trial is much influenced by weather conditions during the first few months after its commencement. Unseasonal or unusually severe drought occurring within a year or so of planting can result in the failure of trees which might otherwise have survived. Small trees are also more susceptible to frost than older specimens with taller stems and thicker bark, since temperatures at night are lowest near the ground. Variations in the severity of winter from year to year introduce an element of chance which can only be reduced if the trials are repeated at intervals.

The results of the trials, modified and supplemented as necessary by knowledge gained from other sources, are summarised in Tables 6 and 7. A brief guide to the characteristics and uses of those species which have succeeded under arboretum conditions (i.e. exposed to the vagaries of the climate) and which can consequently be recommended for planting in the western Transvaal are given in Table 6. Species which have not so far proved themselves under these conditions but which merit further trial are listed in Table 7. The remainder of the species tried, i.e. those which have failed partially or completely and are not worth persevering with except, perhaps, as ornamentals under garden conditions, are noted in Table 8.

The symbols employed in Table 6 are self-explanatory. In those columns where "X" is sometimes used repetitively, "X" denotes "Suitable", "XX" denotes "Very suitable" and "XXX" denotes "particularly suitable".

#### Species Recommended for Trial in the Western Transvaal.

A list of species recommended for trial in the western Transvaal is given in Table 9. Brief notes on these species will be found in Appendix II.

Characteristics and Uses of Species which have succeeded in Arboreta in the Western Transvaal.

Name of Species		Description					Rate of Growth per annum in W. Tvl.		Uses							Miscellaneous				
Botanical	Common	Form of Crown	Foliage	Colour of (Fl)owers or (Fr)uits		Fast (3 ft. or more)	Medium (2 ft.)	Slow (1 ft. or less)	Converted Timber	Poles	Firewood	Fodder		Honey		Shelterbelts	Hedges	Donga Reclamations	Ornament	Miscellaneous
				Height in W. Transvaal (feet)	Colour							Autumn Tints	(F)ruit	(L)eaves	(N)ectar					
			(S)preading (I)ntermediate (N)arrow	(D)eciduous or (E)vergreen	(D)ark green (L)ight green (G)rey-green (R)ed (Y)ellow															
<u>Acacia</u> <u>baileyana</u> <u>karroo</u>	Bailey's Wattle Sweet Thorn	35 20	S S	E D	G L	Fls. yellow Fls. yellow	XX				XX XX	F	N N	P P	XX			XX XX		
<u>Brachychiton</u> <u>populneum</u>	Kurrajong	34	S	E	D	Fls. purply-white		X				L			XX				X	
<u>Callitris</u> <u>endlicheri</u> <u>glauca</u> <u>verrucosa</u>	Black Callitris White Callitris Turpentine Pine	56 63 44	N I/N I	E E E	D D D	G G G		X X X	XXX XXX XX	XX XX XX	X X X				XXX XX XX	XX XX XX			X X X	1,2
<u>Casuarina</u> <u>glauca</u>	Swamp Oak	55	I	E	G		X		XXX	XX	XX	L			X				X	1
<u>Cedrus</u> <u>deodara</u>	Deodar	48	I	E	G		X		XX	XX	X				XX			XXX		6
<u>Celtis</u> <u>africana</u> <u>australis</u>	White Stinkwood Nettle Tree	20 24	S S	D D	L D	Y		X	XX XX			L							XX X	
<u>Cupressus</u> <u>glabra</u> <u>sempervirens</u> var. <u>horizontalis</u> var. <u>stricta</u>	Smooth Arizona Cypress Mediterranean Cypress Churchyard Cypress	51 62 49	I I N	E E E	G D D			X X X	X XX X	X XX X	X X X				XX XX XXX	XX XX XX			X X XX	
<u>Eucalyptus</u> <u>calylei</u> <u>camaldulensis</u> <u>conica</u> <u>crebra</u> <u>hemiphloia</u> <u>largiflorens</u> <u>melanophloia</u> <u>melliodora</u> <u>microtheca</u> <u>pilligaensis</u> <u>polyanthemus</u> <u>populifolia</u> <u>sideroxydon</u> <u>trabutii</u>	Caley's Ironbark River Red Gum Fuzzy Box Narrow-leaved Ironbark Grey Box Black Box Silver-leaved Ironbark Yellow Box Flooded Box Narrow-leaved Box Red Box Bimbil Box Black Ironbark Trabut's Gum	38 99 38 86 80 86 60 80 74 40 78 63 70 109	I I I I I I S/I I I I I S/I I I	E E E E E E E E E E E E E E	G L L D G G G L L L G L L L			X XX X X XX X XX XX XX XX XX XX XX	XX X XX XX XX XX XX XX XX XX XX XX XX XX	X X X X X X X X X X X X X	XXX XX XXX XXX XXX XXX XXX XXX XXX XXX XXX XXX XXX	N N N N N N N N N N N N N N	P P P P P P P P P P P P P P	X X X X X X X X X X X X X X			X X X X X X X X X X X X X X		X X X X X X X X X X X X X X	1 3 3 3 3 3 3 3 3 3 3 3 3 3
<u>Gleditsia</u> <u>triacanthos</u>	Honey Locust	35	S	D	L	Y		X		X	X	F	N	P				X	X	5
<u>Juniperus</u> <u>ashel</u> <u>occidentalis</u> <u>pachyphlea</u> <u>virginiana</u>	Mountain/Rock Cedar Western Juniper Alligator Juniper Pencil Cedar	33 18 26 34	S S S I	E E E E	D G G G			X XX XX X	XX X XX X	X X X X	X XX X X				XXX X X X			X X X X		
<u>Maclura</u> <u>pomifera</u>	Osage Orange	23	S	D	L			X											X	
<u>Pinus</u> <u>canariensis</u> <u>cembroides</u> <u>halepensis</u> <u>pinia</u> <u>ponderosa</u> <u>roxburghii</u>	Canary Pine Mexican Nut Pine Aleppo Pine Stone/Umbrella Pine Western Yellow Pine Chir Pine	67 40 78 57 11 73	I/N I I S I I	E E E E E E	D D L D D D			X X X X XX X	XXX X X XX XX XXX	XXX X X X X X	XXX X XX X X X	F			XXX X X X XXX	X X X X X X			XX XX X XX XX XX	
<u>Prosopis</u> <u>juliflora</u>	Mesquite	20	S	D/E	L			XX		XX		F					XX		X	1
<u>Quercus</u> <u>ilex</u>	Evergreen/Holm Oak	26	S	E	D			X			X	F		P					XX	
<u>Rhus</u> <u>lancea</u> <u>viminalis</u>	Karree Karree	20 31	S S	E E	D D			X X	X X	X X	X X		N N	P P	XX XX	X X			XX XX	2 2
<u>Robinia</u> <u>pseudo-acacia</u>	Black Locust	29	S	D	D	Fls. white		X		X	X	F	L	N			XXX	XX	X	5
<u>Schinus</u> <u>molle</u>	Pepper Tree	41	S	E	D	Frs. red		X	X				B	P	XX				X	2
<u>Thuja</u> <u>orientalis</u>	Chinese Arbor Vitae	29	I	E	L			X	X	X	X				X	X			X	

TABLE 7

Species which have not succeeded in Arboreta in the  
Western Transvaal but which merit further trial.

Acacia aneura

A. homalophylla

Chilopsis linearis

Eucalyptus tereticornis

## TABLE 8

Species which have failed in Arboreta in the Western Transvaal but which may be suitable for planting under garden conditions.

Acacia cultriformisA. cyanophyllaA. dealbataA. decurrensA. mearnsiiCasuarina cunninghamianaCatalpa speciosaCedrus libaniCupressus lindleyiC. macrocarpaC. torulosaEucalyptus bosistoanaE. bridgesianaE. dealbataE. deaneiE. globulusE. paucifloraE. reduncaE. rudisE. urnigeraE. viminalisJuglans nigraMelia azedarachMorus albaPinus arizonicaP. engelmanniiP. leiophyllaP. michoacanaP. montezumaeP. palustrisP. patulaP. pinasterP. radiataP. wallichianaTamarix gallicaUlmus parvifolia

TABLE 9

Species recommended for trial in the western Transvaal.

Acacia pendula

A. visite

Ailanthus altissima

Casuarina lepidophloia

Cupressus arizonia

C. forbesii

Eucalyptus albens

E. blakelyi

E. bridgesiana

E. calciculatrix

E. intertexta

E. microcarpa

E. papuana

E. salmonophloia

E. slubris

E. transcontinentalis

Pinus aristata

P. gerardiana

P. lambertiana

P. sabriniana

Objects of Tree Planting in the Western Transvaal.

The objects for which trees may be planted in the Western Transvaal are as follows:-

Converted Timber. Trees are not grown commercially in the western Transvaal for the production of sawtimber because of their slow growth. However, the potential usefulness of large trees round homesteads for carpentry purposes is indicated in this column.

Poles. For the same reason that trees are not grown commercially in the western Transvaal for sawtimber they are not planted in the area for telephone and transmission poles. Many species can, however, be successfully grown to meet the local demand for building poles, pit props and fence posts. Several of the eucalypts are particularly suitable for this purpose, combining the advantages of fast grown and straight stems with an ability to coppice. The species chiefly recommended are the following:-

Eucalyptus camaldulensis, E. crebra, E. largiflorens, E. melliodora, E. sideroxylon and E. trabutii.

Of the conifers, several species make good poles, but their rate of growth is less than that of the eucalypts and all except Canary Pine do not coppice. The following species can be grown for the purpose:-

Callitris glauca, Cedrus deodara, Cupressus glabra, C. sempervirens var. horizontalis, Pinus canariensis and P. roxburghii.

Woodlots are best formed by planting the trees at an espacement of 9 x 9 feet, Silvicultural tending operations such as thinning and pruning are not usually called for since the object of management is to produce material of small size and low grade. Exploitation follows a primitive form of coppice selection in which the stand is culled at intervals for trees of the required size.

Firewood. The thermal value of dry wood is more-or-less proportional to its density irrespective of species (except in the case of resinous woods, where it is higher). Equal weights of different woods are thus capable, theoretically, of giving off approximately the same amount of heat. However, although all woods can be burned, not all perform satisfactorily in the hearth or kitchen range.

The property chiefly required of a firewood is a capacity for burning slowly and steadily, without emitting sparks, until only ash remains. Light, resinous woods, such as those yielded by many conifers, do not meet these standards but make good kindling.

Trees are not usually planted solely to provide firewood, but in such cases preference should be given to the following species:-

Eucalyptus camaldulensis, E. crebra, E. largiflores, E. melliodora, E. polyanthemos, E. sideroxylon and E. trabuttii.

Fodder. Sufficient use is not made of fodder trees in South Africa. The pods of several leguminous species are valuable as a supplementary stock feed in winter. In times of drought the foliage of certain other species constitutes a most useful reserve of fresh forage. This can be lapped and fed to animals on the ground at little cost, and could be the means of saving many a beast from starvation. The most suitable fodder trees for cultivating in the western Transvaal are the following:-

- 44 -

Acacia giraffae, Brachychiton populneum, Ceratonia siliqua, Gleditsia triacanthos and Prosopis juliflora.

Near water Quercus robur, Robinia pseudo-acacia and salix babylonica can also be grown for acorns or browse.

Honey. The importance of many trees as a source of nectar and pollen for bees need not be stressed. The following species are particularly useful in this respect, although possibly not worth planting exclusively for the purpose:-

Acacia baileyana, A. cultriformis, A. karroo, Eucalyptus camaldulensis, E. conica, E. crebra, E. largiflorens, E. melanophloia, E. melliodora, E. sideroxylon, E. trabutii, Gleditsia triacanthos, Prosopis juliflora, Rhus lancea, R. viminalis and Schinus molle.

Trees of Liriodendron tulipifera and Quercus robur growing in gardens or other moist places are also attractive to bees.

Shelterbelts or Windbreaks. The most pressing need for trees in the western Transvaal is in the form of shelterbelts to halt soil erosion, conserve moisture and provide shelter for stock from sun, wind and hail. Shelterbelts are most effective if oriented at right angles to the direction of the wind and if composed of only a few rows of trees. In such cases their beneficial influence extends for a distance equal to about 30 times their height to leeward and 5 times their height to windward. In flat terrain roughly 5 percent of the area of a farm can profitably be devoted to shelterbelts.

The trees most suitable for shelterbelts are those which are relatively fast-growing, do not lose their leaves in winter and have dense crowns reaching nearly to the ground. However, near cultivated lands it is advisable to avoid using species with vigorous, superficial root systems and those which are liable to sucker when their roots are damaged by

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- 45 -

ploughing. The distance to which trees with superficial roots may affect crops adversely is proportional to about one-and-a-half times their height.

Although not ideal for shelterbelts because of their relatively tall, clean stems and superficial roots, eucalypts can be successfully employed for the purpose if flanked by a row or two of more bushy trees or if planted in belts 2 or 3 rows wide. In the latter case the rows are felled in rotation and the coppice is allowed to grow up and fill the gaps below the crowns of the larger trees.

The best species for use in shelterbelts in the western Transvaal are the following:-

Callitris glauca, Cedrus deodara, Cupressus glabra, Eucalyptus crebra, E. melliodora, E. polyanthemos, E. populifolia, E. sideroxylon, Pinus canariensis and P. roxburghii.

Hedges. Hedges are planted either for privacy or to form a stock-proof barrier. If required for the former purpose evergreen species only should be used. In the western Transvaal the following species are recommended if no watering can be undertaken once the plants are established:-

Atriplex nummularia, Callitris endlicheri, Cupressus glabra, C. sempervirens, Juniperus ashei, J. occidentalis, J. pachyphlaea, J. virginiana, Ligustrum lucidum, Pyracantha angustifolia, Quercus ilex, Rhus lancea, R. viminalis and Tamarix gallica.

In deep soil the following can be used to form a stock-proof barrier:-

Acacia karroo and Maclura pomifera.

Ornament. The choice of trees for ornamental planting is largely dictated by individual preference. However, it is important to bear in mind that the size of the tree at maturity should be taken into account when making the selection. Many a beautiful tree has been condemned for no other reason

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than that it had grown too big for the situation in which it had been planted.

Trees cultivated for ornament and shade in parks and gardens where moisture is available throughout the year need obviously not be as drought-resistant as those which depend solely upon the rainfall to supply their water requirements. ~~Particulars of a few species suitable only for planting under irrigation in the western Transvaal is given in Table 10.~~

APPENDIX I

TRIALS OF SPECIES IN THE  
ARBORETA AT LICHTENBURG  
AND POTCHEFSTROOM.

- 1 -

Acacia aneura F. Muell.

Family.

LEGUMINOSAE (MIMOSOIDEAE).

Common Name.

Mulga.

Natural Distribution.

A native of Australia, found on the west coast and in the dry, interior <sup>districts</sup> of Western Australia, South Australia, New South Wales and Queensland, often on heavy clays and gravelly ridges. The rainfall throughout the area is about 10 to 20 inches (250 to 500 m.m.) a year, and is heaviest during winter in the south-west but during summer in the north-west (Black, 1922; Maiden, 1904-25; Streets 1962).

Provenance.

Seed of this species was obtained from J.H. Maiden in 1908, and the bulk of this was issued to Lichtenburg, Irene and Machavie Plantations in the same year. No further records of seed importations dating from that period can be traced, and it may therefore be concluded that the same stock was used for both of the trials carried out in the Arboretum at Lichtenburg. Maiden, who is well known as the author of many important treatise on Australian trees, was for many years Director of the Botanic Gardens in Sydney, and it is thus probable that the seed originated from New South Wales.

Description of the Species in its Native Habitat.

A phyllode-bearing, evergreen shrub or small tree, attaining a height of about 25 feet (8 m.) under favourable conditions. In the northern parts of its range it becomes a tree, with a straight stem up to 20 feet (6 m.) in length;

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in the south, on flats bordering the main inland rivers, it is a low, bushy tree, branching at about 6 feet (2 m.) from the ground; on the arid west coast and on dry sites in the interior it assumes a stunted, shrubby ~~in~~ habit (ibid.)

Economic Importance in Country of Origin.

Mulga is generally conceded to be one of the most valuable fodder trees of the arid regions of Australia, as evidence of which the following remarks by Maiden (loc. cit.) may be cited:

"The leaves, or rather, phyllodia ..... form excellent food for stock; in fact, some people call the plant the 'king of fodders', and it has been so much appreciated that it is now scarce in many districts where it was once plentiful ... Mulga should never be cut down, except when absolutely necessary - it should only be pollarded or lopped; and if these operations be performed by careful men no real harm to the tree will result. One reason why the tree is becoming extinct in some areas is because the seedlings are eaten out by stock ... It does not appear to be known to dwellers of the more highly-favoured coast districts that in some years in parts of the West there is practically no grass at any period of the year, and that stock not only feed on scrub plants such as Mulga, but actually thrive thereon."

The wood of this species is seldom obtainable in utilisable sizes, but is dark brown, exceedingly hard, and useful for carving, turnery, fencing and similar purposes.

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Trials in the Arboretum at Lichtenburg.

The first attempt to establish the species in the Arboretum at Lichtenburg was made in November, 1908, when seed was sown in situ in "patches" 6 feet (2 m.) apart. In August the following year the trial was reported to have failed completely.

A second trial was initiated in March, 1912. On this occasion, 127 plants, which had been raised in the Irene Nursery near Pretoria and which were already 2 years old, were set out at the same espacement as before.

That winter the young plants were "eaten down" by hares, and the following year all but 15 of them were destroyed by termites. A few more losses, attributable to the latter cause, occurred in 1914, but a year later the remaining trees had grown to a height of 5 to 7 feet (1.5 to 2 m.) and appeared quite healthy. However, only 4 of them survived the drought of 1916 (one of which bore some flowers). The rest all succumbed to frost in 1918.

No trial of this species seems to have taken place in the Arboretum at Potchefstroom.

Discussion of Results.

It is questionable whether these results can be regarded as conclusive. A single seed stock seems to have been used for both trials, and this may well have originated from one of the less inclement parts of the species' range in New South Wales.

Two further importations of seed were made on subsequent occasions by the South African Department of Forestry. Both of these were obtained from New South Wales - the first from Bourke (an area which receives a

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rainfall of 20 inches (500 m.m.) per annum) and the second, without locality, through Maiden. These stocks were widely distributed to centres in the Cape Province, Orange Free State and Transvaal, but the results, once more, were disappointing. However, 3 trees survive under exceedingly hot, dry conditions on the Baobab Reserve north of the Zoutpansberg, while a small stand reached a height of 15 to 20<sup>feet</sup> (5 to 6 m.) ~~feet~~ in 17 years at Wilgeboomnek Plantation in the Orange Free State, where severe frost is experienced. Other trees are reported to have done well on private farms.

In the light of these erratic results it is impossible to recommend the planting of A. aneura on a substantial scale for the production of fodder anywhere in this country. Nevertheless, an attempt should be made to secure seed from selected localities in the drier and cooler parts of its range for the purpose of conducting fresh trials under comparable conditions in the western Transvaal and other suitable parts of South Africa.

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Acacia baileyana F. Muell.

Family.

LEGUMINOSAE (MIMOSOIDEAE).

Common Names.

Bailey's Wattle, Cootamundra Wattle.

Natural Distribution.

A species with a very limited distribution in New South Wales, occurring principally in the Cootamundra - Wagga-Wagga-Barmedman area and further to the north at Ingleba (Maiden, 1904-25). It is most frequent at altitudes of up to 1,600 feet (488 m.) and probably does not occur in localities with a rainfall much below 20 inches (500 m.m.) a year.

Provenance.

No definite information with regard to the provenance of the seed used to establish a plot in the Arboretum at Potchefstroom can be gleaned from Departmental records, though it is probable that this was collected at Pan Plantation in the eastern Transvaal. The origin of the trees at Pan, however, is not known.

Description of the Species in its Native Habitat.

A small, evergreen tree of exceptionally pleasing appearance, seldom exceeding a height of 15 feet (5 m.) in the wild state though in one instance reaching 24 feet (7 m.) (*ibid*). It is much admired and widely cultivated in Australia for its decorative, silvery foilage and its attractive, yellow flowers.

Economic Importance in Country of Origin.

The species is of no economic importance in Australia, being used solely for ornament.

Trail in the Arboretum at Potchefstroom.

A double plot of the species was established in

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1912 by setting out nursery stock at an espacement of 6 x 6 feet (2 x 2 m.)

The year after they were planted out, the young trees were slightly touched by frost, but nevertheless grew to an average height of 6 feet (2 m.) The following winter they were more severely affected by the cold, and many of them succumbed. Notwithstanding this, by October, 1914, the average height of the remaining trees had increased to 10 feet (3 m.), and frost damage was now confined to their crowns. Compared with an adjacent plot of A. cultriformis, the stand of A. baileyana at this stage showed superior vigour but appeared to be slightly less hardy to frost.

Until March, 1930, the trees continued to make good growth, attaining a mean height of 35 feet (11 m.) in that year and suffering little from drought and frost. However, a steady decline set in thereafter, attributable, no doubt, to the fact that the species is not naturally long-lived. By 1959, only two, crooked trees were left on the plot, both of which were dying back in the crown. These had an average D.B.H. and height of 5.2 inches (13 cm.) and 15 feet (5 m.), respectively. Their delicate, feathery foliage, bluish-grey when young but gradually changing to light green, cast a deep shade.

#### Discussion of Results.

The trial at Potchefstroom may be said to have achieved its purpose, which is to demonstrate that the species can be successfully cultivated in the western Transvaal as a fast-growing, albeit rather short-lived ornamental tree in situations where it will receive little attention.

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Acacia cultriformis A. Cunn.

Family.

LEGUMINOSAE (MIMOSOIDEAE).

Common Name.

Knife-leaf Wattle.

Natural Distribution.

A native of Australia, occurring in the Hunter, Dumaresq and Macintyre River districts of northern New South Wales (Moore, 1893) and southern Queensland (Bailey, 1900). Over the greater part of its range it enjoys a predominantly summer rainfall somewhat in excess of 20 inches (500 m/m.) per annum.

Provenance.

It would seem that seed received (without locality) from Messrs. Vilmorin-Andrieux of France was supplied to both Lichtenburg and Machavie Plantations in 1910. It is reasonable to infer that this was used to establish plots in the Lichtenburg and Potchefstroom Arboreta two years later, although stocks were also beginning to be collected locally in South Africa at the time.

Description of the Species in its Native Habitat.

In Australia the species is described as a tall, bushy shrub (Bentham and Mueller, 1863-78). It is usually mealy-glaucous when young, and its phyllodes are almost triangular in shape, rigid and persistent for several seasons.

Economic Importance in Country of Origin.

While of no economic importance, the species, is, nevertheless, planted for the sake of its ornamental, silvery-grey phyllodes or "leaves".

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Trials in the Arboreta at Lichtenburg and Potchefstroom.

In each of the two Arboreta, trials were initiated in 1912. At Lichtenburg, 127 plants, which had been raised over the previous year in the local nursery and had reached a height of 12 inches (30 c/m.) were put out at an spacing of 6 x 6 feet (2 x 2 m.) in March. The same spacing was adopted at Potchefstroom, where a double plot was planted up.

In 1913, several plants were destroyed by termites at Lichtenburg, but the remainder appeared healthy. At Potchefstroom there were indications that the plants were suffering from drought, and that winter severe damage was caused by frost.

For the next few years neither of the plots was much affected either by frost or by drought. At Potchefstroom, the plants grew into sturdy bushes which, by October, 1915, had reached a height of about 6 feet (2 m.)

As a result of the severe drought which occurred in 1919, the trees in both Arboreta developed a yellowish, unhealthy colour. In the winter of 1920, frost wiped out the entire stand at Lichtenburg. At Potchefstroom, although the trees gradually regained their former, healthy appearance with the return of more normal seasons, they showed little vigour. When inspected in 1931 they had many dead branches and were generally in a poor condition. By 1959, only three, crooked, sparsely-foliaged specimens remained, of which the mean D.B.H. was 3.3 inches (8 s/m.) and the mean height 15 feet (5 m.) One of their number had become suppressed by an adjoining stand of eucalypts, and all had an untidy appearance.

Discussion of Results.

A. cultriformis has long enjoyed a reputation in South Africa of being extraordinarily resistant to both frost and drought. This, however, takes scant account of the fact that it is not found in either very cold or very dry areas in Australia.

The trials at Lichtenburg and Potchefstroom clearly demonstrate that the tree is not as hardy as has always been supposed, though when planted on deep soils it is unlikely to be killed by drought in the western Transvaal. For all that, it is slower-growing and less attractive in appearance than A. baileyana, and, like it, is comparatively short-lived.

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Acacia cyanophylla Lindl.

(Planted as A. saligna Wendl.)

Family.

LEGUMINOSAE (MIMOSOIDEAE).

Common Names.

Port Jackson Willow (an unfortunate misnomer),  
Orange Wattle, Blue-leaved Acacia.

Natural Distribution.

Endemic in Western Australia, where it is found in the vicinity of the Swan River (Perth) (Bentham and Mueller, 1863-78), frequently as an understory in stands of Eucalyptus gomphocephala. The rainfall in the area is more-or-less confined to the winter months and averages between 30 and 40 inches (760 to 1000 m.m.) a year (Streets, 1962).

Provenance.

Seed for the trial at Potchefstroom was supplied by the Conservator of Forests, Cape Colony, and was presumably collected locally.

Description of the Species in its Native Habitat.

The species has been described in the following terms (extract on research file sine auct.): "A low-growing, spreading tree, branching near the ground, its radiating branches and long, drooping branchlets forming a perfect, leafy canopy. Its leaves, or more properly phyllodes, are long and narrow and of a bluish cast."

Economic Importance in Country of Origin.

Although its bark is sometimes employed for tanning leather and its wood makes a good fuel, the species is useful chiefly for shade and ornament.

Trial in the Arboretum at Potchefstroom.

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Eighty-one plants 6 months old and 9 inches (23 c.m.) high, which had been raised locally in the nursery, were put out in January, 1909, at the customary espacement for those times of 6 x 6 feet (2 x 2 m.)

When inspected in October that same year, all the plants had been frosted to the ground, though several had commenced to sprout again from the roots. During the course of the summer, some of these new shoots grew to a height of no less than 8 feet (2.4 m.) but were all cut back again by frost in the winter.

This cycle was repeated for a number of years until, in 1914, several shoots which received some protection from a neighbouring stand survived the winter. These persisted for a few years, but were finally killed outright by frost in 1919.

#### Discussion of Results.

This tree, which originates from a Mediterranean type climate, has not proved a success anywhere in the summer rainfall area in South Africa, though it is one of the two species most commonly used for the reclamation of littoral sand dunes in the constant and winter rainfall areas. It is unable to stand the cold in the western Transvaal and should not be grown there notwithstanding its apparent hardness to drought.

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Acacia dealbata Link.(Syn. A. decurrens Willd. var. dealbata

(Link.) F. Muell. ex Maid.)

Family.

LEGUMINOSAE (MIMOSOIDEAE).

Common Name.

Silver Wattle.

Natural Distribution.

Widely distributed in south-eastern Australia and Tasmania. In New South Wales its range extends from the coastal plain to the Tableland (Moore, 1893), while in Victoria it ascends to sub-alpine elevations, mainly in valleys and along the banks of rivers (Bentham and Mueller, 1863-78). It probably also occurs in Queensland and South Australia (Lord, 1950). In Tasmania it is both widespread and abundant locally (Curtis, 1956), growing most luxuriantly in ferny gullies and other damp places, and forming the main underwood in tall, eucalypt forest where the rainfall is 40 inches (1000 m.m.) a year or more.

Provenance.

It is no longer possible to ascertain from which part of its very extensive range the species was brought to South Africa probably about the middle of the nineteenth century. The seed used for establishing a plot at Lichtenburg was collected at Woodbush Plantation in the northern Transvaal, while that supplied to Potchefstroom either emanated from the same source or was obtained from Natal.

Description of the Species in its Native Habitat.

A. dealbata is described (Bentham and Mueller, 1863-78) as a handsome, evergreen tree with very glaucous or hoary branchlets and leaves. It is usually between 20

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and 50 feet (6 and 15 m.) tall (Lord, 1950), though sometimes it approaches twice that height in Tasmania, becoming larger than either A. decurrens or A. mearnsii in the wild state. According to Lord (ibid.), it cannot be recommended for planting in gardens on account of its propensity for suchering.

#### Economic Importance in Country of Origin.

The species is considered to be of little value in Australia except as fuel, and the tannin content of its bark is lower than that of A. decurrens or A. mearnsii.

#### Trials in the Arboreta at Lichtenburg and Potchefstroom.

At Lichtenburg, a plot was established in 1906/07 by sowing the seed broadcast.

During the winter of 1907, the young trees were either killed outright by the cold or else frosted to the ground. Those of them which sprouted again survived for two more seasons, the largest reaching a height of about 5 feet (1.5 m.) in December, 1908, only to be cut down again by frost during the course of the ensuing winter.

About 15 trees sprouted once more in the spring and came through the next few winters without further mishap, attaining an average height of about 12 feet (4 m.) in March, 1913. In September the following year, however, almost all of them were killed by drought, and the trial was pronounced soon afterwards to be a failure.

At Potchefstroom, 81 plants 9 inches (23 c.m.) tall, which had been raised locally in the nursery over the previous 6 months, were planted out at an espacement of 6 x 6 feet (2 x 2 m.) in January, 1909.

Here, the young trees were little affected by frost, and by October had attained a height of 5 feet

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(1.5 m.) A year later they stood no less than 12 feet (4 m.) high. By October, 1914, their average height was 24 feet (7 m.) and they were fruiting profusely, as a result of which a vigorous crop of seedlings subsequently sprang up beneath them.

Frost and drought continued to have little effect upon the trees until October, 1923, when, however, they were said to be suffering very much more after a dry winter than those of either A. decurrens or A. mearnsii in the Arboretum. In 1928, they lapsed into a moribund state and only a few survived to the following year.

Sparse regeneration is all that remains of the trial today.

#### Discussion of Results.

The oft-repeated contention that A. dealbata is hardier than either A. decurrens or A. mearnsii is not supported by the results of these trials, and the species has not proved itself in the western Transvaal. This is, perhaps, not surprising when it is borne in mind that the tree is associated in Australia with moist habitats, being, as Lord remarks, "abundant on the banks of rivers and creeks."

The possibility that A. dealbata might yet prove of value for fuel and shelter in the Lichtenburg and Potchefstroom areas cannot be altogether discounted, for there remains a chance that a hardier strain than that so far tried in this country could be found in Victoria or Tasmania. However, because of the known tendency for the tree to spread, especially along watercourses, such an introduction might not be advisable.

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Acacia decurrens (Wendl.) Willd.

(Syns. A. decurrens (Wendl.) Willd. var.  
normalis, A. normalis ined.)

Family.

LEGUMINOSAE (MIMOSOIDEAE).

Common Name.

Green Wattle.

Natural Distribution.

A native of Victoria, New South Wales and Queensland, where it occurs mainly in valleys from the coast to the Dividing Range.

Provenance.

Nothing appears to be known of the circumstances surrounding the introduction of this species to South Africa, neither is any information available with regard to the seed issued in 1908 for trial in the Arboretum at Potchefstroom other than that it was collected in this country.

Description of the Species in its Native Habitat.

A. decurrens is described as a beautiful, ever-green tree of upright habit, attaining a height of from 30 to 40 feet (9 to 12 m.) Audas, - Maiden, 1904-25). It has extremely attractive, fern-like, foliage and prominently angled or sometimes almost winged branchlets.

Economic Importance in Country of Origin.

Bark of this species is used in Australia for tanning leather (loc. cit.), but its timber is of little value except as fuel.

Trial in the Arboretum at Potchefstroom.

This plot was established in January, 1909, under the invalid name A. normalis, which was sometimes used at

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that time to distinguish the species from the Black Wattle, A. mearnsii.

Eighty-one nursery plants 9 inches (23 cm.) high, which had been raised locally over the preceding 6 months, were set out at the usual espacement of 6 x 6 feet (2 x 2 m.).

During the course of the same year, a "large number" of plants was inadvertently hoed out and had to be replaced the following summer. Those which were not destroyed in this manner were badly frosted.

In October, 1910, half of the plot, situated on stony ground, was observed to have died right back, but the rest of the trees looked healthy and had attained a height of 10 feet (3 m.) During the following winter, those of the trees on stony ground which had sprouted again were cut back once more by frost. Many trees were again injured by frost during the winter of 1913, yet by October the average height of the stand had increased to 20 feet (6 m.).

This satisfactory progress was maintained for a number of years, despite the fact that the trees suffered periodically from both frost and drought, but after an unusually dry spell in 1923 their condition seems to have deteriorated steadily. In 1959, only a single sapling remained.

#### Discussion of Results.

For many years, A. decurrens was held to be slightly more resistant to frost than A. mearnsii, though the evidence was often conflicting. This contention is not borne out by results at Potchefstroom, where 4 trees of the latter species still remained healthy in 1959. It

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is probable, therefore, that neither species possesses any marked superiority over the other in this respect.

A. decurrens is very rarely seen in the Transvaal as far west at Lichtenburg and Potchefstroom, and, on account of susceptibility to drought and frost, its use in the area cannot be recommended.

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Acacia homalophylla A. Cunn. ex Benth.

Family.

LEGUMINOSAE (MIMOSOIDEAE).

Common Names.

Spear Wood, Yarran, Myall.

Natural Distribution.

A native of the dry, interior regions of Queensland, New South Wales, Victoria and South Australia (Streets, 1962). It abounds on the barren heaths of New South Wales from Lachlan to the Barrier Range (Maiden, 1904-25), and is found in Victoria on the saltbush flats of the lower Murray River.

Provenance.

The seed supplied to Lichtenburg for trial in the Arboretum was received from J.H. Maiden, and presumably originated from New South Wales.

Description of the Species in its Native Habitat.

A small but graceful tree 15 to 40 feet (5 to 12 m.) tall (Audas, 1934), with glabrous or hoary foliage (phyllodes).

Economic Importance in Country of Origin.

The species thrives in bleak, arid areas where grass and other herbage is often scarce. In times of drought it is said to yield an unfailing supply of good forage, to which stock of all kinds is very partial (Turner, 1891). For this reason it is deemed worthy of careful conservation and even of cultivation in Australia. It yields a copious gum of good quality. Its wood is seldom of utilisable size, but was once much fancied for spears and is now prized for turnery and even cabinet work, being hard, dark and exceedingly handsome. Smallwood makes

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an excellent fuel.

Trial in the Arboretum at Lichtenburg.

Seed was sown in suitably prepared "patches" at intervals of 6 x 6 feet (2 x 2 m.) in November, 1908, but in August the following year the trial was reported as having failed completely. No reason for this is indicated in the records.

Discussion of Results.

Apropos of the failure of this trial, the following observations made by Turner (loc. cit.) are of interest: "They (the seeds) are very hard and will require to be steeped for a few days, or carefully torrefied, before sowing, or germination will be considerably delayed. They should be sown in the early autumn months, and in places where it is intended that the trees are to grow, for the seedlings are very impatient of being transplanted, and in fact scarcely ever survive the operation."

A further small supply of seed of this species was received in 1922 from Morocco. This was sown in the Bloemfontein nursery but failed to germinate within the time allowed.

It is probable that the complete lack of success which attended the trial at Lichtenburg can be ascribed, as in the instance just cited, to failure of the seed to germinate. This in turn, could well be accounted for by ignorance of the best methods of procuring early germination. In defence of those responsible for the conduct of the trial it should, however, be mentioned that 3 years elapsed before the site was utilised again for another species, during which time the seed presumably lay unmolested in the ground.

A further attempt should unquestionably be made

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to establish this species in South Africa because of its potential value to stock farmers in dry areas, but adequate precautions should be taken to ensure that satisfactory germination is obtained.

Acacia karroo Hayne.

(syn. A. horrida Willd.)

Family.

LEGUMINOSAE (MIMOSOIDEAE).

Common Names.

Sweet Thorn, Cape Acacia.

Natural Distribution.

Indigenous to South Africa (Verdoorn, 1954), where it extends further south than any other native species of Acacia, occurring within about 75 miles (120 k.m.) of Cape Town. From thence its range extends to the northern Transvaal and beyond into central Africa. It is found also in the arid regions of Botswana and South West Africa, and on parts of the highveld is one of the few trees that grow spontaneously (Codd, 1951). However, it is rare in sub-tropical areas and is seldom found on the upper slopes of the mountains, favouring the more fertile, "sweet" soils of the foothills and plains. It often occurs along the banks of streams, mostly in areas with a rainfall of 12 to 35 inches (300 to 900 m.m.) a year.

Provenance.

Not recorded, but the seed may well have been collected locally in the Western Transvaal.

Description of the Species in its Native Habitat.

A small to medium-sized, deciduous tree up to 40 feet (12 m.) in height, with a rounded or spreading crown armed with long, straight, paired, white spines. In mid-summer the air is perfumed by its canary-yellow flowers, which are borne in great profusion in dense, globular heads.

Economic Importance in Country of Origin.

The species is of very limited economic value.

Young foliage and ripe pods are eaten by stock, and gum was at one time collected from its stem and branches for export (Codd, 1951). Its wood makes a good fuel and its bark can be used for tanning, but imparts a reddish colour to the leather.

Trial in the Arboretum at Lichtenburg.

The plot, under the name of A. horrida, was planted up in 1906 at an espacement of 6 x 6 feet (2 x 2 m.), using 1-year old nursery stock 6 inches (15 c.m.) high.

In August, 1909, the young trees already stood 4 to 6 feet (1 to 2 m.) high but were very bushy, and were accordingly trimmed to a single stem. Towards the end of the following month the new growth was killed by late frost. Several trees were again cut back by frost during the next three, successive winters. By this time the tallest of their number had reached a height of 13 feet (4 m.) and their average height was 7 feet (2 m.).

Frost damage recurred from time to time over the next few years, and in 1920 it seemed that the trees had been killed to the ground by the combined effects of frost and drought. Surprisingly, about 30 of them made an almost complete recovery, and the rest sprouted again from ground level. Their growth, however, was very slow from then onwards, and in 1926 they were described as having a "stunted, hungry appearance".

When last inspected, in 1959, the plot consisted, for the most part, of a dense, impenetrable scrub 7 feet (2 m.) high. Ten trees emerged above the general canopy level, and had attained a height of up to 20 feet (6 m.) and a maximum D.B.H. of 9.3 inches (24 c.m.). Their form

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ACACIA KARROO : LICHTENBURG

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was very poor, and only two of them contained any utilisable wood.

Discussion of Results.

This trial serves to demonstrate (if this were needed) the extraordinary toughness and resilience of the species which, unfortunately, has little to commend it but its rather picturesque appearance. It might, however, be considered for soil reclamation work in the western Transvaal, and its pods are useful as fodder.

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Acacia mearnsii De Wild.

(Syns. A. mollissima sensu auct. mult. e.g. Benth in Hook., Lond. Journ. 1842, non Willd.; A. decurrens (Wendl.) Willd. var. mollis Lindl.)

Family.

LEGUMINOSAE (MIMOSOIDEAE).

Common Name.

Black Wattle.

Natural Distribution.

A. mearnsii occurs over a wide area in Australia, where it is found in the States of South Australia, Victoria, New South Wales, Queensland and Tasmania (Maiden, 1904-25). Its range extends from Naracoorte in south-eastern South Australia (Black, 1922) through Victoria and the cooler districts of New South Wales (where it reaches its greatest development on the southern tablelands) into inland, extra-tropical Queensland (loc. cit.) In Tasmania it is both widespread and frequent (Curtis, 1956). Typically, it is a tree of cool, mountain regions with a well-distributed rainfall, occurring on moist valley soils or on hillsides, often as an understorey in high eucalypt forest.

Provenance.

According to Sherry (1947), the introduction of A. mearnsii to South Africa took place as long ago as 1864, and there is probably no means of ascertaining from which part of Australia seed was obtained. The stock used to establish a trial in the Arboretum at Potchefstroom was supplied by the Conservator of Forests, Cape Colony, but there is no record of any seed being issued to Lichtenburg, and the origin of the plot there is obscure.

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Description of the Species in its Native Habitat.

A spreading tree, usually about 30 feet (9 m.) in height (Black, loc. cit.) but sometimes much taller (Mueller, 1887-88), with shortly pubescent branchlets. Its feathery, evergreen foliage and its trunk are darker than those of *A. decurrens* (Audas, 1934), but its flowers paler and almost over-powerfully scented (Maiden, loc. cit.)

Economic Importance in Country of Origin.

The tree is considered to yield the best tan-bark of any *Acacia* species in Australia (Maiden, loc. cit.), and is exploited for this purpose in several States. Its timber, however, is regarded as inferior and is little used except for fuel.

Trials in the Arboreta at Lichtenburg and Potchefstroom.

The trial of this species in the Lichtenburg Arboretum was conducted under the name *A. decurrens*. Botanical identification of the trees is no longer possible, but the Green Wattle (properly known as *A. decurrens*) was usually referred to in the early records of the Transvaal Forestry Division as *A. decurrens* var. *normalis* or *A. normalis*, and the unmodified specific epithet *decurrens* was taken to denote the variety *mollis* - i.e. the Black Wattle.

Seed was sown broadcast in 1906/07, but the plants were all frosted to the ground during their first winter. Some of them sprouted again in the spring, and of these the tallest stood about 5 feet (1.5 m.) high in December, 1908.

For a number of years thereafter the amount of damage caused by frost was negligible, and by March, 1913, the stand had attained an average height of 16 feet (5 m.)

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Drought, however, intervened, and in September the following year all but 9 trees had succumbed. The remnants were finally uprooted two years later.

At Potchefstroom, the stand was established under name of A. mollissima. Eighty-one plants 9 inches (23 cm.) high, which had been raised in the nursery over the previous 6 months, were put out at an espacement of 6 x 6 feet (2 x 2 m.) in January, 1909.

Tender, young shoots were caught by late frost the following spring, but the plants nevertheless grew luxuriantly and, in October, 1911, were said to be doing better than any other Acacia species in the Arboretum. One large sapling perished in 1912 but the remainder continued to grow vigorously and were neither affected by frost nor drought, reaching an average height of 25 feet (8 m.) in October, 1914. Thereafter, their vigour seems to have declined, however, and the climate commenced to exact its toll once more.

When the plot was last inspected in September, 1959, only 4 of the original trees remained. These had grown to quite large size, having an average height of 56 feet (17 m.) and a M.D.B.H. of 17.7 inches (45 cm.). Their form, though leaving a lot to be desired, was not unduly poor for more-or-less free-growing trees of this species, which are normally rather crooked and heavily branched. To all appearances their condition was moribund, but this could be expected since the species is never very long lived. A good deal of spontaneous regeneration was found on the site.

Discussion of Results.

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The planting of A. mearnsii in the Lichtenburg and Potchefstroom districts would not be recommended by the Forest Department today on account of the deficient rainfall, and it is surprising, therefore, that 4 trees should have survived for 50 years in the Arboretum at the latter centre and that the species should be regenerating quite freely there. This does not, of course, constitute sufficient reason to reverse the recommendations of the Department in the present connection, but it would suggest that, contrary to what is widely supposed, A. mearnsii is no less hardy to frost and drought than A. dealbata and A. decurrens, both of which failed in the Arboretum at Potchefstroom.

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Acacia penninervis Sieb.

(probably the variety falciiformis (DC.) Benth.)

Family.

LEGUMINOSAE (MIMOSOIDEAE).

Common Name.

Mountain Hickory.

Natural Distribution.

Endemic in south-eastern, continental Australia and possibly also in Tasmania. In Victoria (Maiden, 1904-25) it occupies granitic mountain ranges in the vicinity of the Broken, Ovens and Snowy Rivers. From thence its range extends northwards through the Blue Mountains and along the coastal plains of New South Wales to Moreton Bay in Queensland. Its occurrence in Tasmania seems doubtful as Curtis (1956) does not list it, but according to Flora Australiensis it is found near Brown's River, south of Hobart.

Provenance.

Seed for the trial at Lichtenburg was obtained either from the Conservator of Forests, Cape Colony, or else from the Rhodes Matopa Park in Rhodesia.

Description of the Species in its Native Habitat.

A small, evergreen tree, with glabrous, penni-veined phyllodes, sometimes attaining a height of 40 feet (12 m.) or more (Maiden, loc. cit.)

Economic Importance in Country of Origin.

The bark of the variety falciiformis is exceedingly rich in tannin, and is almost comparable in quality with that of A. mearnsii. Its wood is dark brown in colour, tough and durable, and is particularly suitable for tool handles.

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Trial in the Arboretum at Lichtenburg.

Seed was sown in "patches" spaced 6 feet (2 m.) apart in November, 1908. By August the following year all the plants which resulted therefrom had died.

Discussion of Results.

The species would seem to be quite unsuited to the western Transvaal, where conditions are much drier than those prevailing in its natural habitat. The variety falciformis is, however, a potentially valuable stand-by for the wattle industry in Natal and the eastern Transvaal, though it does not grow as vigorously as the Black Wattle, A. mearnsii.

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Brachychiton populneum (Schott) R.Br.

(Syn. Sterculia diversifolia G. Don).

Family.

STERCULIACEAE.

Common Name.

Kurrajong.

Natural Distribution.

A native of Australia, where it is found on the seaward side of the Dividing Range from Melbourne, in Victoria, through New South Wales to Rockhampton in Queensland, Its range extends also to the warmer and drier regions of the interior, where the rainfall averages only 10 to 25 inches (250 to 630 m.m.) a year (Streets, 1962). The species does not tolerate poor, acid soils and is most abundant on calcarous formations, occurring naturally in the form of isolated trees or very scattered stands.

Provenance.

The seed used to establish a plot in the Lichtenburg Arboretum was received from J.H. Maiden, and presumably originated from New South Wales. A second consignment of seed was obtained in 1904 from one Mr. Wood of Brisbane, Queensland, and it would seem that part of this was used to raise plants for trial at Potchefstroom, although definite confirmation is not obtainable from the records.

Description of the Species in its Native Habitat.

The species is described by Turner (1891) in the following words: "An exceedingly ornamental tree, often attaining a height of 60 feet (18 m.) on the eastern slopes of the Dividing Range, and from 20 to 30 feet (6 to 9 m.)

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in the hilly country of the interior .....

On deep soils of a dry nature the kurrajong will make a beautiful, umbrageous head ..... Its beautiful, green foliage in midsummer is easily recognised among other vegetation."

Economic Importance in Country of Origin.

Turner (loc. cit.) continues: "In the arid interior of this continent, during drought time this tree has often proved a most valuable standby to the stock-owner, and has been the means of saving many animals when other herbage has failed. Cattle and sheep are exceedingly fond of its leaves, and thrive on them well. As a rule when feeding stock on the leaves of this tree, the branches only are cut off by thoughtful persons, leaving the trunk standing, which soon throws out a fresh supply of branches and leaves ..... The timber of this tree is soft and spongy, and almost useless."

Trails in the Arboreta at Lichtenburg and Potchefstroom.

At Lichtenburg, a plot was established in 1905 at an espacement of 6 x 6 feet (2 x 2 m.), using plants 12 months old and 6 inches (15 cm.) high which had been raised in the local nursery.

The young trees were damaged by frost almost every winter until 1920, sometimes to the extent of being cut back practically to the ground. In that year the effects of drought were also felt for the first time. Eight trees were lost, and 10 more died from the same cause the following year. In 1922, the survivors were said to have a very sickly appearance, and all were stag-headed.

Severe frost damage was experienced intermittently thereafter, but, in 1959, 28 trees still remained



BRACHYCHILTON POPULNEUM : LICHTENBURG

on the 0.1 acre (0.004 hec.) plot. These, although fairly healthy, were unevenly distributed over the area, the stocking being best towards the middle and on the two sides which received some protection from other species, suggesting frost and cold wind rather than drought as the cause of mortality. The surviving trees had a mean D.B.H. of 7.3 inches (18 cm.) and a height of 23 feet.(7 m.) Their branching was rather irregular, and clusters of shoots arose from spurs along from their trunks and limbs.

The trial at Potchefstroom was commenced in 1908, when 81 plants 2 years old and 18 inches (45 cm.) tall were set out at a 6 x 6 foot (2 x 2 m.) espacement.

In August that same year, the trees were frosted at the top and 31 were killed to the ground. In 1909 several of them were again touched by frost yet, despite this, the plot remained fully stocked and showed much promise.

Over the next few years little further damage was caused by frost and the trees were scarcely, if at all affected by drought. The abnormally low rainfall of 1927 caused most of them to become stag-headed, however, and it was actually believed that they were dying. This assessment proved to be unduly pessimistic, for 58 trees were still alive in 1959 - equivalent of a stocking of no fewer than 866 stems per acre (2,140 per hec.) Although overcrowded they were apparently quite healthy, and a mean D.B.H. 7.0 inches (18 cm.) and a height of 34 feet (10 m.) Their lower trunks were erect and moderately straight, but their crowns were haphazardly branched and ungainly.

#### Discussion of Results.

According to Robertson (1926), this species does not favour very cold sites on the tablelands of New South

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Wales, and it is evident that conditions in this respect are marginal for it in the western Transvaal. Nevertheless, cognisance should be taken of the fact that no trial seems to have been conducted as yet with seed obtained from the most southerly (and therefore, presumably, coldest) part of its range. Its resistance to drought is beyond question.

The value of the Kurrajong has not been sufficiently appreciated by stock farmers in South Africa, and greater use might well be made of it for the establishment of "fodder banks" that can be drawn upon in times of need. The species is also an excellent one for avenues and shade in dry areas and might even be considered for shelterbelts, especially if used in conjunction with a suitable species of eucalypt.

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Callitris endlicheri (Parl.) F.M. Bail.

(Syn. calcarata (A. Cunn.) R. Br.)

Family.

CONIFERAE.

Common Names.

Black Callitris, Black or Mountain Pine.

Natural Distribution.

Fairly widely distributed in the eastern States of Australia, where its range extends from southern Victoria to central Queensland (Audas, 1934). It is particularly widespread in New South Wales, occurring most abundantly west of the Dividing Range from the rocky declivities and canyons of the tablelands to the hills and ridges at the edge of the plains (Bentham and Mueller, 1963-78; Maiden, 1904-25).

Provenance.

The seed supplied to Lichtenburg for trial in the Arboretum was received from J.H. Maiden of the Botanic Gardens, Sydney; that used to raise plants for the Potchefstroom Arboretum either came from the same source or was obtained from Mr. Wood of Brisbane.

Description of the Species in its Native Habitat.

A small to medium-sized tree of pyramidal form, attaining a height of up to 80 feet (24 m.) and a diameter of  $4\frac{1}{2}$  feet (137 cm.) (Streets, 1962). In general appearance it is distinguished from other members of the genus by its black bark and its bright green foliage (Maiden, loc. cit.) It is more rigid in habit than C. glauca, and its branches tend to droop less (Baker and Smith, 1910). When growing on ridges it is often rather stunted, trees of more than 8 inches (20 cm.) in diameter being rarely found.

Economic Importance in Country of Origin.

According to Maiden (loc. cit.), this species yields one of the handsomest timbers in its class. Its wood is fine-grained, dark in colour, beautifully mottled, fragrant and capable of taking a high polish. It is valued for interior decoration, joinery, coach-work and furniture. The roundwood is claimed to be immune to termite attack (Baker and Smith, loc. cit.) and is probably also durable in contact with the ground (Streets, loc. cit.) The tree furnishes a good oleo-resin, and its bark has a tannin content of up to 36%.

Trials in the Arboreta at Lichtenburg and Potchefstroom.

The stand at Lichtenburg established under the name of C. calcarata consisted initially of a mixture of this species and C. gauca. Planting was carried out in 1906 at an espacement of 6 x 6 feet, (2 x 2 m.) using 12-month-old nursery stock 6 inches (15 cm.) high.

For a number of years the young trees were slightly frosted each winter but made steady, if slow growth, attaining an average height of 9 to 10 feet (3 m.) in 1913. The following year, most of the trees taken for C. calcarata were reported to be suffering badly from drought, but those of C. gauca seemed to be unaffected. Growth continued to be a little slow for several years thereafter, but from 1924 onwards the trees appeared to become more thrifty.

When the plot was inspected in 1953, only 3 trees of C. calcarata could be found. These had a mean D.B.H. of 5.8 inches (15 cm.) and an average height of 40 feet (12 m.) Sixty trees of C. gauca remained bringing the total stocking up to 630 stems per acre, (1,556 per hec.) and of these the mean D.B.H. and height were 7.2 inches (18 cm.) and 46 feet (14 m.), respectively.



CALLITRIS GLAUCA : LICHTENBURG

In 1959, only trees of the latter species remained.

The trial at Potchefstroom was commenced in February, 1908, when 81 transplants 2 years old and 1 foot (30 cm.) high were set out at an espacement of 6 x 6 feet (2 x 2 m.).

The young trees were not affected by cold, but several of them died of drought in 1912. A year later, however, their average height was already 8 feet (2.4 m.) and they had a vigorous appearance. Although periodic losses were caused thereafter by drought, the stand as a whole remained healthy and made satisfactory growth.

In 1959, 23 trees were left on the plot, representing a stocking of 343 stems per acre (847 per hec.). These had a mean D.B.H. of 9.8 inches (25 cm.) and a height of 56 feet (17 m.) Their form was rather poor, for most of them were forked or else had sinuous or leaning trunks. Two were dead and others were dying back in the crown.

#### Discussion of Results.

In its natural habitat, C. calcarata occurs typically under rather less arid conditions than C. glauca, although the ranges of the two species overlap in places. In South Africa it is held to be slightly less drought-hardy than the latter, which impression is confirmed by the results of the trials at Lichtenburg and Potchefstroom. None-the-less, it may survive to maturity under plantation conditions in the western Transvaal.

Compared with C. glauca, C. calcarata is usually a smaller tree and is generally of poorer form. Its timber, although attractive, is not quite as highly esteemed for most purposes in Australia as is that of C. glauca. The only advantages which it therefore possesses over the latter are the potential use of its bark as a source of tannin and the fresher, more pleasant green of its foliage.

Callitris glauca R.Br.

(This species was reduced to synonymy with Frenela (Callitris) robusta) A. Cunn. by Bentham in "Flora Australiensis" but subsequently re-instated by Baker and Smith in "A Research on the Pines of Australia.")

Family.

CONIFERAE.

Common Names.

White Callitris, White Pine.

Natural Distribution.

The most widely distributed of all members of the genus, C. glauca occurs in every State in Australia except Tasmania, though nearly always at some distance from the sea and mainly in the southern half of the continent (Baker and Smith, 1910; Bentham and Mueller, 1863-78; Streets, 1962). It is most abundant in the dry interior of New South Wales and Queensland, reaching its best development in areas with an annual rainfall of 18 to 28 inches, (450 to 700 mm.) though it occurs also in parts with as little as 14 inches (350 mm) of rain a year. Its altitudinal range is chiefly between 500 and 1,250 feet (150 and 380 m.) the climate being warmer-temperate to sub-tropical, with high summer temperatures but some 5 to 15 frosts in winter. The tree is generally gregarious, forming scrub forests on sandy, barren lands.

Provenance.

The seed used to raise plants for trial at Potchefstroom was supplied by J.H. Maiden. Trees of this species in the Lichtenburg Arboretum were planted as C. calcarata (C. endlicheri) and their origin is not known.

Description of the Species in its Native Habitat.

An erect, evergreen tree with light, narrow crown, varying from small to medium in size according to its environment. In the far interior it is stunted in habit, but nearer the Dividing Range in the east it grows to over 100 feet (30 m.) in height and a diameter of 2 to 3 feet (60 to 90 cm.) (Baker and Smith, loc cit.) Its bark is hard, compact and furrowed but paler than that of C. endligheri, with which it is associated over parts of its range; its foliage, too, is paler and more glaucous.

C. glauca is the chief constituent of the "Pine Scrub" which covers large tracts of the Australian hinterland - an extremely dense plant community in which up to 8 young trees 3 to 8 feet (1 to 2.4 m.) tall have been counted on an area of only 14 square inches (90 sq. cm.) (Maiden, 1904-23). With judicious thinning, however, this scrub is capable of being turned into an economic asset.

Economic Importance in Country of Origin.

The timber of this tree is preferred to that of C. endligheri because of its relative freedom from knots, straighter grain and greater durability, and is used more extensively in Australia than that of any other member of the genus. It is easily worked and occasionally has very handsome markings, which greatly enhance its value for panelling and similar purposes. Other uses for it include flooring, ceiling, weather boards, scantlings and similar builder's requisites. It is renowned for its durability in contact with the ground and is almost completely resistant to termites (Robertson, 1926), for which reasons it is in demand for telephone poles and fencing posts. The tree is useful also for shade and shelter, and

its bark is of limited value as a source of tannin.

Trials in the Arboreta at Lichtenburg and Potchefstroom.

At Lichtenburg, the species was planted in mixture with C. endlicheri, under which name an account of the trial is to be found. In 1959, no trees of the latter species existed any longer on this plot, which consisted of a pure stand of C. glauca. The stocking was slightly more open towards the centre than on the edges but the trees were fairly uniform in size throughout, suggesting tolerance of a high order and a considerable degree of drought-hardiness. The trees were slightly crooked but erect and fairly lightly branched.

Two stands of C. glauca exist in the Arboretum at Potchefstroom one of which was established under the name of C. calcarata (C. endlicheri) and possibly contains a few trees of the latter species. Both plots were planted up in February, 1908, at an espacement of 6 x 6 feet (2 x 2 m.), using nursery stock 10 months old and 9 inches (23 cm.) high in the one case and 20 months old and 12 inches (30 cm.) high in the other.

During the first few years after their establishment the young trees successfully resisted both drought and frost. Only in 1919 was one of the plots affected by frost. In 1923 the foliage in both turned slightly yellow, presumably as a result of drought. A satisfactory rate of growth was maintained in spite of this, and a thinning was carried out in 1949.

At the time of the last re-measurement, 1959, the following data were recorded for the two plots, respectively: number of stems per acre, 433 and 567 (1,070 and 1,400 per hec.) mean D.B.H., 10.1 and 9.0 inches; (25 and 23 cm.)

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average height, 63 and 56 feet (19 and 17 m.) The trees were of fairly good form on the whole, with narrow, symmetrical, lightly-branched crowns, but some were slightly crooked and many were forked. The defective stems could, however, have been almost, if not entirely eliminated in a thinning.

#### Discussion of results.

C. glauca is evidently well adapted to the unfavourable climate of the western Transvaal, and has proved just as successful under equally dry conditions at Lobatsi, in Botswana. It yields a serviceable wood which, unlike many another, appears to retain something of its natural durability when grown under plantation conditions outside its native habitat. Unfortunately, its rate of growth is not such as to encourage planting on a commercial basis for timber, though it can be confidently recommended for farm wood-lots, shelterbelts and avenues in the Lichtenburg and Potchefstroom areas. For all these purposes it is probably superior to any other species of Callistris introduced thus far into South Africa.

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Callitris verrucosa R.Br.

Family.

CONIFERAE.

Common Names.

Cypress or Turpentine Pine.

Natural Distribution.

A species of the dry interior of Australia, where its range extends from Mount Hope and the plains west of the Dividing Range in New South Wales across the arid heart of the continent into Western Australia (Baker and Smith, 1910). It is also recorded from South Australia, but its presence in Queensland seems doubtful (Black, 1922).

Provenance.

Seed supplied by Prof. J.H. Maiden was used to establish a plot in the Lichtenburg Arboretum.

Description of the Species in its Native Habitat.

A stunted tree or shrub, sometimes attaining a height of up to 20 or 30 feet (6 to 9 m.)(Baker and Smith, loc. cit.) On the eastern side of the Murray River in South Australia it forms a "scrub" no more than 6 feet (2 m.) high (Black, loc. cit.) It is readily distinguishable from C. glauca because of its dark green foliage.

Economic Importance in Country of Origin.

The species is not often of sufficient size to be exploited for timber, but its wood is straight-grained, easy to work and suitable for the construction of dwellings where termites are prevalent (Baker and Smith, loc. cit.) It can also be used for railway sleepers and telegraph poles (Streets, 1962). The tannin content of its bark is too low to warrant commercial exploitation.

Trial in the Arboretum at Lichtenburg.

The plot was established in 1905/06 by planting out 9-inch (23 cm.) high nursery stock at an espacement of 6 x 6 feet (2 x 2 m.).

The young trees did not suffer from drought, but a few were slightly frosted in 1912 and again in 1921. Growth was a little slow, though consistent, for in 1913 the stand had an average height of 11 feet (3 m.) and its appearance was healthy. Steady progress was maintained thereafter, and a light thinning was carried out in 1929.

When inspected in 1959, 49 trees remained on the 0.1 acre (0.004 hec.) plot, the mean D.B.H. of which was 8.3 inches (21 cm.) and the average height 44 feet (13 m.). A few of them were forked and others were slightly crooked, but their form was reasonably good and their appearance still healthy. Branching was moderately light, and the plot would undoubtedly have created a better impression had it been more adequately thinned. The stocking towards its centre was good and the innermost trees were well developed, indicating that the species is perfectly hardy under the prevailing climatic conditions.

Discussion of Results.

This plot has made altogether better growth than might have been expected, bearing in mind the fact that in the wild state the species apparently does not grow beyond a height of 30 feet (9m.). Indeed, its rate of growth and size closely rival those of C. glauca growing nearby.

In Australia, C. verrucosa is unquestionably of lower economic value than C. glauca, and at Lichtenburg it exhibits no particular silvicultural advantage over it.

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There is thus no reason to advocate planting it in preference to the latter species from a utilitarian point of view, though as an ornamental it will be favoured by many on account of the more attractive colour of its foliage.

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Casuarina cunninghamiana Miq.Family.

CASUARINACEAE.

Common Names.

Beefwood, River Oak.

Natural Distribution.

A native of Australia, where it occurs from southern New South Wales to northern Queensland and the Northern Territory, reaching from the coast inland across the tablelands to the upper, western slopes of the Dividing Range (Streets, 1962). Its altitudinal range is from sea level to about 3,500 feet (1,070 m.) The climate varies from temperate to tropical, with a mean annual temperature of from 55°F. to 80°F. (13°C to 27°C) and from 0 to 60 days of frost a year. The mean annual rainfall is between 20 and 60 inches (500 and 1500 mm), but the species is found mainly along the banks of fresh-water rivers and thus enjoys abundant soil moisture throughout the year.

Provenance.

No light is thrown on the origin of the plants raised at Potchefstroom for trial in the Arboretum by the records of the Transvaal Forestry Division.

Description of the Species in its Native Habitat.

Perhaps the largest of all Casuarinas, C. cunninghamiana reaches a height of about 100 feet (30 m.) and a diameter of 6 feet (183 cm.) or more in Australia (Maiden, 1904-25). Its branches are fairly slender and erect, and its crown somewhat glaucous.

Economic Importance in Country of Origin.

The tree yields a hard, very strong, durable timber of moderate weight, which is used for shingles, panelling, furniture and similar purposes. Like that of other

Casuarinas, it burns well and the ashes retain their heat for a long while. Yet it is not on account of its timber that the species is considered most valuable in Australia but because of the stabilising influence it exercises on river banks. Indeed, the suggestion has been made that the destruction of River Oaks within a certain distance of any watercourse except "under a special licence only to be obtained after due enquiry" should be made a penal offence (Maiden, loc. cit.) Writing of this species Maiden states: "It is a tree which is readily propagated, and which should be faithfully conserved, for besides its value as a stock food in times of drought it is one of the best trees we have for protecting the friable banks of rivers. The banks had in the course of ages acquired an equilibrium which has been largely destroyed by the white man. He has ruthlessly cut down the River Oaks to obtain more ready access to the river frontage, and to enlarge the area of cultivated land, but the latter aim has often been defeated through the consequent falling in of banks ....." Young seedlings are palatable to stock and are liable to be eaten out unless protected from grazing, but the species is not regarded as one of the better fodder trees of Australia as its branchlets are said to be rather woody and astringent unless fed with some more succulent foliage (Audas, 1934).

Trial in the Arboretum at Potchefstroom.

The plot was established in February, 1908, in which year 81 plants 7 months old and 9 inches (23 cm.) high were put out at the usual espacement of 6 x 6 feet (2 x 2 m).

The early growth of the stand was most encouraging, and by the time they were 18 months old the trees had already reached a height of 7 feet (2 m.) and

could be described as "true and regular". Twice during the first few years, however, it was found necessary to remove double leaders.

In October, 1913, the trees had increased in height to an average of 18 feet (5 m.) but they now appeared to be suffering from drought, and a thick mat of discarded "foliage" was beginning to build up on the ground beneath them. They never regained their vigour, and two years later several of them had commenced to die back from the top. This process continued, and in 1927 the 79 surviving trees, whose height now averaged 25 feet (8 m.) were stagheaded and appeared to be moribund.

In 1959, all that remained of the stand was a fringe of multi-stemmed coppice along two of its sides.

#### Discussion of Results.

Although this species is common in areas with a low rainfall west of the Dividing Range in New South Wales and Queensland, it almost invariably occurs under riverine conditions or on low-lying flats with a high water table. Its failure in the Arboretum at Potchefstroom is therefore not surprising, although the results might well have been better had some attention been given to thinning.

In localities where soil moisture is reasonably plentiful, the species is a useful one for avenues and shelterbelts, making rapid growth and sometimes actually attaining a greater height than that recorded in Australia.

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Casuarina glauca Sieb.

Family.

CASUARINACEAE.

Common Name.

Swamp Oak.

Natural Distribution.

A native of Australia, where it occurs in every State except Tasmania and, possible, the Northern Territory. Characteristically, it is found growing in riverine swamps and tidal creeks near the coast, but in Western Australia it not only occurs near the sea but also in the interior (Maiden, 1904-25). Unlike C. cunninghamiana, it tolerates saline conditions, commonly replacing the former on the banks of streams and rivers along the Pacific seaboard of New South Wales and Queensland.

Provenance.

Seed for the trial at Potchefstroom was supplied by Prof. J.H. Maiden of Sydney, New South Wales.

Description of the Species in its Native Habitat.

An erect tree, generally about 40 to 50 feet (12 to 15 m.) tall but sometimes much larger, with a stem diameter of 2 feet (60 cm.) Its bark is more-or-less cracked or flaky and its crown glaucous (ibid.)

Economic Importance in Country of Origin.

The tree yields a hard, strong, durable timber weighing 56 lb. per cubic foot (0.89 gms/cu.cm.) with a pale, chocolate-coloured heartwood and an exceptionally striking figure. Its many uses include shingles, panelling and furniture, besides which it carves well (Audas 1934). The "foliage" is palatable to cattle (Maiden, 1904-25).

Trial in the Arboretum at Potchefstroom.

The plot was established in February, 1908, at

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the usual espacement for those times of 6 x 6 feet (2 x 2 m.), using plants 9 inches (23 cm.) high and 7 months old raised in the nursery.

During the first winter, 25 per cent of the young trees were eaten off by hares, but all grew again in the spring. The following winter they were slightly touched by frost.

Over the next few years the stand was quite unaffected by frost and drought and made good growth, reaching an average height of 17 feet (5 m.) by October, 1917. Three years later it was said to be resisting drought better than the stand of C. cunninghamiana nearby. This satisfactory state of affairs continued for only 2 more years, however, for after 1918 the health and vigour of the trees gradually deteriorated, most of them beginning to die off at the top.

In 1959, 30 trees remained on the plot, which corresponds to a stocking of 448 stems per acre. (1,100 per hec.) These had a mean D.B.H. of 8.1 inches (20 cm.) and a height of 55 feet (17 m.) Although erect and moderately lightly branched, most of them were forked. Their appearance was still fairly healthy but their crowns were thin, and few large specimens remained near the middle of the plot. The stumps of trees which had previously died back were still sprouting feebly.

#### Discussion of Results.

The species has fared considerably better than its preference for swampy sites near the coast might lead one to expect. It is very resistant to frost and would seem to be more tolerant of semi-arid conditions than A. cunninghamii, which is consistent with its physiological adaption to brak soils. Further trials, particularly of the strain from the dry, interior of Western Australia, might prove rewarding.

Catalpa speciosa Ward.Family.

BIGNONIACEAE.

Common Name.

Hardy Catalpa.

Natural Distribution.

A tree of the south-eastern United States, where it is found on bottom lands along the upper reaches of the Mississippi and Ohio Rivers in Illinois, Kentucky, Tennessee, Missouri and Arkansas. The rainfall over the area varies from 35 to 55 inches (890 to 1,400 mm.) a year, and the temperature from 12<sup>o</sup>F to 107<sup>o</sup>F. (-11<sup>o</sup>C to 42<sup>o</sup>C), with an annual mean of 50<sup>o</sup>F. to 66<sup>o</sup>F. (10<sup>o</sup>C. to 19<sup>o</sup>C). (Streets, 1962). The species has been widely planted in the middle west and is now naturalised in many areas where formerly it did not occur.

Provenance.

The records of the Transvaal Forestry Division are silent as to the origin of the seed used to establish a plot in the Arboretum at Potchefstroom.

Description of the Species in its Native Habitat.

A medium-sized to large, deciduous tree with a handsome, pyramidal crown, sometimes attaining a height of 120 feet (37 m.) and a diameter of over 4 feet (122 cm.) though usually much smaller. When growing in the forest it has a well-formed bole, but otherwise it is liable to be crooked. It is sensitive to site conditions, preferring the fertile, moist soils of valleys.

Economic Importance in Country of Origin.

In the United States the species is said to produce more good fence posts in a short time on suitable sites, than any other native tree. Its wood is very durable

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when used for railway sleepers or posts, but the tree itself is subject to heart rot caused by an infection which enters the trunk through old branch scars.

Trial in the Arboretum at Potchefstroom.

The trial was commenced in August, 1908, when 1-year-old nursery stock 2 feet (61 cm.) tall was planted out at an espacement of 6 x 6 feet (2 x 2 m.)

New growth was cut back by late frost the following spring, but by October, 1910, the trees had reached an average height of 8 feet (2.4 m.) and seemed healthy. In January, 1913, it was recorded that prolonged drought had had no discernible effect upon their foliage.

The trees remained healthy until 1922 but made little further growth, and in that year they were said to be suffering from drought. From this they never fully recovered, and in 1926 they had died back to a height of about 3 feet (1 m.) By 1959 the plot was vacant.

Discussion of Results.

C. speciosa has not come up to expectations anywhere in South Africa, and is clearly unsuited to the dry, rather infertile soils of the western Transvaal highveld.

Cedrus deodara (Roxb.) Loud.

Family.

CONIFERAE.

Common Name.

Deodar.

Natural Distribution.

Widespread in the western Himalaya from Afghanistan to Gerhwal, in India, at an altitude of from 4,000 to 10,000 feet (1,220 to 3,048 m.), where it is probably the most important softwood. The best forests of the species are to be found in areas with a rainfall of 40 to 70 inches (1,000 to 1,780 m.m.) a year, but trees of timber size also occur in localities where the precipitation is below 30 inches (760 m.m.) provided that the soil is deep and fertile (Streets, 1962).

Provenance.

Not recorded.

Description of the Species in its Native Habitat.

An exceedingly fine, picturesque tree, at times exceeding a height of 200 feet (61 m.) and a girth of 35 feet (11 m.) (Dallimore and Jackson, 1961). It is distinguished from other members of the genus by its relatively long needles, drooping branches and bowed terminal shoot.

Economic Importance in Country of Origin.

The tree yields a moderately hard, strongly scented timber which is very durable both in contact with the soil and when used for harbour piling. It is extensively employed for building purposes, railway sleepers, joinery and furniture.

Trial in the Arboretum at Potchefstroom.

Plants raised in single tins in the Belfast Forest Nursery were used to establish a plot at Potchefstroom in



CEDRUS DEODARA : POTCHEFSTROOM

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February, 1908. These were 15 inches (38 cm.) tall and approaching 3 years old when they were planted out at the then customary espacement of 6 x 6 feet (2 x 2 m.)

Apart from being slightly damaged by late frosts in 1909 and appearing to suffer a little from drought in the summer of 1912/13, the young trees stood up exceedingly well to the harsh climate of the western Transvaal and made steady, even growth. The entry for 1918 in the records of the Arboretum reads as follows: "These trees have done remarkably well. Straight stems. Average height 30 ft. (9 m.) One of the most promising species in the Arboretum at present." Two trees died unaccountable in 1920, but the rest of the stand continued to look healthy and vigorous, at least for the time being.

When inspected in 1959, the plot still had a stocking of 299 stems per acre (738 per hec.) and the trees now averaged 9.5 inches (24 cm.) in diameter and 48 feet (15 m.) in height. Their form was very good, for their stems were straight and their branches regular. One, however, was dead and the tops of several others had died back. The plot was open towards the centre, suggesting that the species is not completely drought hardy under the prevailing conditions when planted in stand form, although the invasion of the area by eucalypt regeneration increased the competition for moisture to some extent.

#### Discussion of Results.

The tree is very resistant to frost and is also sufficiently drought hardy to be eminently suitable for planting in the form of avenues and shelterbelts in the western Transvaal. It is one of the most ornamental of all conifers, and its use for the beautification of parks, streets and gardens is to be recommended.

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espacement of 6 x 6 feet (2 x 2 m.) using plants 15 inches (38 cm.) high and approximately 3 years old which had been transferred from the Belfast Forest Nursery.

During 1909, 17 trees suspected of being C. deodara were replaced. That winter, damage to tender, young growth was caused by late frost, but apart from this the trees were not at any time noticeably affected either by frost or by drought. Nevertheless, sporadic failures occurred over the years which could never quite be accounted for. Growth, too, was rather slow, for, in 1927, the height of the remaining 63 trees was no more than 20 feet (6 m.) and many of these were stag-headed.

By 1959, only 2 survivors were left on the plot, of which the average diameter was 6.9 inches (17 cm.) and the height 29 feet. (m.) The top of one of them was dead, but both were of moderately good form.

#### Discussion of Results.

The results of this trial are decidedly disappointing. Contrary to what might have been supposed, this species has not stood up to the rather severe climate of the western Transvaal as well as its congener from the Himalaya. This, when taken in conjunction with the fact that its form is also less good, points to the conclusion that it is not worth persevering with under these conditions.

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Celtis africana Eurm.f.

(Syns. C. rhamnifolia Presl., C. kraussiana Bernh.)

Family.

ULMACEAE.

Common Names.

Camdeboo or White Stinkwood.

Natural Distribution.

Widely distributed in South Africa from the Cape Peninsula to the Zoutpansberg, whence its range extends northwards as far as Ethiopia. It occurs on an exceptionally wide variety of sites, for it is found alike on coastal dunes and on mountain slopes 7,000 feet (2,134 m.) above sea level, in moist, high forest and on exposed, dry ridges on the fringes of the Karroo. It owes one of its common names in part to the Camdeboo Mountains in the Cape Province, but its wood bears no resemblance to Black Stinkwood from the Knysna Forests.

Provenance.

The origin of the seed used for trials at Lichtenburg and Potchefstroom is not recorded.

Description of the Species in its Native Habitat.

As might be expected, the species varies much in stature and habit depending upon the climatic and site conditions under which it grows. In the high forests of Zululand it becomes a lofty tree up to 80 feet (24 m.) tall, with a clean, straight hole as much as 3 feet (91 cm.) in diameter; in stream-bank forest under sub-humid conditions it grows to a lesser height but develops a beautiful, rounded, umbrageous crown; on dry, rocky hillsides, as in the valley of the Orange River about Bethulie, it tends to assume a low, shrubby habit.

Economic Importance in Country of Origin.

The tree is much cultivated for shade and ornament in streets, parks and gardens, but yields a good, moderately hard, tough wood with superior bending properties. Of pleasing appearance, this is light in colour, with darker markings. It is generally considered to be one of the most useful of native hardwoods, being suitable, amongst other things, for furniture.

Trials in the Arboreta at Lichtenburg and Potchefstroom.

At Lichtenburg, the plot was established in 1907, when 12-month-old plants 12 inches (30 cm.) high, which had been raised from "local seed", were set out at an espacement of 6 x 6 feet (2 x 2 m.)

From the start the trees made very bad growth and were described, two years after planting, as "just existing". In 1913, their average height was about 3 feet (1 m.)

Several trees died from drought in 1920, and the rest seemed scarcely more promising than before. No improvement took place in the years which followed, and by 1926 practically all were dead.

The trial at Potchefstroom was commenced in 1908, when plants of the identical age and size as those used at Lichtenburg were put out at the same espacement.

The entire block failed and had to be replanted in 1909. The following winter, 46 of the new trees were killed to the ground by frost, and further damage caused by the same agency was experienced in 1911 and 1912. A year later, the unthrifty appearance of the stand, which by then measured 6 feet (2 m.) in height, was attributed to drought.

Over the next two years a few of the trees made rather better growth but the stand was again hit by drought in 1917. Although some improvement was noted in 1920 and



CELTIS AFRICANA : POTCHEFSTROOM

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1921, the condition of the trees gradually deteriorated from that time onwards. In 1959, the few survivors were multi-stemmed and of very poor form, though apparently healthy and averaging about 20 feet (6 m.) in height.

Discussion of Results.

In the absence of precise knowledge of the origin of the seed used for these trials, the results can probably not be regarded as conclusive. At best, however, conditions in the western Transvaal must be considered marginal for the species, and planting cannot be recommended unless some protection can be given to the trees against frost and drought.

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Celtis australis Linn.Family.

ULMACEAE.

Common Name.

Nettle Tree.

Natural Distribution.

Widely distributed in the Mediterranean region, its range extending thence eastwards through Asia Minor, the Caucasus and Iran to Nepal in the western Himalaya (Streets, 1962). In the areas bordering the Mediterranean Sea it is found mainly on plains and hillocks in the lowlands, though it occasionally climbs the mountains to an altitude of 3,000 feet (910 m.); in the Middle East it occurs under uniformly dry conditions from sea level up to about 5,000 feet (1,520 m.); in the Himalaya it occupies a wide variety of sites from swamps to dry, rocky slopes, and ascends to an elevation of 8,000 feet (2,438 m.)

Provenance.

Seed for the trial at Potchefstroom appears to have been obtained from one or other seed merchant without any details as to where it was collected.

Description of the Species in its Native Habitat.

A tree of moderate size, usually 50 to 70 feet (15 to 21 m.) in height and 10 feet (305 cm.) in girth, though the trunks of very old specimens have been known to reach twice this circumference (Elwes and Henry, 1906-13).

Economic Importance in Countries of Origin.

The tree yields a tough, strong, elastic timber which is used for oars, tool handles and agricultural implements. Its foliage is fed to cattle in the more arid parts of its range and its seeds contain a sweet oil (Elwes and Henry, 1906-13).

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Trial in the Arboretum at Potchefstroom.

The trial was commenced in 1908, when 81 plants, 2 feet (61 cm.) high and about 2 years old were put out at an espacement of 6 x 6 (2 x 2 m.)

Many blanks required filling at the end of the first winter, and this operation was repeated in 1911, - on both occasions without success. Notwithstanding this, the survivors of the original planting grew fairly vigorously and reached a height of 12 feet (4 m.) by 1915.

The subsequent history of the trial is one of periods of retrogression, during which the trees died back in the crown, alternating with periods of renewed growth. This continued up to 1959, when the general canopy level of the stand had risen to 24 feet (7 m.) The trees at that stage appeared healthy but were slightly stag-headed and very intricately branched.

Discussion of Results.

C. australis would seem to be slightly hardier than the native species described in these pages, and is therefore to be preferred for roadside planting and for use in other situations where only a minimum of attention can be bestowed upon it. On the other hand, as a lawn tree in parks and gardens it cannot match the graceful appearance and full, rounded crown of the latter, which is therefore to be preferred when circumstances permit its use.



CELTIS AUSTRALIS : POTCHEFSTROOM

Chilopsis linearis ( Cav.) Sweet.

(Syn. C. saligna Don.)

Family.

BIGNONIACEAE.

Common Names.

Flowering or Desert Willow.

Natural Distribution.

A native of North and Central America, where it occurs from western Texas to southern California in the United States and from Baja California and Sonora to Tamaulipas, Zacatecas and Durango in Mexico (Standley, 1920-24).

Provenance.

No information available.

Description of the Species in its Native Habitat.

A slender shrub or small tree, sometimes 30 feet (9 m.) tall, with a short trunk 12 inches (30 cm.) in diameter. Its leaves bear a strong resemblance to those of some willows (ibid.)

Economic Importance in Countries of Origin.

The species is often cultivated for the sake of its showy, sweetly scented flowers. It yields a soft, weak, close-grained, dark brown wood which is sometimes used for fence posts; its tough, slender branches are employed for weaving baskets, and sundry medicinal properties are attributed to its flowers.

Trial in the Arboretum at Lichtenburg.

One hundred and seven plants 2 years old but only 6 inches (15 cm.) high were put out at an espacement of 6 x 6 (2 x 2 m.) in March, 1912.

In September the following year it was estimated that 65 per cent of the young trees had died off, and the remainder did not look healthy. Further losses were caused

by frost and drought a year later, and by 1916 the last of the survivors had succumbed.

Discussion of Results.

The climate of the western Transvaal would seem to be too harsh for this rather desirable, ornamental tree. However, in the absence of any information on the provenance of the seed supplied to Lichtenburg no definite conclusions can be reached, for over parts of its range the species occurs in a Mediterranean-type climate with little or no frost. It is by no means unlikely that seed from specially selected localities might fare considerably better in the Lichtenburg and Potchefstroom areas, failing which the tree might still be tried under garden conditions.

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Cupressus arizonica Greene.

Plots were established in both the Lichtenburg and Potchefstroom Arboreta under this name. That at the latter centre is now known to be C. glabra Sudw., and is dealt with in due sequence. At Lichtenburg all the trees have died off, and re-identification is thus not possible.

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Cupressus glabra Sudw.(Planted for C. arizonica Greene.)Family.

CUPRESSACEAE.

Common Names.

Smooth Arizona Cypress.

Natural Distribution.

Confined to central Arizona, U.S.A., where it is found from Oak Creek Canyon in Coconino County to the Mazatzal Mountains in Gila County some 80 miles (128 k.m.) to the south (Wolf and Wagener, 1948). Its principal occurrence is along the drainage system of the Verde River at an altitude of 4,000 to 5,000 feet (1200 to 1500 m.)

Provenance.

In view of the confusion which has existed between this species and C. arizonica, no reliance can be placed on the old records of the Transvaal Forestry Division.

Description of the Species in its Native Habitat.

A small tree, usually 20 to 45 feet (6 to 14 m.) tall though occasionally reaching a height of 60 feet (18 m.) with a diameter of up to 3 feet (91 cm.) (ibid.) Its crown is densely-foliaged and may have a spread of 35 feet at maturity, but in the case of young specimens is compact and ovate-conic in shape. One of the most easily recognised characteristics of the tree, which at once distinguishes it from C. arizonica, is its smooth, non-fibrous, grey to cherry-red bark, which exfoliates in thin layers or plates. Its foliage is very glaucous and possesses active resin-secreting glands.

Economic Importance in Country of Origin.

The principal use of this species is for fencing posts, both small trees and the branches of larger ones being

utilised. The natural durability of such posts appears to vary somewhat, but those which contain a high proportion of heartwood last for many years (ibid.)

#### Trial in the Arboretum at Potchefstroom.

The trial was commenced in February, 1908, when 81 plants 9 inches (23 cm.) high and 18 months old were put out at a 6 x 6-foot (2 x 2 m.) espacement.

The young plants stood their first winter in the field very well, and at no time during the course of the trial were losses from frost or drought reported. Growth was quite vigorous, and by 1918 the trees had a mean height of 20 feet (6 m.) That year they were pruned to 5 feet (1.5 m.)

Progress continued to be satisfactory, and in 1927 the 80 trees on the plot had reached a mean height of 35 feet (11 m.) It was observed at the time that the stand needed thinning (this was already very much over-due by present-day standards) and attention appears to have been given to the matter for, in 1958, only 30 trees remained. These were still healthy and had an average D.B.H. of 9.4 inches (24 cm.) and a height of 51 feet (16 m.) But for a tendency to lean, their form was good. They had fairly narrow crowns and their purplish bark was distinctly ornamental.

#### Discussion of Results.

This tree, which occurs naturally under a rigorous climate, has proved quite one of the hardiest cypresses under South African conditions. From Belfast on the eastern highveld to Lobatsi in Botswana it has amply demonstrated its ability to withstand severe frost as well as long periods of oppressive heat and drought. It is thus one of the most suitable members of the genus for planting



CUPRESSUS GLABRA : POTCHEFSTROOM

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in the western Transvaal, both for ornament and for shelter. Nor are these the only purposes for which it can be used, for its also widely cultivated as a hedge plant.

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Cupressus lindleyi Klotzsch.

(Planted as C. lusitanica Mill.)

Family.

CUPRESSACEAE.

Common Names.

Mexican Cypress.

Natural Distribution.

A tree of Central America, where it occurs in Mexico, Guatemala, El Salvador and Costa Rica (Wolf and Wagener, 1948). It is found chiefly in the higher mountain ranges at an altitude of 6,000 to 10,000 feet (1,828 to 3048 m.), preferring areas of high rainfall or moist, valley bottoms (Martinez, 1947).

Provenance.

The early records of the Transvaal Forestry Division are rather confused, but it would seem that the seed sown at Potchefstroom for trial in the Arboretum was either collected at Ermelo in the eastern Transvaal or else was supplied by an overseas seed merchant.

Description of the Species in its Native Habitat.

A fine tree up to 100 feet (30 m.) in height and 12 feet (366 cm.) in girth, with an erect, straight bole, a dense broadly conical crown and gracefully pendulous branchlets.

Economic Importance in Countries of Origin.

The species yields a pale yellow timber of good quality which is used both for constructional purposes and for pulp. The tree grows rapidly and is much planted in parks and gardens, lending itself, among other things, to topiary work.

Trial in the Arboretum at Potchefstroom.

Eighty-one plants 15 months old and 9 inches

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(23 cm.) high were set out at an espacement of 6 x 6 feet ( 2 x 2 m.) in February, 1908.

In August that year it was reported that the trees had stood the winter well but that 60 per cent of them appeared to be "sports". These were replaced in March, 1909, but later in the year 38 more were removed for the reason already given. Even then, doubts were expressed as to whether all the remaining trees were quite typical of the species.

For several years early spring growth was caught by frost, but the trees nevertheless made vigorous growth and reached an average height of 16 feet (5 m.) in 1914. Six years later, 6 suppressed specimens were cut out in the middle of the plot, but the rest continued to do well and were pruned to 6 feet (2 m.) in 1918. From then onwards, however, the condition of the stand began to deteriorate and it seemed to be suffering from drought. Intermittent failures occurred and by 1927 only 44 survivors were left, the mean height of which was 30 feet (9 m.) Two years later, 14 of these had succumbed.

When the plot was inspected in 1959, 9 trees remained, representing a stocking of 134 stems per acre (330 per hec.). Only one of these was still healthy, the rest having dead tops and a moribund appearance. One was quite dead. The stand had a mean D.B.H. of 10.0 inches (25 cm.) and a height (including dead tops) of about 40 feet (12 m.).

#### Discussion of Results.

In the moister parts of South Africa, C. lindleyi has been planted quite extensively for timber production. It succeeds best in the cooler-temperate, humid zone of the

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summer rainfall area. where its rate of growth sometimes rivals that of the faster-growing pines. It is not, however, resistant to drought and is quite unsuitable for planting in the western Transvaal except under garden conditions or near water. Although it is said to have been touched by frost at Potchefstroom between the years 1910-1914, it is, in fact, exceedingly frost-hardy, and is unlikely to be seriously affected by cold anywhere in this country. Its potential uses in the western Transvaal are necessarily limited to shade and ornament, but for these purposes it is one of the best members of the genus provided that its moisture requirements can be met.

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Cupressus macrocarpa Hart. ex G. Gord.

Family.

CUPRESSACEAE.

Common Name.

Monterey or Lemon-scented Cypress.

Natural Distribution.

This species has an extraordinarily limited natural range. A native of California, U.S.A. it occupies a strip of land two miles (3.2 km.) long and two hundred yards (180 m.) wide along the coast south of the Bay of Monterey. It also occurs at Point Lobos. Despite its restricted distribution it has been cultivated with marked success all along the Pacific seaboard as far north as Vancouver, and has acclimatised itself to conditions in many other parts of the world.

Provenance.

No details concerning the seed used either at Lichtenburg or Potchefstroom can be obtained from the records of the Transvaal Forestry Division.

Description of the Species in its Native Habitat.

A tree up to 70 feet (21 m.) tall and 20 feet (6 m.) in girth, with a broadly-conical crown becoming much flattened at maturity (Streets, 1962). It withstands strong off-sea winds and grows right down to the water's edge, though in such situations it is inclined to assume a picturesquely distorted habit.

Economic Importance in Country of Origin.

The tree is of value for shelter near the sea and yields a fairly heavy, fine-grained, aromatic timber. This, though very durable, is not much used on account of its knottiness (ibid).

Trials in the Arboreta at Lichtenburg and Potchefstroom.

The plot at Lichtenburg was established in 1906,

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using plants 12 months old and 9 inches (23 cm.) high.

Almost from the outset the young trees proved susceptible to frost and drought, and only 39 of them survived until 1910, when their height was 6 feet (2 m.) No improvement took place in the years which followed, for the stand developed a sickly appearance and continued to suffer from both drought and frost. By 1923, the number of living trees had dropped to 16, and 4 years later almost all of these were dead.

At Potchefstroom the species was tried as a hedge plant, together with five other cypresses, a juniper and a pine.

The plants suffered severely at intervals from frost and drought, and within 14 years most of them had died. After a further interval of 6 years only two still lived.

#### Discussion of Results.

The species is obviously unsuited to conditions in the western Transvaal. Coming, as it does, from the Californian littoral, where frost is light or absent, where most of the precipitation occurs in winter and where sea fogs are common, this is no more than might have been expected. Hutchins' precept of "climatic fitness" seems to have been totally disregarded in the present instance, and the results fully vindicate his views on the subject.

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Cupressus sempervirens Linn. -

including the varieties horizontalis (Mill.) Gord. and stricta Ait. (syns. fastigata DC. and pyramidalis O. Targioni-Tozzetti).

Family.

## CUPRESSACEAE.

Common Names.

Mediterranean or Common Cypress (var. horizontalis);  
Churchyard or Italian Cypress (var. stricta).

Natural Distribution.

A native of the Mediterranean region, where its range extends from Greece and Cyprus, through the Taurus Mountains in Turkey to Syria, the Lebanon, Jordan, Israel and northern Iran (Dallimore and Jackson, 1961). It is believed to have been introduced into Italy and Crete in ancient times, and its two varieties have been recognised from the earliest period of recorded history.

Provenance.

The seed of the variety horizontalis used at Potchefstroom was supplied by the Conservator of Forests, Cape Town, while that of var. stricta sown at the same centre was purchased from Messrs. Vilmorin-Andrieux of Paris. The stocks supplied to Lichtenburg may well have originated from the same two sources, but this cannot be established with certainty.

Description of the Species in its Native Habitat.

In the Mediterranean region the species reaches immense age, sometimes attaining a height of 150 feet (46 m.) and a girth of 10 feet (305 cm.) in cultivation. However, it seldom becomes taller than 100 feet (30 m.) in the wild state (Streets, 1962). The varieties horizontalis and stricta are both found in the natural forests. These

can be distinguished only by their habit, the former having horizontal branches and a narrowly-conical crown, and the latter being fastigiately branched.

Economic Importance in Countries of Origin.

The timber of this tree has been prized from ancient times. It is moderately hard, close grained, fragrant, easy to work and very durable. Its uses include building construction and furniture especially chests (Streets, loc. cit.)

Trials in the Arboreta at Lichtenburg and Potchefstroom.

At Lichtenburg, the two varieties were planted in intimate mixture in a plot established at an espacement of 6 x 6 feet ( 2 x 2 m.) in 1907/08.

In September, 1910, 10 trees were killed to the ground by frost, and 4 years later 12 more died back as a result of drought. Drought accounted for another 12 trees the following year and for 54 more the year after that. Nor were these losses the last, for 30 more fatalities resulted from the combined effects of frost and drought in 1920, followed by another 4 in 1921 and yet another 4 in 1922. The growth of the survivors was slow and their form rather poor.

Only 8 trees remained in 1959, 7 of which were of the variety horizontalis. The average height of the 8 trees taken together was 22 feet (7 m.) and their mean D.B.H. was 9.5 (24 cm.) inches. Their appearance could scarcely be described as ornamental, for the larger specimens contained a good deal of dead wood, especially towards the top.

At Potchefstroom, the varieties were kept apart in separate plots, which were established in February, 1908, at an espacement of 6 x 6 feet (2 x 2 m.), using plants 9

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inches (23 cm.) high and 15 months old.

Trees of the variety horizontalis suffered from neither frost nor drought in the years immediately after planting and maintained a reasonable rate of growth, reaching an average height of 20 feet (6 m.) in 1918. A few deaths were recorded in 1920 and 1921 from causes unspecified, but 77 out of the original total of 81 trees remained alive in 1927, when their mean height was 45 feet (14 m.) Some failures occurred the following year and again the year after that, and the need for thinning was commented on.

In 1959, 23 trees were found on the plot, representing a stocking of 343 stems per acre (847 per hec.). The average D.B.H. of these was 9.5 (24 cm.) inches and their height was 62 feet (19 m.) The stand had a pleasing appearance and the form of the trees was good but for the fact that some were slightly sinuous near the base. Their crowns were symmetrical and often almost columnar, and their branches short and regular. Most of them were still healthy, but several were dead.

The variety stricta came through its first winter without mishap, though 3 trees died unaccountably during the winter of 1909 and 4 more succumbed the following year. For some time they were affected by neither drought nor frost and made quite vigorous growth, attaining a mean height of 9 feet (3 m.) by 1910. In 1918 their height had increased to 25 feet (8 m.) and they were described as being in a flourishing condition.

A single tree died off in 1920, but the rest continued to make very good progress and reached a mean height of almost 50 feet (15 m.) in 1927. As in the case of the previous trial, the need was undertaken, for only 19 trees

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were left on the plot in 1959. These were multi-stemmed and had an average height of 49 feet (15 m.) One had considerably outgrown the rest, and elsewhere on the plot an open gap had appeared.

#### Discussion of Results.

The Results of the trials at the two centres are a little inconsistent. The gradual dying off of the trees at Lichtenburg over a long period indicates that the species is not adapted to the local climate. This accords with Hutchins' views on the unsuitability of trees from the Mediterranean region for planting in the Transvaal. On the other hand, the plots of the two varieties at Botchefstroom both made good growth and seemed well able to withstand the conditions to which they were exposed.

With regard to the varieties themselves, var. horizontalis would seem to be, if anything, slightly hardier as well as more vigorous than var. stricta, although there is little to choose between them.

C. sempervirens is one of the hardier species of cypress, and its planting in the western Transvaal for ornament can be recommended.

It is also suitable for shelterbelts, but whether it can be considered dependable enough for this purpose in the area is more open to doubt.

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Cupressus torulosa D. Don.

Family.

CUPRESSACEAE.

Common Names.

Himalayan Cypress.

Natural Distribution.

A tree of the western Himalaya, occurring from Chamba to Nepal at an altitude of 6,000 to 9,000 feet (1,828 to 2,743 m.) mostly on hot, dry slopes where few other species grow. It is also reported from China along the arid, upper reaches of the Tung River at an altitude of between 5,000 and 8,000 feet (1,520 to 2,438 m.) (Streets, 1962).

Provenance.

No indication exists as to the origin of the stock used at Lichtenburg, but that supplied to Potchefstroom appears to have been obtained from the French seed merchants, Messrs. Vilmorin Andrieux.

Description of the Species in its Native Habitat.

In the western Himalaya, C. torulose becomes a very large and graceful tree, occasionally growing to a height of 150 feet (46 m.) and a girth of 20 feet (6 m.) though often no more than 100 feet (30 m.) tall and 8 feet (244 cm.) in girth.

Economic Importance in Countries of Origin.

The species yields a moderately hard, fragrant and very durable timber which, in the Himalaya, is used chiefly for building construction (ibid.) In other parts of India the tree is much planted for amenity purposes.

Trials in the Arboreta at Lichtenburg and Potchefstroom.

At Lichtenburg, a trial plot was planted up in 1906 at an espacement of 6 x 6 feet (2 x 2 m.), using 9-

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inch-high (23 cm.) nursery stock 18 months of age.

The young trees made good growth at the start and had reached an average height of 9 feet (3 m.) by August, 1909. The following year some of them seemed to be dying off as a result of frost or drought, but this was not the case, for all recovered and were reported to be looking quite healthy in 1912. In September a year later the most vigorous of them had grown to a height of 18 feet (5 m.)

At this point, the early promise shown by the plot came to an abrupt end for, in 1914, 13 trees died to the ground and the tops of others commenced to die back. This process continued throughout 1915, and the following year only a few trees were left, the rest apparently having been killed by drought. A couple of survivors struggled on until 1926, but by 1928 these, too, had succumbed.

At Potchefstroom, 81 plants 1 foot (30 cm.) high and 2 seasons (sic) old were set out at an espacement of 6 x 6 feet (2 x 2 m.) in January, 1908.

The young trees stood their first two winters well but were badly injured by late frost in 1910, those in the centre of the plot being worst affected. Few, however, were killed outright, and vigorous growth commenced again from side branches. In 1913, the plot suffered slightly from drought before the onset of the spring rains.

For a good many years thereafter the stand remained healthy and made fair growth. In 1923, its foliage turned yellow, evidently as a result of drought, but recovery was complete within 2 years. Seventy-five trees averaging 30 feet (9 m.) in height, still remained on the plot in 1927 and at this stage the need for thinning was remarked, on. Shortly afterwards, however, a severe drought set in and many of them began to die off. This went on into 1929, when few healthy specimens remained.

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At the time of the last inspection, in 1959, 5 trees survived, of which the mean D.B.H. and height were, respectively, 9.3 inches (24 cm.) and 45 feet (14 m.) Two of these had died back extensively in the crown, but their form was moderately good.

#### Discussion of Results.

C. torulosa has long enjoyed a reputation in South Africa of extreme hardiness to frost and drought. The disappointing results obtained at Lichtenburg and Potchefstroom call for a re-appraisal of its usefulness in cold, dry areas.

At Belfast, Plantation, on the eastern Highveld, where temperatures in winter drop appreciably below those at Potchefstroom, three plots of C. torulosa established at different times in the arboretum were quite unaffected by frost. At Jessievale Plantation, where minimum temperatures are much the same as at Potchefstroom, the species was untouched by frost in the arboretum, and only in lower-lying parts of the plantation has it ever sustained damage. The tree is thus able to withstand a great deal of frost, and the fairly extensive injury caused to the stand at Potchefstroom in its third year must be attributed to freak conditions.

On the score of drought-hardiness, there is little to be said in mitigation of the poor performance of the species both at Lichtenburg and Potchefstroom. It is therefore concluded that the tree is unsuitable for planting in dry areas except for ornament in parks and gardens, where it will receive extra moisture.

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Eucalyptus amygdalina Labill.

A plot established as E. amygdalina in the Arboretum at Potchefstroom failed completely. This name was applied at the time to a complex of several, closely-related species, and the exact identity of the trees concerned can no longer be determined.

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Eucalyptus bosistoana F. Muell.

Family.

MYRTACEAE.

Common Name.

Bosisto's Box.

Natural Distribution.

A native of the coastal districts of Victoria and Southern New South Wales, where it is always found within a distance of 40 miles (64 km.) from the sea. Its main occurrence is at low altitudes, and only towards the northern limit of its range does it ascend to 1,000 feet (300 m.) above sea level. The mean annual rainfall throughout the area is 25 to 40 inches (635 to 1,000 mm.) and is fairly well distributed, though in the south the winters are wetter than the summers. Frosts are infrequent. The species shows a marked preference for the better quality soils, such as fertile loams overlying limestone, but will grow on both wet and dry sites (Hall and Johnston, 1953).

Provenance.

The seed supplied to Lichtenburg was collected from trees in the Arboretum at Pan Plantation in the eastern Transvaal. These had been grown from seed received from Prof. J.H. Maiden of Sydney, New South Wales.

Description of the Species in its Native Habitat.

Unlike other eucalyptus belonging to the "Box" group, E. bosistoana is a true forest tree. Its form is generally good and it reaches large dimensions, attaining a height of up to 150 feet (46 m.) and a diameter of 3 feet (91 cm.) under favourable conditions.

Economic Importance in Country of Origin.

The tree yields a heavy, very strong, very durable timber with a uniform texture and somewhat interlocked grain.

This is in demand for constructional work, harbour piles, railway sleepers, poles and fuel, but is not in very free supply.

Trial in the Arboretum at Lichtenburg.

The adjacent plots were established at an espacement of 6 x 6 feet ( 2 x 2 m.) in September, 1920.

All the trees were killed to the ground by frost during their first winter. One of the plots was replanted with the same species in the spring, but a year later only 6 trees were still alive. By 1925, these, too, had died off.

Discussion of Results.

*E. bosistoana* is clearly unsuited to the climate of the western Transvaal, and further trials in the area would serve no useful purpose.

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Eucalyptus bridgesiana R.T. Bak.(Syn. E. stuartiana F. Muell.)Family.

MYRTACEAE.

Common Name.

But But.

Natural Distribution.

Widespread on the tablelands and along the western slopes of the Dividing Range in New South Wales, whence its range extends a short distance into Queensland and eastern Victoria. Its altitudinal range is between 500 and 3,500 feet (150 and 1,070 m.) above sea level. Summer temperatures are fairly high, though the winters are frosty. The mean annual rainfall varies from 25 to 45 inches (635 to 1,140 mm.) a year and is fairly well distributed, though higher during the winter months in the south and during the summer months in the north. Occasional falls of snow are experienced in winter. Characteristically, the species is found in valleys on alluvial soils of a somewhat heavy type or on the lower slopes of mountains and hills, where it occurs in open, savanna-like formations (Hall and Johnston, 1953).

Provenance.

Seed for the trial at Lichtenburg was received through a certain Mr. Baikie from Mr. Murphy of Woy Woy, New South Wales.

Description of the Species in its Native Habitat.

A tree 40 to 70 feet (12 to 21 m.) tall and 2 feet (61 cm.) in diameter under average conditions, but somewhat larger on particularly favourable sites. Its bole is inclined to be short and poorly developed and its crown heavily branched, though umbrageous.

/.....

Economic Importance in Country of Origin.

The tree is an excellent one for shade and ornament, but its timber is brittle and of no commercial value. Both nectar and pollen are yielded by its flowers.

Trial in the Arboretum at Lichtenburg.

The plot was established early in 1908 at an espacement of 6 x 6 feet, using plants one year old and 12 inches (30 cm.) high.

The young trees proved extremely hardly to frost and made rapid early growth, reaching an average height of 27 feet (8 m.) by 1913. Two of them died of drought the following year, however, and many more began to show signs of distress.

A light thinning was carried out in 1918, following which the condition of the stand improved for a while, but 5 more trees died off in 1920. Three years later, the standards on the outside of the plot were described as being straight and having large crowns but those nearer the middle as being very lanky.

A second thinning was undertaken in 1924, notwithstanding which 3 more, weakly trees were killed by borers over the next 2 successive years. In 1929 a third thinning was given, when stag-headed specimens and all coppice shoots were removed.

For some years thereafter the stand looked healthy and put on fresh growth. However, the larger trees commenced to die off again in 1938, and, by 1939, only coppice remained on the plot. This was of poor form and was restricted to about one-half of the total number of stumps.

Discussion of Results.

E. bridgesiana is a tree of pleasing appearance

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and is eminently suitable for shade and shelter because of its dense, relatively spreading crown. It is, however, clearly too sensitive to drought to be planted in the form of woodlots in the western Transvaal, added to which its wood is less useful, even for fuel, than that of other species which can be grown successfully in the area.

/.....

Eucalyptus caleyi Maid.Family.

MYRTACEAE.

Common Name.

Caley's Ironbark.

Natural Distribution.

Widely scattered, though nowhere abundant, on the western slopes of the Dividing Range in central and northern New South Wales and southern Queensland. It ascends to higher elevations than any other Ironbark, its altitudinal range being from about 1,000 to 3,000 feet (300 to 900 m.) The annual rainfall is about 25 to 30 inches (635 to 760 mm.) a year, most of which occurs in summer. (Maiden, 1909-1931).

Provenance.

Seed for the trial at Lichtenburg was collected at Howell in New South Wales.

Description of the Species in its Native Habitat.

A glaucous tree of medium size, usually reaching a height of between 60 and 80 feet (18 and 24 m.) and a diameter of from 2 to 4 feet (60 to 122 cm).

Economic Importance in Country of Origin.

The tree yields a red, heavy, hard, durable wood which is marketed with that of other Ironbarks. Honey produced from its flowers is of a choice grade and is comparable with that derived from E. melliodora. The tree is, however, considered to be of more use for ornament than for any economic purpose.

Trial in the Arboretum at Lichtenburg.

The trial was commenced in 1934. No other detail is recorded.

The young trees developed a bushy habit and were badly frosted in 1936 and 1937, when their average height was still about 6 feet (2m.) Their vigour subsequently

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EUCALYPTUS CALEXYI : LICHTENBURG

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improved, however, for by 1942 their average height had increased to 15 feet ( 5m.)

When the plot was last inspected, in 1959, 83 trees still remained of which the mean height was 38 feet (12 m.) and the mean D.B.H. 4.9 inches (12 cm.). These were healthy but slightly crooked, and numerous, characteristically narrow forks occurred at all heights. Their branches were light and their crowns thin. The stocking was slightly depleted towards the centre of the plot, but the species nevertheless showed evidence of being very hardy to drought.

#### Discussion of Results.

E. caleyi has been little planted in South Africa, and a satisfactory assessment of its potentialities is therefore difficult to make. Although very hardy to drought, it appears to have no advantage in this respect over E. crebra or E. sideroxylon, neither does it appear to be any more frost-resistant or vigorous. In the circumstances, there is little reason to plant it more extensively.

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Eucalyptus camaldulensis Dehn.(Syn. E. rostrata Schlecht.)Family.

MYRTACEAE.

Common Name.

River Red Gum or Rostrata Gum.

Natural Distribution.

The most widely distributed of all the eucalypts, E. camaldulensis is found in every State of Australia except Tasmania, Its principal occurrence, however, is along the Murray River and its tributaries and in the lowlands of south-western Victoria. Over most of its range it is found at an altitude of between 100 and 750 feet (30 and 228 m.) above sea level, but in the tropics it ascends to 2,000 feet (610 m.) The rainfall tends to be heavier during winter in the south-west but during summer in the north-east, and throughout most of the area is about 10 to 25 inches (250 to 380 mm.) per annum. The tree frequently occupies flood plains and badly drained flats which stay moist for several months in the year, reaching its best development on silty soils of good depth (Hall and Johnstone, 1953).

Provenance.

One of the two stocks sown at Lichtenburg (which may also have been used for the trial at Potchefstroom) was obtained from Prof. Maiden, and presumably originated from New South Wales. The other stock sent to Lichtenburg was collected in South Africa by the Conservator of Forests, Umtata.

Description of the Species in its Native Habitat.

E. camaldulensis, like most riverain and savanna species, is inclined to develop an umbrageous crown and a

short, thick bole. Nevertheless, it grows to fairly large size, often reaching a height of 80 to 120 feet (24 to 37 m.) and a diameter of 3 to 7 feet (91 to 213 cm.) (ibid.)

Economic Importance in Country of Origin.

The wood of this species is reddish in colour, hard and durable, and has an interlocked grain. In Australia, it is used, either hewn or sawn, for many purposes. The tree is also highly esteemed by bee keepers, and flowers almost all the year round.

Trials in the Arboreta at Lichtenburg and Potchefstroom.

E. camaldulensis is represented by three plots in the Lichtenburg Arboretum, of which two were established in the same year and probably originated from the selfsame seed stock. As these adjoin one-another, they are treated as one plot. This double plot was planted up in 1905/06 at an espacement of 6 x 6 feet (2 x 2 m.) using stock 9 inches (23 cm.) high which had been raised over the preceding 12 months in the local nursery.

In common with all other eucalypts in the Arboretum, the young trees suffered from frost during the winter of 1907, though not to the extent that many did. A few trees were frosted again in 1912, but the stand nevertheless made rapid growth and by 1913 had attained an average height of 25 feet. (8 m.) This had increased to 33 feet (10 m.) in 1918, when a thinning was carried out.

Two years later the trees suffered very severely from the combined effects of frost and drought, and three large specimens died off. Frost damage recurred in 1922, 1926 and 1937, and the stand was again affected by drought in 1941.

When last inspected, in 1959, the trees on the two



**EUCALYPTUS — CAMALDULENSIS — • POTCHEKSTROOM**

plots taken together had a mean D.B.H. of 7.8 inches (20 cm.) and a mean height of 51 feet (16 m.) The mean stocking per acre was 495. Their boles were slightly crooked and had a tendency to fork, while their crowns were rather ragged in appearance. The centre of each plot was somewhat open, though not entirely devoid of large trees.

The third plot at Lichtenburg was established a year later than the first two, but at the same espacement and using nursery transplants of the same size.

At first the trees were very bushy, but in 1911 they were reported to be "making nice, straight stems". This plot, unlike the others of the species, was not damaged by frost the following year, and had attained an average height of 18 feet (5 m.) by 1913. Five years later it had reached a height of 28 feet, (8 m.) and a thinning was carried out.

In 1920, 6 trees were killed to the ground by frost and the rest of the stand was badly injured. Four more losses occurred in 1923, and thereafter the plot suffered periodically from frost up to 1937. Despite these setbacks, a fair rate of growth was maintained, and the trees had a healthy appearance.

When the Arboretum was last inspected in 1959, 48 trees remained on the 0.1-acre (0.004 hec.) plot, together with much coppice re-growth. The former had a mean D.B.H. of 7.3 inches (18 cm.) and a height of 43 feet (13 m.) but were of mediocre form, for their boles were slightly crooked and sometimes forked, while their branches were inclined to be heavy. In contrast to the other plots of the species, the stocking towards the centre was quite good and the innermost trees were of fair size.

At Potchefstroom, the trial was commenced early in 1908, adopting the same initial espacement and size of planting stock as had been used at Lichtenburg.

From the very outset the young trees successfully withstood the frost, and only in 1913 did they ever seem to be suffering from drought. In that same year, they reached a mean height of 30 feet (9 m.), which, by 1914, had risen to 35 feet (11 m.). This vigorous growth continued and thinnings were undertaken in 1922, 1924 and 1926.

In 1959, 13 trees (equivalent to a stocking of 194 stems per acre (479 per hec.) were left on the area. These had a mean D.B.H. of 21.3 inches (56 cm.) and a height of no less than 99 feet (30 m.) Their form, although quite typical of the species, was none too good, but they still appeared healthy and their progeny was invading an adjacent, vacant plot.

#### Discussion of Results.

E. camaldulensis is probably the most extensively cultivated of all eucalypts in the drier parts of South Africa - more particularly in the summer rainfall area, where it has won the confidence of farmers to an extraordinary degree.

The results of the trials at Lichtenburg and Potchefstroom are not altogether consistent, and in Australia it has been observed that there exists a "marked difference between strains of the species in resistance to drought" (ibid.) In a tree with so wide a natural distribution, it is probable that different strains also vary considerably in their resistance to frost.

While the species is probably not as hardy to frost as E. pauciflora, E. sideroxylon or E. viminalis nor

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as drought-resistant as E. bicolor, E. microtheca or E. polyanthemos, it probably combines frost and drought hardiness as effectively as almost any other eucalypt. When grown in small plots its form leaves something to be desired, for the outer trees tend to lean towards the light while those in the middle are often whippy and crooked. Forks and heavily-branched crowns are also apt to be numerous. As an ornamental tree its bark is often picturesque, especially on the north exposure, in cold districts where it acquires a salmon-pink or orange tint. Taking all factors into consideration, E. camaldulensis is a very good, general-purpose, utility tree for dry, cold districts, and is suitable for woodlots, shelterbelts, avenues and many other purposes.

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Eucalyptus conica Deane et Maid.

Family.

MYRTACEAE.

Common Name.

Fuzzy Box.

Natural Distribution.

A native of New South Wales and southern Queensland, where it occurs over much of the country to the west of the Dividing Range, occupying alluvial or sometimes swampy flats and light, granitic soils. Often it is found in mixture with other eucalypts such as E. hemiphloia or else with Callitris glauca (Maiden, 1909-31; Robertson, 1926; Streets, 1962).

Provenance.

The seed used to establish a plot at Lichtenburg was collected by Murphy at Tullamore in central New South Wales, and was supplied by the Botanic Gardens, Sydney.

Description of the Species in its Native Habitat.

A small, graceful tree 30 to 50 feet (9 to 15 m.) tall, with pendulous branches (ibid.)

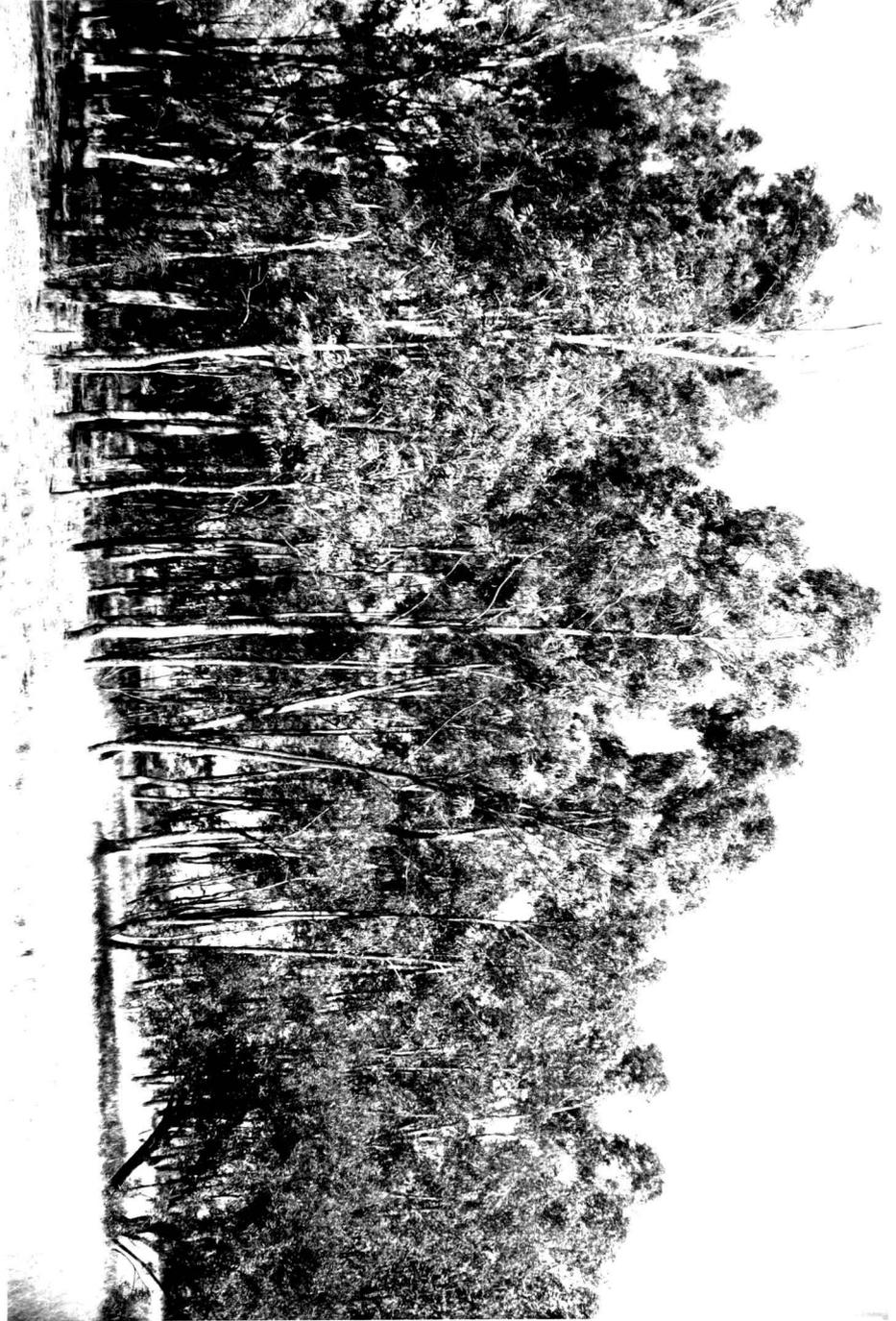
Economic Importance in Country of Origin.

The tree is a useful one both for ornament and timber production yielding a tough, durable, reddish-yellow wood (ibid.)

Trial in the Arboretum at Lichtenburg.

The plot was established in February, 1934, at an espacement unspecified.

Practically all the young trees survived the winter but, although healthy, were bushy in form. Three years later they still had an average height of only 4½ feet (1.5 m.) Their vigour subsequently improved, however, for by 1942 their mean height had increased to 25 feet (8 m.)



EUCALYPTUS CORNICA : LICHTENBURG

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A light thinning was carried out in 1953.

In 1959, 92 standards (representing a stocking of 920 stems per acre (3,270 per hec.) and a good deal of coppice remained on the area, the former having a mean D.B.H. of 5.0 inches (13 cm.) and a height of 38 feet (12 m.) The stocking of the plot was virtually complete, and some comparatively large trees existed near its centre, indicating that the species is completely hardy under the conditions obtaining at Lichtenburg. On the other hand the form of the trees left much to be desired, for, although very lightly branched, most of them were either forked or else had a pronounced sweep. Despite these defects the stand did not compare badly with others of the species in more humid parts of the country.

#### Discussion of Results.

Although extraordinarily hardy, this species has serious shortcomings, for its growth is relatively slow and its form is decidedly poor, added to which its foliage is rather sparse. It cannot, therefore, be recommended for shelterbelts, and its only use would seem to be for fuel in areas where other trees cannot be grown.

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Eucalyptus crebra F. Meull.

(Syn. E. racemosa Cav.)

Family.

MYRTACEAE.

Common Name.

Narrow-leaved Ironbark.

Natural Distribution.

More widely distributed than any other Ironbark, this species is abundant on the slopes of the Dividing Range in New South Wales and in the drier parts of Queensland. The climate is continental, with high temperatures (frequently exceeding 100°F (38°C.) in the shade) in summer and some frost in winter. Rain occurs mainly during the months of summer, the annual precipitation averaging, for the most part, 20 to 25 inches, (500 to 635 mm.) but rising to 60 inches (1,520 mm.) in some localities. The tree is particularly well adapted to sub-tropical, semi-arid conditions, and reaches its best development on heavy-loam soils (Blakely, 1955; Hall and Johnston, 1953).

Provenance.

The seed used for the trial at Lichtenburg was collected locally on the reserve, while that from which plants were raised at Potchefstroom was supplied by Prof. J.H. Maiden. Unlike most stocks received from the latter source, it seems to have been collected in Queensland and not in New South Wales.

Description of the Species in its Native Habitat.

A moderately large tree, typically 60 to 80 feet (18 to 24 m.) tall and 1½ to 2½ feet (45 to 76 cm.) in diameter, though bigger near the coast and somewhat smaller on poor soils in the interior. It normally develops a fairly straight bole and a symmetrical crown, with slender drooping branchlets (ibid.)

Economic Importance in Country of Origin.

The species has a hard, heavy, durable wood which is mainly used in the round for piles and poles or else hewn for sleepers and heavy, constructional timbers. In Australia it is considered to be one of the best Ironbarks for general purposes, yielding a fair quantity of nectar and making a fine tree for park-lands (ibid.)

Trials in the Arboreta at Lichtenburg and Potchefstroom.

The trial at Lichtenburg was commenced in March, 1921, when transplants raised in the nursery were put out at an espacement of 6 x 6 feet (2 x 2 m.)

Twenty of the young trees died of frost and drought during the winter of 1922, but the rest looked healthy. Three years later the whole stand appeared to be dead, but this was evidently not the case for, in 1936, its mean height was 25 feet (8 m.)

Thirty-one trees remained alive in 1959, representing a stocking of 310 stems per acre (765 per hec.) These were 7.1 inches (18 cm.) in diameter and 49 feet (15 m.) tall. Their form was better than that of any other eucalypt in the Arboretum, for they were straight-boled (though sometimes forked) and comparatively lightly branched. The stocking of the plot was patchy, though no worse in the centre than on the edges, suggesting that frost rather than drought was accountable for the failures.

The plot at Potchefstroom was established in 1908 at an espacement of 6 x 6 feet (2 x 2 m.), plants 7 months old and 9 inches (23 cm.) high being used for the purpose.

Right from the start, the young trees proved perfectly hardy to frost as well as drought. Their growth, too was good and their stems erect and straight. In 1914 they had an average height of 20 feet (6 m.) A thinning was carried out in 1926, and a year later the remaining trees



EUCALYPTUS CREBRA : POTCHEFSTROOM

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had attained an average height of no less than 70 feet (21 m.)

When the plot was last inspected, 1959, 13 standards were found (representing a stocking of 194 stems per acre (480 per hec.) together with a good deal of coppice. The former had an average D.B.H. of 12.6 inches (32 cm.) and a height of 86 feet (26 m.) Their form was very good, for their boles were straight, erect and quite lightly branched. Their foliage, although pendulous and fine, cast a fairly deep shade.

#### Discussion of Results.

E. crebra is a most desirable tree for planting in the western Transvaal. While as resistant to drought as most eucalypts and fairly hardy to frost, its form is superior to that of any other species that can be grown in the area. It is thus eminently suitable for the production of poles and posts of all descriptions, besides which it makes an excellent fuel. It can be used to advantage for wind-breaks, since it is not too quick to shed its lower branches when adequately illuminated<sup>min</sup> from the side. As an avenue tree it has few rivals.

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Eucalyptus cypellocarpa L. Johnson.

(Syn. goniocalyx F. Muell.)

Family.

MYRTACEAE.

Common Names.

Mountain Grey Gum or Spotted Mountain Gum.

Natural Distribution.

A native of Victoria and New South Wales. In the former State it occurs mainly to the south of the Dividing Range; in the latter it is found chiefly along the seaward edge of the southern and central tablelands, though sometimes also near the coast in the south and on scarps and tablelands in the north. It is thus principally a species of the mountains and their foothills, ascending to an altitude of 4,000 feet (1,220 m.). The rainfall over its range is normally reliable and averages 40 to 50 inches (1,000 to 1,270 mm.) a year. Very high temperatures are seldom experienced, but frosts are quite common in winter and light falls of snow sometimes occur. The tree is found on a wide range of soils, and tolerates infertile sand if the subsoil has a high clay content (Hall and Jonston, 1953).

Silviculturally, E. goniocalyx has many of the characteristics of E. globulus but, unlike the latter, its range extends into the summer rainfall area and it does not shun poor soils.

Provenance,

Seed for the trial at Lichtenburg was received from Prof. J.H. Maiden.

Description of the Species in its Native Habitat.

A fine tree, reaching a height of 120 to 200 feet (37 to 61 m.) and a diameter of 3 to 4 feet (91 to 122 cm.)

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with a straight, clean bole and large, dense crown.

Economic Importance in Country of Origin.

A most desirable forest tree, it yields a hard, heavy, strong, durable timber which is used for heavy structures such as bridges and wharves as well as for flooring and similar purposes.

Trial in the Arboretum at Lichtenburg.

The plot was planted up in 1906, but almost all the young trees were killed by frost during the very severe winter of 1907 when about 3 feet (1 m.) tall.

Discussion of Results.

This species has done very well at one or two stations on the eastern highveld, and it is unfortunate that the trial at Lichtenburg should have been wiped out so soon after it had begun. However, there is little likelihood of the tree growing satisfactorily in the western Transvaal on account of the rainfall being so much lower than in its natural habitat, and further trials are therefore not recommended.

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Eucalyptus dealbata A. Cunn.

Family.

MYRTACEAE.

Common Name.

Tumble Down Gum.

Natural Distribution.

A native of New South Wales and southern Queensland, where it is widely distributed on the tableland and western plains, growing best on well-drained, granitic slopes (Blakely, 1955; Maiden, 1909-31; Streets, 1962).

Provenance.

The seed supplied to Lichtenburg Plantation was received from the Director of the Botanic Gardens, Sydney, but the locality in which it was collected is not recorded.

Description of the Species in its Native Habitat.

A small, straggly tree, usually 15 to 30 feet (5 to 10 m.) tall.

Economic Importance in Country of Origin.

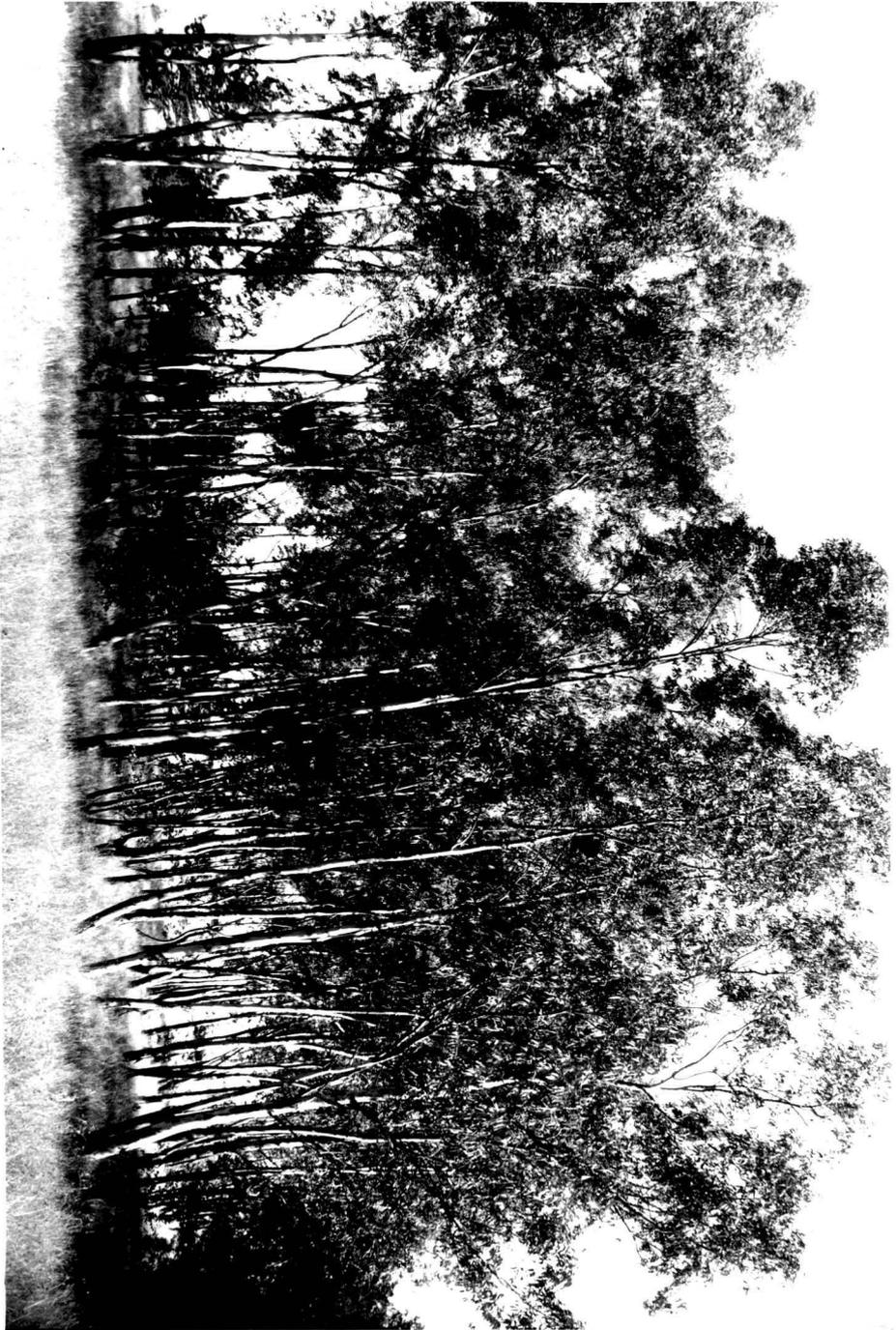
The tree is of little economic value because of its small size, but flowers very freely and is intensively worked by bees. Its timber is red and durable in the ground, and is used on this account for fencing posts and bridge construction.

Trial in the Arboretum at Lichtenburg.

The plot was planted up in March, 1932, at an espacement of 8 x 8 feet (2.4 x 2.4 m.)

The young trees had a healthy appearance but made little growth, averaging no more than 3 feet (1 m.) in height in 1936. The following year they suffered very severely from frost, after which their condition remained poor. By 1940 all trace of them had disappeared.

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EUCALYPTUS DEALBATA : LICHTENBURG

Discussion of Results.

This species might have been expected to survive at Lichtenburg since its range includes the cooler and drier parts of New South Wales. However, it possesses little merit from a silvicultural point of view, and there seems to be no particular reason why the attempt to introduce it to the western Transvaal should be persevered with.

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Eucalyptus deanei Maid.Family.

MYRTACEAE.

Common Name.

Deane's Gum.

Natural Distribution.

A tree of the humid, coastal belt of New South Wales and Queensland and of the New England tableland. Near the coast it is found mainly in deep valleys and on well-drained soils derived from sandstone, while further inland it is most common on the eastern slopes of the mountains, especially those composed of granite. In northern New South Wales its range overlaps those of both E. grandis and E. saligna but it ascends to higher and cooler elevations than the former (Maiden, 1909-31).

Provenance.

The stock used at Lichtenburg was collected at Pan Plantation in the eastern Transvaal. The trees at the latter centre were probably raised from seed supplied by Maiden, although the records are slightly confused.

Description of the Species in its Native Habitat.

A fine, shaft-like tree, growing to a height of 200 feet (61 m.) and in form closely resembling E. saligna, though somewhat more heavily crowned.

Economic Importance in Country of Origin.

The tree yields a red, durable timber, similar to that of E. saligna, which works easily and takes a good polish.

Trial in the Arboretum at Lichtenburg.

The plot was established in 1918 at an espacement of 6 x 6 feet (2 x 2 m.) using plants 6 months old and 6 inches (15 cm.) high which had been raised in the nursery at Pan.

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During their first and second winters, the young trees were severely injured by frost and drought, appearing at one stage to have been killed outright. About 9 of them sprouted again from ground level, however, only to suffer further damage during the winters of 1921 and 1922. For several winters thereafter they escaped further injury and made modest growth, but suffered once more from frost in 1927.

Five trees survived until 1959, only 2 of which contained any usable timber. These had an average diameter of 6.3 inches (16 cm.) and a height of 30 feet (9 m.), but were stag-headed and of such poor form as to be hardly recognisable as this species.

#### Discussion of Results.

The species is clearly unsuited to conditions in the western Transvaal. It may, however, be deduced that drought, rather than frost, was primarily responsible for the heavy mortality and wretched growth of the trees at Lichtenburg since the species has successfully withstood lower temperatures in the Pan and Belfast Arboreta.

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Eucalyptus globulus Labill.Family.

MYRTACEAE.

Common Name.

Blue Gum.

Natural Distribution.

The main occurrence of the species is in southern and south-eastern Tasmania, but it is also found in Victoria. The climate is cool, with a moderately high rainfall of up to 60 inches (1520 mm.) a year. The tree is found near the coast and in more hilly country at an altitude of 1,5000 feet (460 m.) Little snow is experienced and hot, desiccating winds are also rare. The species does not thrive on poor soils but favours moist, through well-drained, heavy loams of good quality (Hall and Johnston, 1953).

Provenance.

No indication is given by the records as to the origin of the seed sown at Potchefstroom for trial in the Arboretum.

Description of the Species in its Native Habitat.

A medium-sized to large tree up to 180 feet (55 m.) in height and from 4 to 7 feet (122 to 213 cm.) in diameter, with a straight bole and well-developed crown.

Economic Importance in Country of Origin.

The tree has a yellowish-brown wood with an open texture and an interlocked grain. This is strong and heavy but only moderately durable and somewhat difficult to season and work. Its uses include general construction, boat-building and tool handles, while locally it is employed also for piles, poles and fencing.

Trial in the Arboretum at Potchefstroom.

The plot was established in 1910 at an espacement 6 x 6 feet (2 x 2 m.) using one-year-old plants 20 inches

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(50 cm.) tall.

The young trees suffered a great deal from frost during their first winter and 16 of them died. These were replaced the following summer, but 22 blanks were counted in the spring of 1911.

For several years the stand made vigorous growth, despite periodic injury by frost, and reached an average height of 19 feet (6 m.) in 1913. This had increased to 27 feet (8 m.) a year later, but a good many double leaders were in evidence.

Two trees were reported dead in 1920 and 7 more died the following year. This retrogression continued, and by 1929 all the standards seemed to be dying off. In 1959, sparse coppice regeneration with no timber content is all that remained on the site.

#### Discussion of Results.

E. globulus has undergone trial, at one time or another, throughout the greater part of South Africa, but few are the sites on which stands have been brought successfully to maturity. At Potchefstroom, the cold, dry winter and the poor, rather sandy soil both militated against the chances of success from the outset, and the species is climatically unsuited to the western Transvaal.

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Eucalyptus gunnii Hook.

A plot established under this name in the Arboretum at Potchefstroom contains only 6, suppressed coppice stands<sup>col</sup>. Most of the stands planted as E. gunnii in South Africa have proved to be E. ovata Labill., and it is probable that the trees at Potchefstroom also belong to the latter species. Reliable identification in the present instance is, however, not possible.

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Eucalyptus hemiphbia F. Muell.Family.

MYRTACEAE.

Common Name.

Grey Box.

Natural Distribution.

A native of New South Wales and Queensland. In the former State it is found in the central and northern coastal districts; in the latter it occurs over a wide area, though chiefly in the south, where it crosses the Dividing Range and penetrates westwards as far as the dry country round Dalby. Its altitudinal range is from sea level to 1,500 feet (460 m.). The rainfall varies from 20 to 40 inches a year (500 to 1,000 mm.) occurring mainly in summer. The tree is most common on heavy loams derived from shale, but is found also on lighter soils with a clay subsoil (Hall and Johnston, 1953.)

Provenance.

The plants raised at Lichtenburg were grown from seed collected locally in the plantation. The origin of the latter is not recorded. The seed used at Potchefstroom was supplied by the Conservator of Forests, Cape Colony, and is of unknown provenance.

Description of the Species in its Native Habitat.

A tree of moderate size, attaining a height of between 40 and 100 feet (12 and 30 m.) and a diameter of from 2 to 3 feet (61 to 91 cm.) It usually has a fairly straight bole, with ascending branches and a dense crown. Its rate of growth is considered to be slow.

Economic Importance in Country of Origin.

The species is not of great economic value but is a good one from the point of view of honey production,

supplying both nectar and pollen. It yields a very hard, heavy, strong, durable timber, which is suitable for bridges, sleepers and poles, although not available in large quantities.

Trials in the Arboreta at Lichtenburg and Potchefstroom.

The trial at Lichtenburg was commenced in 1921, when nursery stock was set out at an espacement of 6 x 6 feet (2 x 2 m.)

The young trees were damaged by frost during their first winter, and a year later were killed outright.

At Potchefstroom, the plot was planted up in 1908 at a 6 x 6 foot (2 x 2 m.) espacement, using nursery stock 7 months old and 9 inches (23 cm.) high.

Frost had no effect upon the trees when young, and not until 1916 does it seem to have caused any damage. Nevertheless, growth was at first very irregular, and many of the trees produced more than one shoot at the base. By 1914 their average height was 26 feet (8 m.), however, and double leaders were removed in 1917 and 1918. Slight damage was caused by frost in 1920 but the severe drought of 1923 had no apparent effect on them. Thinnings were carried out in 1924 and 1926, and a year after that the average height of the stand was 70 feet (21 m.)

In 1959, 18 standards (equivalent to a stocking of 269 stems per acre (664 per hec.) and a good deal of coppice still remained on the plot. The former had a mean D.B.H. of 11.8 inches (30 cm.) and a height of 80 feet (24 m.) but their form was somewhat poor, for their boles were slightly crooked and they had a tendency to lean. Their crowns cast a dense shade.

Discussion of Results.

In Australia, *E. hemiphloia* is rated as moderately

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hardy to frost. The fact that the plot at Lichtenburg was killed outright by frost in its second year is no indication that the species cannot be grown at that centre because, as has already been noted, these trees were raised from seed which had been collected in the plantation. At Potchefstroom, the plot was only twice injured by frost, and then not seriously. Nevertheless, the species cannot be depended on in the western Transvaal, and as it has no particular advantages over several other eucalypts which have proved themselves in the area, further trial plantings are not warranted.

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Eucalyptus E. largiflorens F. Muell.(Syn. E. bicolor A. Cunn.Family.

MYRTACEAE.

Common Name.

Black Box.

Natural Distribution.

A native of Australia, where its principal occurrence is along watercourses on the plains of western New South Wales. From thence its range extends northwards into south-western Queensland and southwards along the Murray River into Victoria and South Australia. Its altitudinal range is from 100 to 1,000 (30 to 300 m.) feet above sea level. Temperatures throughout the area are high in summer, though occasional frosts occur in winter. The rainfall is, low, averaging 10 to 15 inches (250 to 380 mm.) per annum, but the tree normally frequents broad river-flats and other low-lying areas subject to intermittent flooding, where it prefers the heavier, richer soils. It usually forms pure, open stands, but sometimes occurs in mixture with other eucalyptus or, in the drier parts of its range, with shrubby species such as Acacia pendula (Hall and Johnston, 1953).

Provenance.

The seed sown at Lichtenburg was supplied by Prof. J.H. Maiden of Sydney, and probably therefore originated from New South Wales. No information is available regarding the source of the seed sown at Potchefstroom.

Description of the Species in its Native Habitat.

E. <sup>largiflorens</sup> bicolor is considered in Australia to be a poor forest tree, one of its few virtues being that it grows in areas visited by drought. It attains a height of 30 to 60

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feet (9 to 18 m.) and a diameter of 1 to 2 feet (30 to 60 cm.)  
(ibid.)

Economic Importance in Country of Origin.

The species is an excellent one for shade and shelter, having an umbrageous crown, but is of little economic value. It yields a dark red, hard, heavy, durable timber which is useful for short poles, fence posts and fuel.

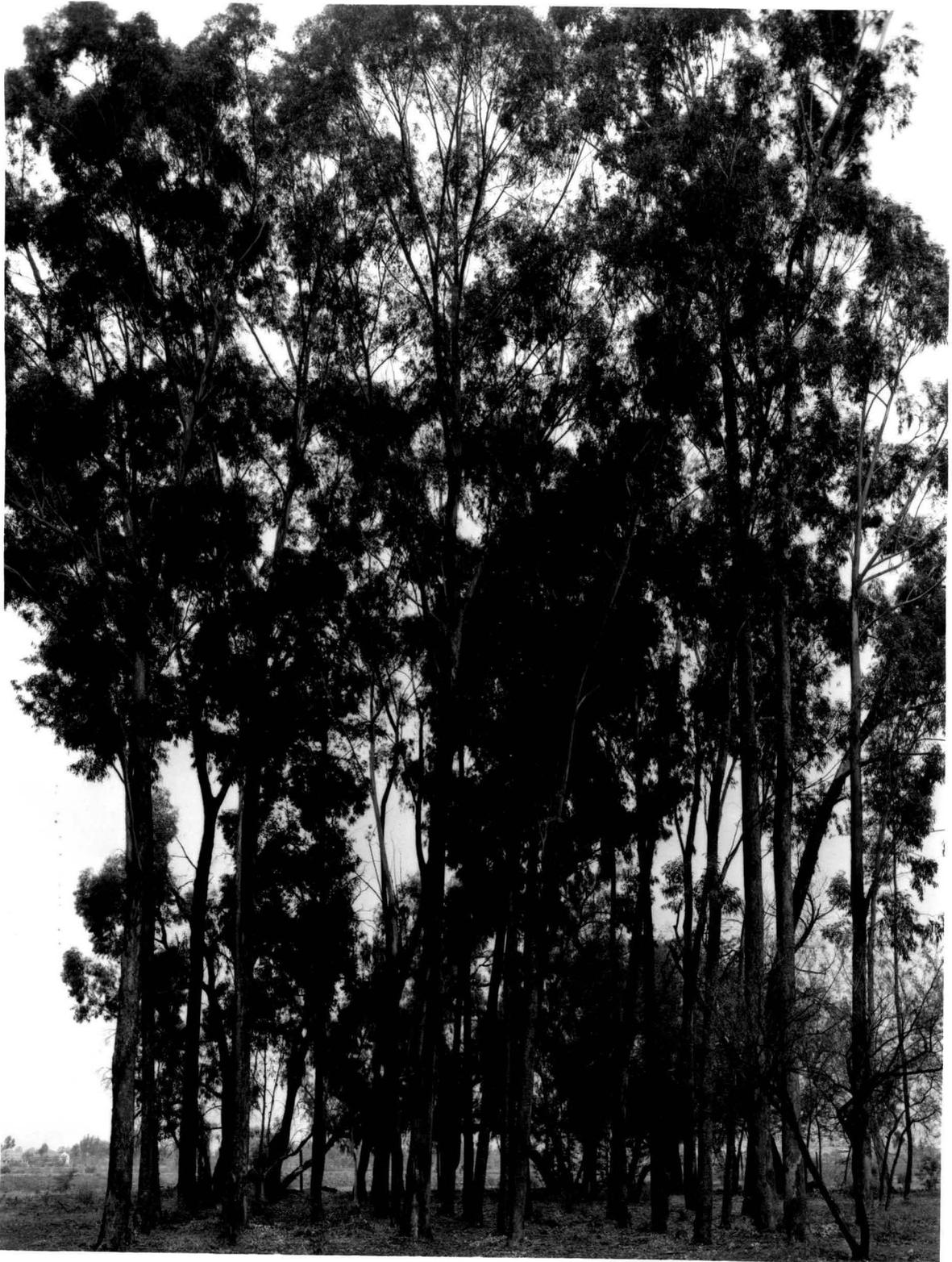
Trials in the Arboreta at Lichtenburg and Potchefstroom.

The plot at Lichtenburg was established in 1905/06 at an espacement of 6 x 6 feet (2 x 2 m.), using 9-inch-high (23 cm.) plants raised locally in the nursery.

The young trees suffered rather severely from frost during the winter of 1907, several of them being killed outright. Thereafter they escaped further injury until 1927, when both standards and coppice were slightly affected. Throughout its entire existence, the stand never once seemed to be suffering from drought.

Growth for the first few years was a little slow, and the trees developed a somewhat bushy habit. Their appearance and vigour gradually improved, however, and by 1913 they had reached an average height of 21 feet (6 m.) A light thinning was undertaken in 1918, by which time the average height of the stand had increased another 10 feet (3m.)

This satisfactory rate of growth was maintained until the trees received their last measurement in 1959. Some 58 standards still remained on the plot, averaging 7.3 (18 cm.) inches in diameter and 61 feet (19 m.) in height. Furthermore, almost every stool was coppicing and there was little diminution in the size of the trees towards the centre of the plot, signifying an altogether



EUCALYPTUS BICOLOR : LARGIFLORENS : POTCOHEFSTSRGHOOM

exceptional degree of drought resistance. The standards, although slightly crooked, were of moderately good form, being clean to a fair height and comparatively lightly branched.

At Potchefstroom the trial was commenced in 1916, when 81 plants 4 inches (10 cm.) high were set out at Lichtenburg.

The young trees were slightly frosted in 1919, and, as at Lichtenburg, their growth for the first few years was rather slow. However, drought seemed to have little or no effect on them, neither were they at any stage injured again by frost. Their vigour slowly improved as the years passed, and in 1927, when they were thinned out to 32 stems, their average height was 40 feet (12 m.)

At the time of the last inspection in 1959, 25 standards and a good deal of coppice remained on the plot, the former having a mean D.B.H. and height of 12.8 inches (32 cm.) and 86 feet, (26 m.) respectively. The form of the standards was reasonably good, for although some had crooked boles and a good many more leaned out towards the light, most of these would have been eliminated in a thinning. After 43 years the stand still appeared to be in a very healthy condition and the canopy was fairly dense.

#### Discussion of Results.

E. <sup>largiflorans</sup> bicolor is slightly susceptible to frost, more especially in the years immediately after establishment, but is extremely hardy to drought. Its growth, while a little tardy at first, improves considerably once the trees are well established.

The species is unquestionably of potential use in the western Transvaal, more especially for the establishment

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of woodlots to supply fencing material and fuel. Whether it possesses any worthwhile advantage over the several eucalypts which are already commonly grown in the area (except, possibly, in regard to drought resistance) is debatable, however, and it is not quite as desirable a tree as E. polyanthemos for shelterbelts because its coppice is rather less densely foliated.

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Eucalyptus melanophloia F. Muell.Family.

MYRTACEAE.

Common Name.

Silver-leaved Ironbark.

Natural Distribution.

A tree of the western slopes and plains of New South Wales and of the adjacent parts of Queensland, where it is associated with other dry country Ironbarks in mixed, savanna woodland. Its altitudinal range is from 500 (152 m) to rather more than 1,500 feet (460 m.) The climate in summer is hot, though some frost occurs in winter. Rain falls mainly during the summer months and averages 15 to 25 inches (380 to 635 mm.) a year. The tree grows best on fertile silts or loams, but is also found on a variety of other soils such as clay, gravel and sand (Hall and Johnston, 1953).

Provenance.

The seed used for the trial at Lichtenburg was collected at Narrabri in New South Wales at an altitude of 697 feet (212 m.) above sea level.

Description of the Species in its Native Habitat.

A medium-sized tree 40 to 60 (12 to 18 m.) or rarely 90 feet (27 m.) tall, with a trunk up to 3 feet (91 cm.) in diameter (*ibid.*)

Economic Importance in Country of Origin.

The species is of no importance as a forest tree and is useful mainly for ornament. Its wood is hard, heavy and durable but inferior to that of most Ironbarks, and is suitable only for fence posts and rough constructional work.

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Trial in the Arboretum at Lichtenburg.

The plot was planted up in February, 1934 - probably at an espacement of 8 x 8 feet (2.4 x 2.4 m.).

Practically one-half of the young trees died off during their first winter. Blanks were filled early in 1935, but heavy mortality occurred again the following year - apparently as a result of frost - and the growth of the remaining trees was very slow. Further damage was caused by frost in 1936 and 1937, and the stand appeared to be failing.

The condition of the trees remained very poor until 1942. Some improvement seems to have taken place thereafter for, in 1959, the stand had a mean D.B.H. of 5.0 inches (13 cm.) and a height of 60 feet (18 m.) The stocking was still 600 stems to the acre (1482 per hec.) The trees were erect and fairly straight (although sometimes forked) and their branches were moderately light, despite the fact that their crowns had an unusually rounded profile. A couple of rather large gaps occurred near the centre of the plot where the trees had failed.

Discussion of Results.

E. melanophloia is quite one of the most attractive eucalypts in the Arboretum, for its strikingly glaucous, decussate, "juvenile" foliage persists throughout the crown and contracts in an extraordinarily pleasing manner with the grey, furrowed bark of the trunk. As a windbreak, however, it has little merit since its foliage is inclined to be sparse, while its use for the production of poles and firewood is not to be recommended because of its relatively slow growth and evident susceptibility to frost when young.

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EUCALYPTUS MELANOPHLOIA : LICHTENBURG

Eucalyptus melliodora A. Cunn.Family.

MYRTACEAE.

Common Name.

Yellow Box.

Natural Distribution.

Widely distributed in New South Wales and Victoria. It is most common on the inland side of the Dividing Range, but occurs also near the coast and ascends the northern tablelands, penetrating thence in to southern Queensland. Its altitudinal range is from a little above sea level to about 3,000 feet (910 m.) The climate is warm and dry, maximum temperatures in summer at times exceeding 100°F. (38°C) in the shade, and hot, desiccating winds being common. The rainfall varies from 15 to 36 inches (380 to 900 mm.) a year, in the south occurring mainly in winter but in the north mainly in summer. In the moister parts of its range the species is found on gentle, mountain slopes but in drier areas its main occurrence is on river flats. Generally it is found on fairly fertile, loamy soils (Hall and Johnston, 1953).

Provenance.

The seed used at Lichtenburg for the trial in the Arboretum was obtained through a certain Mr. Baikie from Murphy of Woy Woy, New South Wales.

Description of the Species in its Native Habitat.

A graceful, medium-sized tree 60 to 100 feet (18 to 30 m.) tall and from 2 to 3 feet (61 to 91 cm.) in diameter, with a clean bole, large crown and somewhat pendulous branches.

Economic Importance in Country of Origin.

In Australia, the species is considered to be of

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more use for honey-production, shade, shelter and ornament than for timber. Its wood is dense, very heavy, hard and durable, but owing to the fact that it has an interlocked grain is difficult to work. It is therefore used mainly in the round as a heavy constructional timber and as fuel.

#### Trial in the Arboretum at Potchefstroom.

The plot was established in February, 1908, at the usual espacement for those times of 6 x 6 feet (2 x 2 m), using nursery stock 4 months old and 9 inches (23 cm.) high.

From the outset the young trees proved perfectly hardy to frost and at no time during the life of the stand did they ever seem to suffer from drought. Their growth, too, was fairly good, and by 1914 they had reached an average height of 25 feet (8 m.)

This satisfactory progress continued, and thinnings were carried out in 1924 and 1926. Vigorous coppicing ensued, and the whole appearance of the stand was very healthy.

Nineteen standards remained on the plot in 1959, representing a stocking of 284 stems per acre (700 per hec.) The mean D.B.H. of these was 12.3 inches (31 cm.) and the mean height 80 feet (24 m.) Most of them were of good form and had upright, fairly straight boles. Their crowns, although light for the species, cast an appreciable amount of shade. Healthy coppice was still much in evidence.

#### Discussion of Results.

Although this species has made slightly less rapid growth than certain other eucalypts in the Arboretum at Potchefstroom, it ranks, nevertheless, as one of the most desirable members of the genus for planting in the western Transvaal. It is exceedingly hardy to drought and seems well

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able to stand the cold winters. The relative straightness of its stem commends it for the production of poles and fencing material, while its dense, spreading crown renders it eminently suitable for shelterbelts. Local experience of the wood as a fuel corroborates Australian observations, and the tree is one of the best sources of nectar for bees. For all these reasons the species is deservedly popular with farmers in the drier parts of the summer rainfall area wherever frost is not too severe.

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Eucalyptus microtheca F. Muell.

Family.

MYRTACEAE.

Common Name.

Flooded Box.

Natural Distribution.

Widely distributed throughout the northern half of continental Australia, where it is found in Queensland, the Northern Territory and Western Australia. It is thus well adapted to tropical heat and rain, and also withstands droughty conditions. Most commonly it grows on heavy, black clays which are waterlogged in wet weather but become baked and cracked during the dry season (Blakely, 1955, Streets, 1962).

Provenance.

The seed supplied to both Lichtenburg and Potchefstroom was received from Prof. Maiden, but since it could not have been collected in New South Wales its origin must remain unknown.

Description of the Species in its Native Habitat.

A small to medium-sized tree up to 40 feet (12 m.) in height and occasionally 18 inches (45 cm.) in diameter. It has widely spreading branches and is sometimes, though not always, of a pleasing, shapely appearance.

Economic Importance in Country of Origin.

A most useful tree in tropical forestry. Its timber, which is almost black in colour, is one of the hardest and most durable of all Australian woods and is particularly resistant to termites. The uses to which it is put include bearings, bushes, bolts, shafts and parts of wheels for heavy vehicles. Locally, it is used also for fencing.

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Trials in the Arboretum at Lichtenburg and Potchefstroom.

The trial at Lichtenburg was commenced in March, 1911, when plants 2 years old and 18 inches (45 cm.) high were put out at an espacement of 6 x 6 feet (2 x 2 m.).

The young trees suffered slightly from drought in 1914 and were at first very crooked and bushy, but by 1917 a few of them had started to make stronger growth. Light frost damage recurred in 1918. Two years later, 35 trees were killed to the ground and the rest were severely injured by the cold. Mild damage was again experienced during the course of the next two winters.

The plot received a thinning in 1924, at which stage the trees appeared healthy, though crooked and still rather small. Two years later the coppice was cut back by frost. A second thinning was carried out in 1929, when the standards had a height of 25 to 30 feet (8 to 9 m.) but were still rather crooked.

At the time of the final inspection in 1959, difficulty was experienced in distinguishing between standards and coppice regrowth, and a good deal of the latter was evidently included inadvertently in the enumeration data. Altogether, 77 trees were measured on the 0.1 acre (0.004 hec.) plot, these having a mean D.B.H. of 6.5 inches (16 cm.) and a height of 43 feet (13 m.) The stocking was still virtually complete, and quite well-grown trees were found near the centre of the plot, indicating a very high degree of drought resistance. Unfortunately, the form of the trees was very poor, for their boles were crooked and often forked.

At Potchefstroom the plot was established in February, 1908, adopting the same espacement as before and using 7-month-old plants 9 inches (23 cm.) high.



EUCALYPTUS MICROTHECA : LICHTENBURG.

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In marked contrast to the trees at Lichtenburg, those at Potchefstroom were not at all affected by frost. Their growth, too, was far superior, for in 1914 they averaged 20 feet (6 m.) in height. As before, their appearance was healthy but all were crooked to the very top.

Growth continued to be satisfactory and the trees did not at any time suffer from drought. Thinnings were carried out in 1924 and 1926, which was followed by vigorous coppicing.

Eleven standards remained in 1959, equivalent to a stocking of 164 stems per acre (405 per hec.) These had a mean D.B.H. of 10.9 inches (27 cm.) and a height of 74 feet (23 m.) Their form was bad, for they had a tendency to lean heavily and their crowns were somewhat irregular. Much coppice was also found on the plot which, too, was of poor form.

#### Discussion of Results.

E. microtheca is essentially a tropical species and as such is a climatic misfit in the western Transvaal. Even when not affected by frost its form is very bad, and its growth is inferior to that of several other eucalypts in the area. Although exceedingly hardy to drought, it is therefore not worth persevering with except in a warmer climate.

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Eucalyptus pauciflora Sieb. ex Spreng.

(Syn. E. coriacea A. Cunn.)

Family.

MYRTACEAE.

Common Names.

Cabbage or Snow Gum.

Natural Distribution.

The most common tree of the sub-alpine regions of Australia, where it occurs in the States of South Australia, Victoria, New South Wales, Queensland and Tasmania. In continental Australia it is found typically at an elevation of from 2,000 to 5,500 feet (610 to 1,676 m.) though in Tasmania it descends almost to sea level. Throughout its range frequent and severe frosts are experienced in winter, sometimes accompanied by moderate to heavy falls of snow. Summers are cool. The rainfall is fairly dependable and varies from 25 to 50 inches a year (635 to 1,270 mm.), occurring mainly during the winter months in the south but gradually passing over to predominantly summer distribution in the north. Most commonly, the tree is found on mountain slopes and ridges and on shallow, rocky soils, especially those derived from basalts and granites (Hall and Johnston, 1953).

Provenance.

The seed used at Lichtenburg seems to have originated from Queensland, while that from which plants were raised for trial at Potchefstroom was obtained from a certain Mr. H.A. Horn, whose place of domicile and occupation cannot be established.

Description of the Species in its Native Habitat.

A small to medium-sized tree, usually 30 to 60 feet (9 to 18 m.) tall and 1 to 3 feet (30 to 90 cm.) in

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diameter, with a short, crooked bole and heavily branched crown. Trees up to 80 feet (24 m.) in height with longer boles are sometimes found, but these, too, are mostly of bad form.

Economic Importance in Country of Origin.

E. pauciflora is an important constituent of protection forest in the Australian Alps, besides which it yields a good supply of pollen for bees. Its wood is tough and strong and of some value locally for fencing and fuel, but warps badly when sawn into boards.

Trials in the Arboreta at Lichtenburg and Potchefstroom.

The plot at Lichtenburg was planted up in 1905/06 at an espacement of 6 x 6 feet (2 x 2 m.) using nursery stock 12 months old.

The young trees suffered least of all eucalypts in the Arboretum during the very severe winter of 1907, but were cut back slightly by frost the following year. Their growth at first was slow and their form bushy, but by 1910 they had attained an average height of 13 feet (4 m.)

In 1911 the trees seemed to be suffering from drought, and their appearance deteriorated progressively until, 3 years later, practically all of them were taken for dead. A good many recovered to some extent the following year, but the trial was finally abandoned in 1916.

At Potchefstroom, the plot was established in 1908 at the same espacement as before, using plants 15 inches (38 cm.) tall which had been raised over the previous 2 seasons in the Irene Forest Nursery.

The trees stood the cold well and made unexpectedly good growth, reaching a height of 20 feet (6 m.) in 1910. This increased to 38 feet (12 m.) in 1914, although several individuals growing on gravelly soil had in the meantime died off.

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In 1916 it appeared as if the trees were suffering from drought, but they soon recovered and began once more to make good progress. Their stems, however, were rather crooked. Thinnings were carried out in 1924 and 1926, and a year later the mean height of the stand was 60 feet (18 m.). Vigorous coppicing took place, but the standards looked very whippy.

From 1929 onwards the condition of the stand seems to have deteriorated to a marked degree, for only 6, moribund trees remained in 1959. These were up to 11.5 inches (29 cm.) in diameter but of mediocre form, and one of them leaned right over.

#### Discussion of Results.

E. pauciflora is essentially a species for cool, relatively moist regions, and is not well suited to the dry winters and hot summers of the western Transvaal. Silviculturally, it has few useful attributes which are not possessed in far greater degree by several other eucalypts, and further trials in the area would serve no practical purpose.

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Eucalyptus pilligaensis Maid.

Family.

MYRTACEAE.

Common Name.

Narrow-leaved Box.

Natural Distribution.

Confined to the interior of central and northern New South Wales and southern Queensland, where it is found on low hills and flats at the edge of the plains west of the Dividing Range. It frequently occupies rather heavy, alluvial soils, forming an open savanna woodland in association with various other eucalyptus, Callitris hugellii and Angophora spp. (Streets, 1962).

Seed for the trial at Lichtenburg was collected at Narrabri in New South Wales.

Description of the Species in its Native Habitat.

A slender, well-formed tree 20 to 60 feet (6 to 18 m.) tall.

Economic Importance in Country of Origin.

The tree yields a brown, hard, durable wood with interlocked grain, which is used for fencing and fuel. Its flowers produce a fairly good supply of nectar but are deficient in pollen. Of little economic value, it is useful mainly for fuel, shade and shelter (Penfold and Willis, 1961).

Trial in the Arboretum at Lichtenburg.

The stand was established at an espacement of 6 x 6 feet (2 x 2 m.) in March, 1934.

The young trees grew very slowly and a greay many blanks were filled in February, 1935. Although many trees appeared to be dead after the winter of 1935, recovery was almost complete, and the stand had a mean height of 3 feet (1 m.) two years later.

A light thinning was carried out in 1953.

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EUCALYPTUS PILLIGAENSIS : LICHTENBURG

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In 1959, 72 trees still remained on the plot. These had a mean D.B.H. of 5.3 inches (13 cm.) and a height of 40 feet (12 m.) All were either crooked or had a basal sweep, and many were forked. Their branches were long, slender and bare for the greater part of their length, and the canopy was thin. The plot was somewhat open at the centre as a result of the failure of several trees, and its heart was occupied by somewhat weakly coppice. The species is therefore, not among the most drought-resistant tried at Lichtenburg.

#### Discussion of Results.

E. pilligaensis, while fairly hardy to frost and drought, is not of great potential value in the western Transvaal. Although its rate of growth is not very different from that of E. camaldulensis or E. sideroxylon, the form of the trees is poorer and their crowns are thinner. In consequence, it is neither suitable for poles nor shelter, and further planting is not recommended.

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Eucalyptus polyanthemos Schauer.Family.

MYRTACEAE.

Common Name.

Red Box.

Natural Distribution.

A native of Victoria and New South Wales. In the former State it has a wide distribution and is especially abundant on the foothills of the Grampians and the Australian Alps. From thence its range extends northwards to the lower slopes of the southern and central tablelands of New South Wales. Its altitudinal limits lie between 400 and 2,000 feet (1,20 to 610 m.) above sea level and the rainfall throughout is about 20 to 30 inches (500 to 760 mm.) a year, falling mainly in winter in the south but more evenly distributed in the north. It is thus a species of rather dry areas with quite high temperatures in summer and a good deal of frost in winter. Typically, it is found on heavy soils, such as those derived from shales, slates and phyllites, occurring in open, savanna woodland in association with species such as E. melliodora and E. sideroxylon (Hall and Johnston, 1953).

Provenance.

The seed used both at Lichtenburg and Potchefstroom was supplied by Prof. Maiden, and probably originated from New South Wales.

Description of the Species in its Native Habitat.

A medium-sized tree with a short, rather branchy trunk. On average sites it is 50 to 80 feet (15 to 24 m.) in height and 1 to 2 feet (30 to 60 cm.) in diameter, but it sometimes reaches a height of 100 feet (30 m.) and a diameter of up to 3 feet (90cm.) on fertile, alluvial soils in Victoria.

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Economic Importance in Country of Origin.

The species is not much esteemed for forestry purposes because of its rather poor form, and is considered more suitable for ornament and shelter. Its wood is very tough, strong and durable, and is useful in the round or roughly hewn for poles and fencing material. Small quantities are also used for heavy, constructional work, and it makes a very good fuel. The honey from its flowers is said to have a strong, oily taste when new.

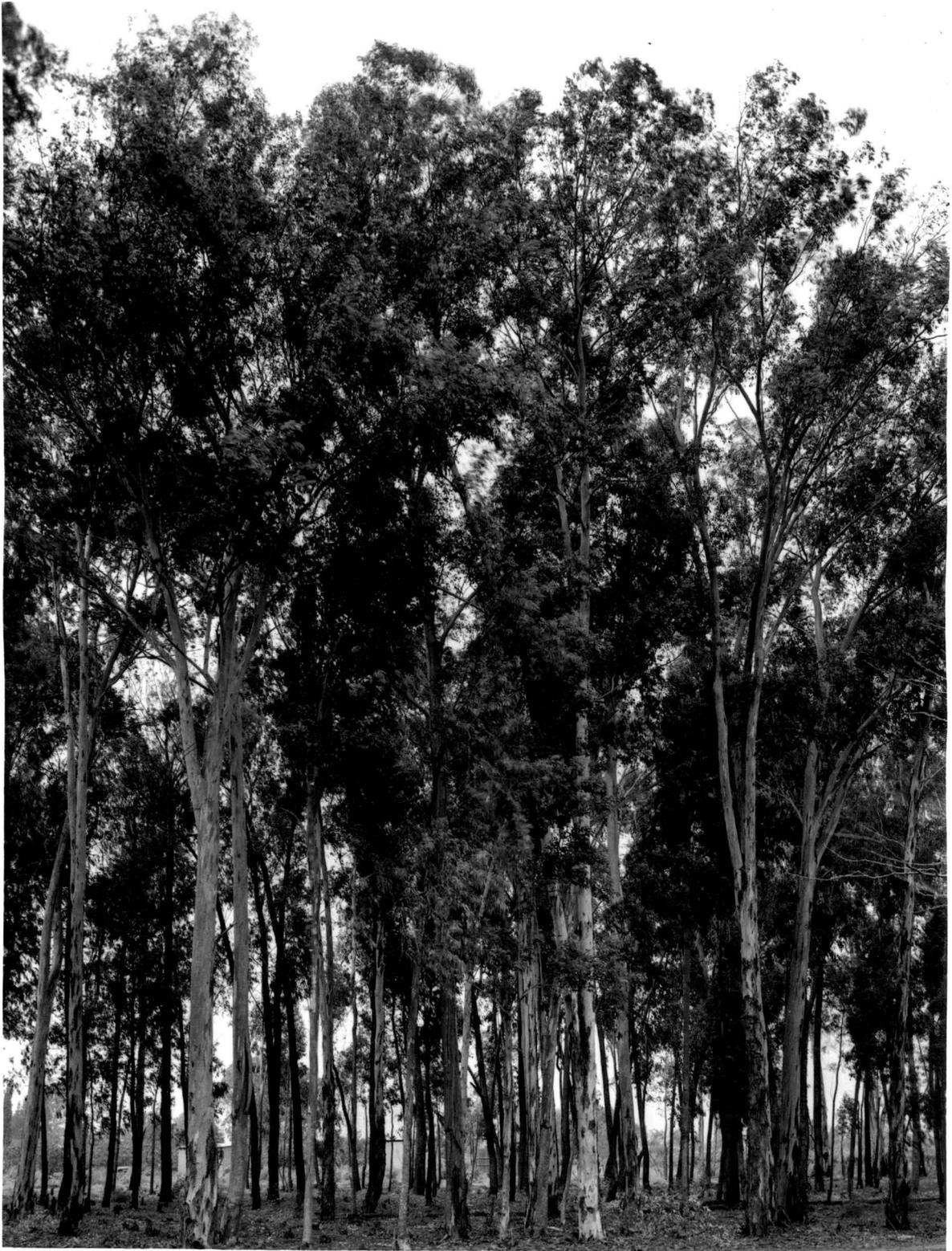
Trials in the Arboreta at Lichtenburg and Potchefstroom.

The trial at Lichtenburg was initiated in 1905/06, when nursery stock 1 year old and 12 inches (30 cm.) high was planted out at an espacement of 6 x 6 feet (2 x 2 m.)

The young trees suffered severely during the particularly cold winter of 1907, and some individuals which had already attained a height of 5 feet (1.5 m.) were cut right back to the ground. Almost all of them sprouted again, but their form had been adversely affected and their habit for the next year or two was low and bushy. However, their vigour improved once more, and by 1913 their average height was 19 feet (6 m.) This had increased to 29 feet (9 m.) in 1918, when a light thinning was carried out. Slight damage was caused again by frost in 1920, but apart from this the trees appeared to be healthy and were at no time affected by drought.

Further thinnings were undertaken in 1924 and 1929, after which the 35 remaining trees on the plot had a height of 45 to 50 feet (14 to 15 m.) Vigorous coppice growth was also removed on the latter occasion.

The trees were still in a thrifty condition when inspected for the last time in 1959. A total of 63 stems was measured, which evidently included a considerable amount



EUCALYPTUS POLYANTHEMOS : POTCHEFSTROOM

of coppice. The mean D.B.H. of the stand was 7.4 inches (18 cm.) and its mean height 52 feet (16 m.) Almost all the stumps were coppicing and some of the inner-most standards were of fair size, indicating that the species is exceedingly drought-hardy. The form of the trees was, however, poor, most of them being rather crooked and inclined to fork, though not too heavily branched.

At Potchefstroom, the plot was established in February, 1908, when 81 plants 7 months old and 9 inches (23 cm.) high were set out at the same espacement.

The young trees came through their first winter without mishap but were cut back slightly by frost in 1910. By this time their height was already 12 feet (4 m.), and they looked very promising. Four years later their height had risen to 25 feet (8 m.) despite periodic droughts, which seemed to have little effect on them. Thinnings were carried out in 1924 and 1926, and the following year the remaining 23 trees averaged 65 feet (20 m.) in height.

Eighteen trees, representing a stocking of 269 stems per acre (664 per hec.), and a great deal of vigorous coppice were found on the plot in 1959. The average D.B.H. of the former was 12.6 inches (32 cm.) and their height was 78 feet (24 m.) Some had fine boles but most of them were forked.

#### Discussion of Results.

E. polyanthemus has proved to be one of the most drought-resistant eucalypts tried so far in the western Transvaal, and is also as hardy to frost as most other species. Because of its rather indifferent form, however, it is less suitable for use in farm woodlots than, for instance E. camaldulensis, E. melliodora or E. sideroxylon, although it yields an excellent firewood. On the other

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hand, it can be unhesitatingly recommended for shelter-belts, especially when great height is not a primary requirement, since its ample, leafy crown and dense coppice render it ideal for this purpose.

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Eucalyptus populifolia Hook.

Family.

MYRTACEAE.

Common Name.

Bimbil Box.

Natural Distribution.

Typically a tree of the western plains of New South Wales and Queensland, though in the relatively dry country round Rockhampton it penetrates to the coast. Its main occurrence is at an altitude of between 500 and 1,500 feet (1,52 to 460 m.) above sea level in areas with a continental climate characterised by summer temperatures of 100<sup>o</sup>F(38<sup>o</sup>C.) or more in the shade and light frost in winter. The rainfall is low, averaging 14 to 20 inches (356 to 500 mm.) a year, and droughts are fairly common. The tree usually occurs on reddish loams and sandy loams, but on low-lying flats it is sometimes found on heavy, black soils (Hall and Johnston, 1953.)

Provenance.

It is probable that the seed used for the trial at Potchefstroom was obtained from Maiden but this cannot be verified.

Description of the Species in its Native Habitat.

A small to medium-sized tree 30 to 50 feet (9 to 15 m.) in height and 1 to 2 feet (30 to 60 cm.) in diameter, with a fairly straight stem and dense, rounded crown.

Economic Importance in Country of Origin.

The species is an ideal one for shade and ornament in dry areas, especially where the soil is heavy, but is not of great value as a forest tree. Its wood is pale brown in colour, hard, strong and very durable, and is useful for various purposes on the farm.

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The honey obtained from its flowers is not abundant but has an agreeable flavour.

Trial in the Arboretum at Potchefstroom.

The trial was commenced in February, 1908, when nursery plants 7 months old and 9 inches (23 cm.) high were put out at the customary espacement for those days of 6 x 6 feet (2 x 2 m.)

The young trees showed no ill effects from frost or drought and seemed healthy, but their growth was slow at first and they were rather crooked. By 1914 they had reached an average height of 14 feet (4 m.) however. Thinnings were carried out in 1924 and 1926, by which time the average height of the stand was 55 feet (17 m.)

Eleven trees remained on the plot in 1959, representing a stocking of 164 stems per acre (405 per hec.). Unfortunately, about half of these had become suppressed by an adjoining eucalypt belt, but their mean D.B.H. was nevertheless 8.9 inches (23 cm.) and their height 63 feet. (19 m.) Although leaning heavily and rather crooked, they still looked quite healthy, and a good proportion of the stumps was coppicing.

Discussion of Results.

E. populifolia is not a particularly useful species for farm woodlots but would be suitable for shelterbelts. It has a pleasing appearance when given plenty of space for the development of its crown, and its leaves glint in the sun rather prettily. It is exceedingly resistant to drought and evidently withstands a great deal of frost. Its occurrence on heavy, black soils in Australia suggests that it might be a valuable tree for the notorious "turf soils" of the highveld, on which relatively few species will grow satisfactorily.

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Eucalyptus redunca Schau.

Family.

MYRTACEAE.

Common Name.

Black Marlock.

Natural Distribution.

A species of the sand plains of Western Australia, where its range stretches inland from the southern coastal belt to Broome Hill (Blakely, 1955).

Provenance.

Seed for the trial at Lichtenburg was supplied by the Conservator of Forests, Cape Colony, but the origin of that used at Potchefstroom is not known.

Description of the Species in its Native Habitat.

A shrub or malee 3 to 8 feet (1 to 2.4 m.) high.

Economic Importance in Country of Origin.

The species is of no economic importance, but is regarded as suitable for shrubbaries and low windbreaks.

Trials in the Arboreta at Lichtenburg and Potchefstroom.

The plot at Lichtenburg was established in 1911 at an espacement of 6 x 6 feet (2 x 2 m.) using 2-year-old plants 18 inches (45 cm.) high.

A good many of the young plants were killed by frost during their first winter, and those that survived did not look healthy. Slight frost damage recurred the following winter, and some of the remaining plants were eaten by termites. A year later, all that remained were wiped out by frost.

At Potchefstroom, the trial was commenced in 1913, when nursery stock 7 months old was planted out at the same espacement as before. That winter, all the young plants were killed, outright by frost.

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Discussion of Results.

The species is clearly too sensitive to frost to survive in the western Transvaal, added to which it is better suited to an area with a winter rainfall. As it is of little or no economic value, its failure is not of any consequence.

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Eucalyptus rudis Endl.

Family.

MYRTACEAE.

Common Name.

Moitch.

Natural Distribution.

Restricted to river banks and alluvial flats subject to inundation in the south-west of Western Australia. It is found on the wetter type of site occupied by E. camaldulensis, with which it tends to hybridise where their ranges overlap, but its distribution is very much more limited (Streets, 1962).

Provenance.

Seed for the trial at Lichtenburg was received through Baikie from Murphy of Woy Woy, New South Wales.

Description of the Species in its Native Habitat.

A tree 30 to 50 feet (9 to 15 m.) tall, with a short, stout trunk and widely-spreading branches.

Economic Importance in Country of Origin.

The tree is deemed suitable for shade and shelter in moist, warm situations. Its timber is similar but inferior to that of E. camaldulensis and is used locally for posts and fuel.

Trial in the Arboretum at Lichtenburg.

The plot was established in 1913 at an espacement of 6 x 6 feet (2 x 2 m.) using plants of unspecified age and size, all of which succumbed to frost that winter.

Discussion of Results.

E. rudis is very closely allied to E. camaldulensis, from which it differs largely in having a rough, persistent bark. From all accounts it is the less desirable of the two species, and there is no reason why the attempt to introduce

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it should be persevered with when the latter is already so well established in the western Transvaal.

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Eucalyptus sideroxylon A. Cunn. ex Woolls.Family.

MYRTACEAE.

Common Names.

Black Ironbark, Mugga.

Natural Distribution.

Fairly widely distributed in eastern, continental Australia, where it is found in Victoria, New South Wales and Queensland. Its principal occurrence is in Victoria to the north of the main mountain complex, but it is also found in the coastal areas of that State. In New South Wales it is fairly common along the western slopes of the Dividing Range, and from thence it penetrates northwards into southern Queensland. It is characteristically a species of rather dry areas with a rainfall of between 15 and 25 inches (380 and 635 mm.) a year, most of which occurs during the winter months in the south but in summer in the north. Summers, are hot, with maximum temperatures rising above 100°F. (38°C.) in the shade, but frost is experienced in winter. The species is found on soils derived from shales, schists, quartzites and granites which are often too poor to carry high quality forest (Hall and Johnston, 1953).

Provenance.

The origin of the seed stocks used at Lichtenburg and Potchefstroom cannot be traced with certainty, but it seems that they may have been collected locally.

Description of the Species in its Native Habitat.

A tree attaining a height of 80 to 100 feet (24 to 30 m.) and a diameter of 3 to 4 feet (90 to 122 cm.) on favourable sites in the coastal belt of Victoria, but

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usually only 60 feet (18 m.) high and 2 feet (60 cm.) in diameter in the drier parts of the interior. It usually has a conspicuous, black, kino-impregnated bark, but a grey-barked form also occurs.

Economic Importance in Country of Origin.

Although regarded in Australia as a second-rate species from the point of view of forestry, its hard, strong, durable timber is in demand for railway sleepers, bridges and constructional work generally. The tree is also much planted in streets, parks and gardens for the sake of its handsome, crimson flowers, the more glaucous form being particularly admired.

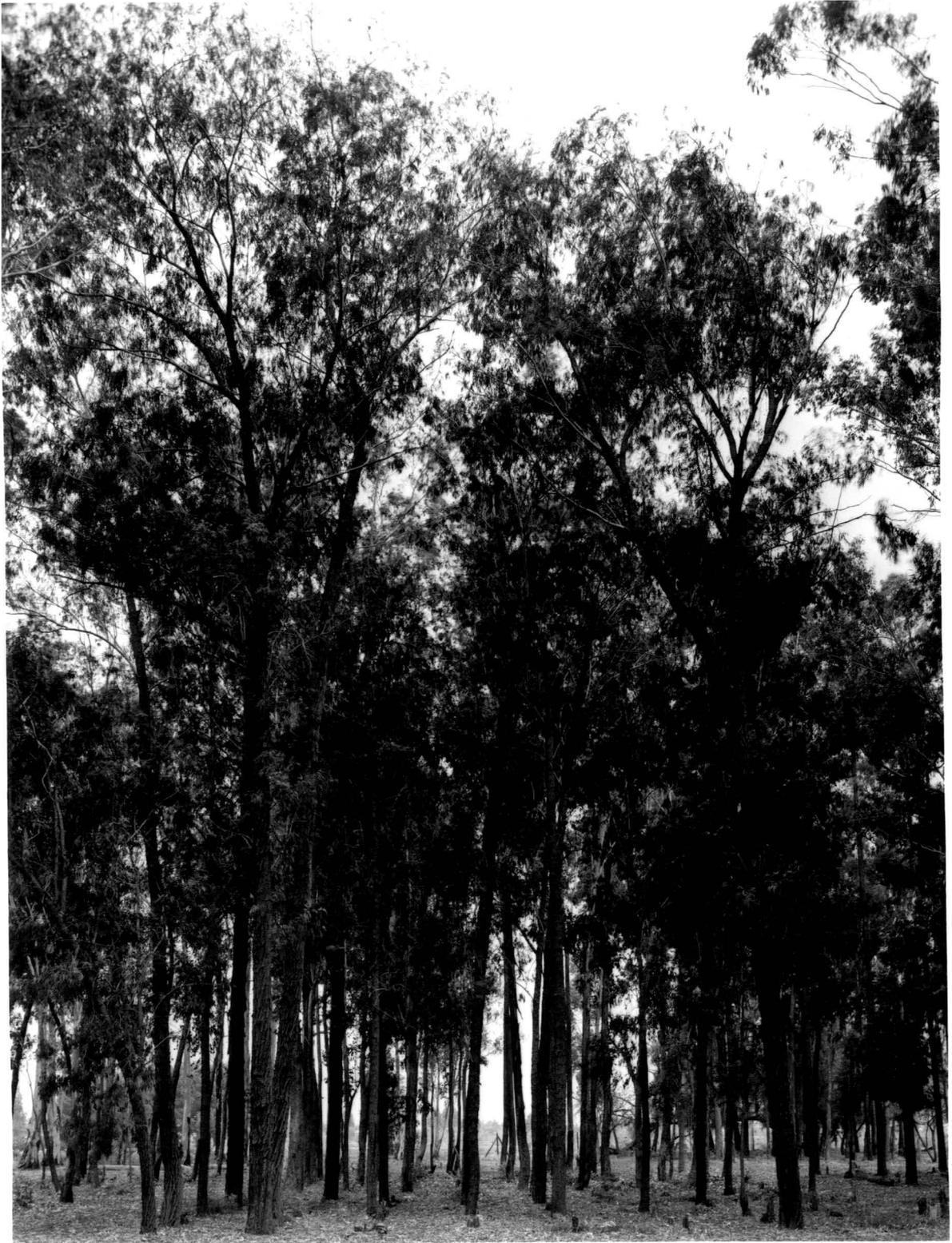
Trials in the Arboreta at Lichtenburg and Potchefstroom.

The plot at Lichtenburg was established in 1905 at a 6 x 6 foot (2 x 2 m.) espacement, using 12-month-old plants 9 inches (23 cm.) high.

The young plants suffered badly during the unusually severe winter of 1907, following which many blanks had to be filled, but never again were they in the least affected by frost. Early growth was good, and in 1913 they already had an average height of 30 feet (9 m.) A few of the smaller trees seemed to be suffering from drought the following year, but on no subsequent occasion did this recur.

Light thinnings were carried out in 1918, 1923 and 1924, as a result of which vigorous coppicing took place. Growth continued to be satisfactory, and in 1929 the standards had an average height of 40 feet (12 m.) Further thinnings were undertaken in 1937 and 1952, yet the plot was still heavily over-stocked when last inspected in 1959, for 56 trees were counted on an area of 0.1 acre

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EUCALYPTUS SIDEROXYLON : POTCHEFSTROOM

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(0.004 hec.) It may well be that some of these were in reality coppice shoots which had been mistaken for standards, for their mean D.B.H. was only 8.1 inches (20 cm.) and their height 48 feet (15 m.) A few of them had dead tops.

Their form, though mediocre, was nevertheless fairly typical of stands of this species. The centre of the plot was occupied by relatively small, weakly trees and was more open than the margins, but this might be attributed in part to the dense stocking.

At Potchefstroom, the trial was commenced in February, 1908, when plants 7 months old and 9 inches (23 cm.) high were put out at the same espacement.

The young trees stood up to the climate exceedingly well right from the start and made rapid growth, reaching an average height of 28 feet (8.5 m.) in 1913. Thinnings were carried out in 1924 and 1926, following which a prolific growth of coppice appeared.

Eighteen trees, representing a stocking of 269 stems per acre, (664 per hec.) remained in 1959. These had an average D.B.H. of 10.7 inches (27 cm.) and a height of 70 feet (21 m.) Their form was reasonably good apart from the fact that some of them were a little crooked, and all except two (which may have been struck by lightning) were still healthy.

#### Discussion of Results.

In Australia, the species enjoys the reputation of being very drought-resistant. This would seem to be well merited, although it is not quite as hardy as, for instance, E. microtheca or E. polyanthemus. It is also very resistant to frost, if not altogether proof against damage in the western Transvaal.

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After E. camaldulensis, E. sideroxydon is possibly more widely planted by farmers in the drier parts of the summer rainfall area than any other eucalypt. It is a very useful tree for windbreaks, having a dense, full crown, and can also be planted with advantage in the form of woodlots for the production of poles, fencing material and fuel. Its flowers are an excellent source of nectar for bees and greatly enhance its desirability as an ornamental tree.

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Eucalyptus tereticornis Sm.(Syn. E. umbellata (Geartn.) Domin.)Family.

MYRTACEAE

Common Names.

Forest Red Gum.

Natural Distribution.

Widespread along the eastern seaboard of continental Australia from Victoria to Queensland, ascending the table lands in the northern parts of its range and crossing the Torres Strait to re-appear in the mountains of New Guinea. Its distribution thus extends from the coast to an altitude of 6,000 feet (1,828 m.) above sea level, from temperate regions to the tropics, from the winter to the summer rainfall area and from a humid climate (with an annual precipitation of 60 inches (1,520 mm.) a year) to a relatively dry one (rainfall 20 inches (500 mm.)). It occurs on a fairly wide variety of soils, preferring, however, those of a better quality such as fertile loams and moist, alluvial deposits and eschewing formations of a very acid character. Usually it forms a constituent of open forest, occupying alluvial flats subject to occasional flooding or mountain slopes and plateaux (Hall and Johnston, 1953).

Provenance.

The seed stock from which plants were raised for trial in the Arboretum at Potchefstroom was obtained from Prof. Maiden, but the origin of that sown at Lichtenburg cannot be traced.

Description of the Species in its Native Habitat.

A tall tree 100 to 150 feet (30 to 46 m.) in height, with a thick, straight bole 3 to 5 feet (90 to 152 cm.) in

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diameter and a spreading, rather open crown.

Economic Importance in Country of Origin.

The tree is considered to be a useful one for forestry in the tropics and sub-tropics, and yields a hard, heavy, durable, timber with an interlocked grain. This is rather similar to that of E. camaldulensis but hardier and heavier, and is suitable for constructional work, harbour piles, mining timber and flooring blocks.

Trials in the Arboreta at Lichtenburg and Potchefstroom.

At Lichtenburg a plot was planted up in 1905, but the young trees were all killed by frost 2 years later.

The plot at Potchefstroom was established in February, 1908, when 81 plants 7 months old and 9 inches (23 cm.) high, which had been raised in the Irene Forestry Nursery, were put out at an espacement of 6 x 6 feet (2 x 2 m.)

Although the young trees stood their first winter well, they were repeatedly injured by frost in the years which followed. Their growth, too, was very uneven, for some of them reached a height of 15 feet (5 m.) by 1910 while others lagged far behind. This disparity in their size became ever more marked, the dominants continuing to flourish but the rest of the stand appearing to stagnate.

Thinnings were carried out in 1924 and 1926. A year later the standards had increased in height to 60 feet (18 m.) but the coppice seemed to be suffering from drought.

From this time onwards the vigour of the whole stand began to decline rapidly, and only 6 standards survived until 1959 (equivalent to a stocking of 90 stems per acre (222 per hec.) These had a mean D.B.H. 14.4 inches (36 cm.) and a height of 87 feet (27 m.), and were all

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situated on the perimeter of the plot. Sparse coppice re-growth was also encountered in the outer rows, but the centre of the plot was bare.

The remaining trees looked healthy except for one, which had a dead top, but their form was poor since most of them were crooked or forked.

#### Discussion of Results.

In a species with so wide a distribution as E. tereticornis, it is to be expected that numerous ecotypes occur, each specially adapted to local conditions. It follows, therefore, that too much weight cannot be attached to the result of two, random trials, especially when the provenance of the seed is known only in the vaguest terms. Whether the species is worth persevering with in the western Transvaal is a moot point, for although it has many useful attributes, it possesses few advantages over E. camaldulensis or E. trabuti, both of which it resembles closely and both of which flourish in the area.

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Eucalyptus X trabutii Vilmorin.Family.

MYRTACEAE.

Common Name.

Trabut's Gum.

Origin.

A hybrid, said to have arisen in cultivation in the grounds of the Nuestapha Hospital, Algeria, of the putative parents E. botryoides and E. camaldulensis. It is described as resembling E. resinifera (Maiden, 1909-31), and botanical material from South African sources in the Forestry Herbarium, Pretoria, is not unlike this species. The trees in the Arboretum at Potchefstroom have a smooth bark similar to that of E. camaldulensis, however.

Provenance.

The records of the Transvaal Forestry Division are incomplete, but it is almost certain that the seed used to establish a trial plot in the Arboretum at Potchefstroom was supplied by Dr. Trabut through the Government Botanist, Algiers.

Description of the Species.

A tree of rapid growth, branching early and having a regular, pyramidal form. The bark on its trunk is often cracked; its foliage is dense and of a dull green colour (ibid.)

Economic Importance in Country of Origin.

Because of its vigour, regular shape and dense foliage, the tree is considered in Algeria to merit special attention. It has a red wood, which is described as having the same appearance as mahogany (ibid.)

Trial in the Arboretum at Potchefstroom.

The plot was established in March, 1913, when 81 plants, which had been raised in the nursery at Irene, were set out at a spacing of 6 x 6 feet (2 x 2 m.)

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EUCALYPTUS X TRABUTI : POTCHEFSTROOM

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The young trees made vigorous, straight growth and reached a height of 15 feet (5 m.) in 1918. Their tops were touched by frost in 1920, and in 1923 they seemed to be suffering slightly from drought, but apart from this their condition was very healthy.

A thinning was carried out in 1926, and a year later the mean height of the stand was no less than 65 feet (20 m.) This excellent progress was maintained, for, in 1959, the remaining 18 standards on the plot (representing a stocking of 269 stems per acre ) 664 per hec.) had grown to a height of 109 feet (33 m.) and a mean D.B.H. of 21.0 inches (53 cm.) Their form was variable, for although some had magnificent, columnar boles, others were crooked, forked or somewhat leaning. One large specimen was dead, but the crowns of the rest were still healthy.

#### Discussion of Results.

This stand has made the most vigorous growth of any in the Arboretum and contains quite some of the most impressive trees. A good deal of variation exists between different individuals in the stand, and this can be attributed to their hybrid nature. There is no doubt that the plot contains genetic material of potential value, and it is to be hoped that this will be exploited while the opportunity lasts.

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Eucalyptus urnigera Hook. f.

Family.

MYRTACEAE.

Common Name.

Urn-fruited Gum.

Natural Distribution.

A tree with a very restricted distribution, occurring only under moist, cool conditions at altitudes of from 2,000 to 3,500 feet (610 to 1,070 m.) in the mountains of Tasmania, usually on well-drained, talus slopes (Curtis, 1956; Streets, 1962).

Provenance.

Seed for the trial at Lichtenburg was obtained from the French firm of seed merchants, Messrs. Vilmorin-Andrieux.

Description of the Species in its Native Habitat.

A small tree, varying in height between 15 and 50 feet (5 to 15 m.), with drooping branches.

Economic Importance in Country of Origin.

A useful species for shade and ornament in cool climates, yielding a pale timber of good quality which is suitable for cabinet work.

Trial in the Arboretum at Lichtenburg.

The trial was commenced in March, 1909, when 66 plants 12 months old and one foot (30 cm.) high were put out at a 6 x 6-foot (2 x 2 m.) espacement.

The young trees came through their first winter successfully, but many succumbed to frost or were blown over by wind a year later. The majority of those that survived fell prey to termites in the summer.

Twelve trees remained on the plot in March, 1913, the heights of which ranged from 4 to 12 feet (1 to 4 m.).

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Their numbers dwindled to 8 later in the year, however, and to 7 the year after. For a time their condition seemed to improve, but in 1920 they suffered very severely from frost and drought, as a result of which 3 more died. By 1920, only one was left alive. This struggled on until 1942 and reached a height of 20 feet (6 m.), but eventually succumbed as well.

#### Discussion of Results.

It is curious that this species should have been affected so much by frost at Lichtenburg since it occurs naturally in a cool climate, though it is readily understandable that it should have suffered from drought. The tree is not suited climatically to the western Transvaal, with its hot summers and dry winters, and further attempts to grow it in the area would probably be fruitless.

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Eucalyptus viminalis Labill.Family.

MYRTACEAE.

Common Names.

Ribbon or Manna Gum.

Natural Distribution.

Widespread in south-eastern, continental Australia and in Tasmania, its range extending from Mt. Lofty in South Australia, through southern Victoria and the table lands of New South Wales to Queensland. In Tasmania it is common in the north and east. While it occurs over a wide climatic range, it is found principally in the winter rainfall area from sea level to an altitude of 2,500 feet (760 m.) in localities which are not subject to prolonged drought. The rainfall over most of its range varies between 25 and 55 inches (635 and 1,400 mm.) annually, and some snow may be experienced in winter at the highest elevations. The species prefers soils of good quality and reaches its best development in moist, elevated valley-bottoms, but tolerates poorer conditions (Hall and Johnston, 1953).

Provenance.

Seed for the trials in both the Lichtenburg and Potchefstroom Arboreta was collected at Belfast Plantation in the eastern Transvaal.

Description of the Species in its Native Habitat.

Commonly a tree 100 to 120 feet (30 to 37 m.) high and 3 to 4 feet (90 to 122 cm.) in diameter, but on particularly good sites it may attain a height of 150 feet (46 m.) and a diameter of 5 feet (152 cm.)

Economic Importance in Country of Origin.

A picturesque species for parks and gardens, but as a timber tree it is considered rather inferior. Its wood

is light in colour and has an open grain, but warps and twists in seasoning. It is neither strong nor durable but is fairly tough and planes well.

Trials in the Arboreta at Lichtenburg and Potchefstroom.

The trial at Lichtenburg was initiated in 1905/06, when nursery stock 9 months old and 9 inches (23 cm.) high was planted out at an espacement of 6 x 6 feet (2 x 2 m.)

The young trees made rapid growth but were cut back by frost during the very severe winter of 1907. Although frost damage recurred the following year, by September, 1910, some of the trees were already nearly 40 feet (12 m.) tall, and a light thinning was carried out.

In 1913, the stand was reported to be suffering from drought. A year later 6 suppressed specimens had died out, and others showed signs of distress. Twenty-one more trees failed as a result of drought in 1916 and a further 21 were removed two years later. Only 46 trees now remained on the plot, the average D.B.H. and height of which was 6.3 inches (16 cm.) and 39 feet (12 m.), respectively.

The stand continued to suffer from drought, 8 dead trees being cut out in 1924, 3 more the following year and 1 the year after that. In 1928, it was decided to fell the remaining trees and allow them to coppice.

The young coppice made vigorous growth, but still the dying-off continued. In 1936 the trees were lightly attacked by a beetle (? Gonipterus scutellatus) and the following year suffered badly from frost. Thereafter, their condition steadily deteriorated, and by 1959 only 7 miserable specimens were left.

The stand at Potchefstroom was established in February, 1908, 81 plants 4 months old and 9 inches (23 cm.)

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high being set out at the same espacement as previously.

Once again, the growth of the young trees was good, and on this occasion they did not seem to suffer at all from frost. Five of them died off in 1910 after reaching a height of 20 feet (6 m.) however, and several more succumbed to drought a year later.

Three of the largest trees on the plot died out in 1912, and the following year the whole stand seemed to be in a moribund condition notwithstanding the fact that it had already reached an average height of 56 feet (17 m.) By 1920, only 35 crooked and unhealthy specimens were left, and in 1959 no trace of these could be found.

#### Discussion of Results.

It is abundantly clear that E. viminalis is unable to stand the frequent and prolonged droughts which occur in the western Transvaal. That it should have suffered at Lichtenburg from frost as well is more surprising, for it has proved hardy on the eastern highveld where the winters are, if anything, more severe. Further trials in the area would be pointless, especially as the species can no longer be recommended for planting anywhere in South Africa because of its susceptibility to the Eucalyptus Snout Beetle, Gonipterus scutellatus.

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Gleditsia triacanthos Linn.Family.

LEGUMINOSAE.

Common Name.

Honey Locust.

Natural Distribution.

Widely distributed in southern Canada and in the central United States west of the Alleghenies, where it occurs from Michigan to Nebraska in the north and from Texas to Alabama in the south, generally on moist, fertile soils near streams. Latterly its range has been much extended by cultivation, especially in the eastern United States (Sargent, 1922).

Provenance.

The seed used to establish a trial plot at Potchefstroom was obtained from one Charles Newberry, whose identity can no longer be established.

Description of the Species in its Native Habitat.

A medium-sized, deciduous tree, commonly 70 to 80 feet (21 to 24 m.) tall and 2 to 3 feet (60 to 90 cm.) in diameter but occasionally reaching a height of 140 feet (43 m.) and a diameter of 6 feet (2 m.) It usually develops a rather short bole and an open, somewhat spreading crown (Harlow and Harrar, 1937). In its typical form the species is armed with stout, simple or branched spines, but the variety inermis is thornless (Sargent, 1922).

Economic Importance in Country of Origin.

G. triacanthos is of secondary economic importance as a timber tree in the United States. Its wood is, nevertheless, used for several purposes and, being very durable in contact with the ground, is deemed suitable for fencing posts. However, the value of the tree lies as much in its pods as in its timber, since these contain a sweetish sub-

stance which makes them very palatable to cattle. When trimmed, the species is said to form a good hedge which, on account of its many, forbidding thorns, soon becomes impassable to man or beast.

#### Trial in the Arboretum at Potchefstroom.

The plot was established in August, 1908, when 81 nursery transplants 1 year old and 12 inches (30 cm.) high were set out at an espacement of 6 x 6 feet ( 2 x 2 m.)

The young trees showed no ill effects due to frost or drought and made satisfactory growth, reaching a height of 11 feet (3 m.) by 1914. This progress continued and from 1915 onwards the trees were reported to be flowering heavily, although fruit was apparently not set until 1921.

In 1924 it was observed that some of the trees had become slightly stag-headed, though it was not apparent whether this was attributable to frost or drought. A year later, half of the stand was reported to be going off as a result of drought, but recovery was complete, for no fewer than 80 trees still remained on the plot in 1927.

When last inspected, in 1959, the trees had a height of 22 feet (7 m.). Half of the plot was badly suppressed by an adjoining stand of eucalypts and was largely bare. The remaining trees were inclined to fork and had comparatively narrow crowns as a result of over-stocking. Although they appeared reasonably healthy, evidence was not lacking that they had died back extensively in the past.

#### Discussion of Results.

G. triacanthos is a most desirable fodder tree and had proved very resistant to both frost and drought in the western Transvaal when planted singly or at a wide

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espacement. There is little object in establishing it in the form of a dense stand, as was done at Potchefstroom, and it should be given ample space for the development of its crown since this will encourage the production of a good crop of pods.

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Juglans nigra Engel.

Family.

JUGLANDACEAE.

Common Name.

Black Walnut.

Natural Distribution.

A native of north and Central America, where its range extends from southern Ontario, in Canada, through the eastern and southern United States to Coahuila and possibly Chihuahua in northern Mexico. Typically, it occupies river banks and the bottoms of canyons at altitudes of between 3,000 to 6,000 feet (910 to 1,828 m.) above sea level (Sargent, 1922; Standley, 1920-24).

Provenance.

The seed used for the trial both at Lichtenburg and Potchefstroom was obtained from a certain Mr. Leslie Gooding and was collected in Mexico.

Description of the Species in its Native Habitat.

A bushy, round-headed tree, usually less than 30 feet (9 m.) tall but sometimes twice this height, with a short, often leaning bole 18 to 30 inches (45 to 76 cm.) in diameter branching near the ground.

Economic Importance in Country of Origin.

Although not of great economic importance at the present time, the tree yields a hard, heavy wood of a rich, dark brown colour. Such is the beauty of the veneer cut from the stumps of large, old trees that in accessible areas the species has been ruthlessly exploited in the past.

Trials in the Arboreta at Lichtenburg and Potchefstroom.

The trials at the two centres were started within about a year of one-another, that at the former being commenced in March, 1909, when 66 plants 2 years old and 18 inches (45 cm.

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high were put out at an espacement of 6 x 6 feet (2 x 2 m.), and that at the latter some 13 months earlier, using 81 plants 1 year old and 20 inches (50 cm.) high.

At Lichtenburg, the young plants came through their first winter well but made slow growth. At the age of 9 years their height was still only 10 feet (3 m.), though they had a very thrifty appearance.

In the spring of 1921, tender, young growth was caught by frost, and the following year 6 trees were reported dead as a result of cold and drought. Four more of them died in 1923, but thereafter their condition improved temporarily. From 1928 onwards, a gradual decline seems to have set in, and they began to die back in the crown. By 1952, only about a dozen sound specimens remained, ranging in height up to 25 feet (8 m.) and in diameter up to 5 inches (13 cm.). These also died back, subsequently for, in 1959, nothing but coppice was left on the plot. The majority of stumps had produced a thicket of shoots, but there seemed little prospect of these ever developing into well-formed trees.

At Potchefstroom, young growth was touched by frost in the spring of 1909, but the trees made somewhat better growth than at Lichtenburg, reaching in height of 10 feet (3 m.) at the age of 6 years. For a while after this they continued in a very flourishing condition, but from 1924 onwards a good many of them started to become stag-headed, commencing, at the same time, to send out numerous epicormic shoots. By 1929 most of them were either dead or dying, and nothing remained of the stand in 1959.

#### Discussion of Results.

The species is fairly hardy to frost and would, no

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doubt, make a pleasing ornamental in the Western Transvaal if planted under garden conditions or near water. There is, however, nothing to be gained in repeating the experiment of establishing it at a close espacement for the production of timber.

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Juniperus ashei Buchholz.

(Syns. J. sabinoides sensu Sarg., non Griseb. nec Nees;  
J. mexicana sensu Sarg.)

Family.

PINACEAE.

Common Name.

Mountain or Rock Cedar.

Natural Distribution.

A Native of North and Central America, where its range stretches from Brazos Country in Texas, through Mexico to Guatemala. In the United States it occurs between the altitudes of 600 and 2,000 feet (180 and 610 m.) attaining its greatest size along the San Bernardo River and often forming great thickets; in Mexico it ascends the mountains to 13,000 feet (3,962 m.), becoming shrubby in habit at the upper limit of vegetation. In Texas it grows on dry, rocky, gravelly or sandy soils and on partially decomposed limestone, forming pure stands on the Edwards Plateau; over the rest of its range it occurs in mixture with various other species (Harlow and Harrar, 1937; Sargent, 1922; Standley, 1920-24).

Provenance.

The seed supplied to Lichtenburg Plantation for trial in the Arboretum was collected on the Prince Edward Plateau in Texas, but the origin of that used at Potchefstroom cannot be definitely ascertained.

Description of the Species in its Native Habitat.

Ordinarily a small tree 20 to 30 feet high (6 to 9m.) with a trunk 1 foot (30 cm.) in diameter, but occasionally growing to a height of 100 feet (30 m.) and a diameter of 3 feet (90 cm.). On exposed sites its bole is apt to divide at or shortly above ground level into several, contorted limbs, but in sheltered situations it develops an erect trunk free of branches for a third of its length.

Its crown is typically more-or-less globose in form, though sometimes narrowly conical, and its root system is rather shallow.

Economic Importance in Country of Origin.

The tree yields a slightly fragrant, hard, close-grained but weak wood of a brownish colour streaked with red. This has been much used for constructional purposes, railway sleepers, telegraph poles, fence posts and fuel.

Trials in the Arboreta at Lichtenburg and Potchefstroom.

At Lichtenburg, the plot was established in 1907-08, using 18-month-old plants 9 inches (23 cm.) high.

The young trees looked healthy right from the start and were seemingly not at all affected by frost or drought, but their growth was slow and their height only 5 feet (152 cm.) in 1913. This had increased to no more than 10 feet (3 m.) by 1937, although they still had a very healthy appearance.

In 1959, the stand had a mean height of 16 feet (5 m.) and an average diameter of about 3 inches (8 cm.) Its poor growth was partly attributable to the fact that it was situated between two plots of eucalyptus, and the trees on one side showed evident signs of suppression, some of them having died off altogether. The rest were healthy though many-stemmed, bushing out from ground level.

The trial at Potchefstroom was commenced in February, 1908, when 81 plants 21 months old and 9 inches (23 cm.) high were set out at the same espacement of 6 x 6 feet (2 x 2 m.)

No casualties were recorded during the early life of the stand and the young trees had a particularly promising appearance. As at Lichtenburg, their growth was slow, however, and in 1914 they still had an average height of only 5 feet (152 cm.) A few of them died in 1924, probably

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as a result of drought, but the rest went on to attain a mean height of 20 feet (6 m.) in 1927.

When the stand was last inspected, in 1959, 51 trees (equivalent to a stocking of 761 stems per acre (1,880 per hec.) remained on the area. The mean D.B.G. and height of these, were, respectively, 5.4 inches (14 cm.) and 33 feet (10 m.) Their form was very bad, for most of them were multi-stemmed, forked, leaning or heavily branched. They still seemed healthy except in the middle of the plot, where they were apparently dying out.

#### Discussion of Results

The species is very hardy to frost and drought but grows too slowly to be of any economic value. Its bushy habit and cheerful, green foliage point to its possible usefulness as a hedge plant, however.

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Juniperus occidentalis Hook. f.

Family.

PINACEAE.

Common Name.

Western Juniper.

Natural Distribution.

A tree of the mountains and high prairies of western North America, where its range extends from British Columbia to the Sierra Nevadas in the Californian sierras. It is usually found at altitudes of from 6,000 to 10,000 feet (1,828 to 3,048 m.) above sea level (Sargent, 1922).

Provenance.

Seed for the trial at Lichtenburg appears to have been obtained from the American firm of seed merchants, Thomas Meehan and Son.

Description of Species in its Native Habitat.

A tree, usually 20 to 60 feet (6 to 18 m.) in height and occasionally 10 feet (3 m.) in diameter, with a straight trunk, enormous, almost horizontally spreading branches and a broad, low head. On dry, rocky slopes and near the northern limit of its range it may, however, assume a shrubby habit, producing many short, erect or semi-prostrate stems.

Economic Importance in Country of Origin.

The species has a light, soft, close-grained, fragrant and exceedingly durable wood of a pale, reddish-brown colour. This is comparable in quality to the rough grades of J. virginiana and is much used for fencing and fuel. The fruits of the tree are gathered and eaten by the Californian Indians.

Trial in the Arboretum at Lichtenburg.

The plot was established in March, 1913, using 116 plants 3 years old and 12 to 18 inches (30 to 45 cm.)

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high, which had been raised at Ermelo. The usual espacement of 6 x 6 feet (2 x 2 m.) seems to have been adopted.

The reees suffered at intervals from drought and made little growth, but were quite unaffected by frost. Three of them were killed by termites in 1920 and 5 more died as a result of drought in 1923, though the rest had a good colour. Growth continued to be very slow, and in 1930 the stand had an average height of only 21 to 15 feet (4 to 5 m.) A few more failures occurred in 1934, probably caused by drought, and a good many dead specimens were again cut out 4 years later.

In 1959, the average height of the stand was still no more than 18 feet (5 m.) The trees were unattractive in appearance, having many stems and a spreading, bushy habit, but were apparently still healthy. The stocking of the plot was good but for one rather large gap in the centre where the trees had evidently died of drought.

#### Discussion of Results.

The species has nothing to commend it from the point of view of ornament, for the trees at Lichtenburg are decidedly ungainly in appearance. However, since there is a tendency for its branches to remain alive almost to the ground it might make a good, trimmed hedge. When planted in a single row it would probably require little or no watering in the western Transvaal.

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Juniperus pachyphlaea Torr.Family.

PINACEAE

Common Name.

Alligator Juniper.

Natural Distribution.

A tree of the mountains of south-western Texas and of the desert ranges of New Mexico and Arizona south of the Colorado Plateau, whence its range extends into Mexico. It reaches its greatest size on moist, protected slopes and on the floors of canyons, becoming dwarfed or sprawling when clinging to precipices or subsisting at high elevations on dry, rocky or gravelly sites. Although it occasionally forms pure, open stands, it is much more common in mixture with nut pines and various kinds of oak (Harlow and Harrar, 1937).

Provenance.

Plants for trial at Lichtenburg were raised from seed supplied by Thomas Meehan and Son, but the origin of those used at Potchefstroom is obscure.

Description of the Species in its Native Habitat.

A small tree, sometimes 50 to 60 feet (15 to 18 m.) tall and 3 to 6 feet (90 to 180 cm.) in diameter, with a short, clear bole and a broad, open, conical crown (ibid.)

Economic Importance in Countries of Origin.

The tree has a light, soft, close-grained, brittle wood (Sargent, 1922), which is apparently not available in sufficient volume to be of appreciable economic importance.

Trials in the Arboreta at Lichtenburg and Potchefstroom.

The plot at Lichtenburg was established in March, 1912, when 50 plants 2 years old, which had been raised in

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the Irene Nursery, were put out at an espacement of 6 x 6 feet ( 2 x 2 m.)

The young trees stood the frost and drought exceedingly well and had a healthy appearance. Despite this their growth was very slow, for in 1930 they had a mean height of only 10 feet (3 m.) A thinning, during the course of which 60 per cent of the stocking was removed, was carried out in 1938. Evidently most of the stumps coppiced, for when last inspected in 1959 the plot was once more almost completely stocked. The trees, however, still had an average height of only 16 feet (5 m.) They were shrubby in habit and multi-stemmed, with rounded crowns. Live side-branches extended almost to the ground, even in the middle of the plot. The stand as a whole had a very ragged appearance, for the trees on one side, where it abuts on a plot of Eucalyptus conica, had started to die off. The stocking towards the centre was still good, however. Natural seedling regeneration was much in evidence, and volunteers had also appeared under a neighbouring stand.

The trial at Potchefstroom was commenced in February, 1910, using nursery plants 18 months old and 12 inches (30 cm.) high, of which 81 were set out at the same espacement as had been adopted at Lichtenburg.

As before, the trees proved exceedingly resistant to frost and drought but very slow of growth. Notwithstanding a healthy appearance, they had reached a height of no more than 15 feet (5 m.) in 1927, and had many stems.

In 1959, 70 trees, representing a stocking of 1,045 stems per acre (2,580 per hec.) remained on the plot. These had a mean D.B.H. of 6.3 inches (16 cm.) and a height of 26 feet (8 m.) Their form was poor, for they tended to be crooked, leaning and forked, and all still bore evidence

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of having at one time been multi-stemmed.

Discussion of Results.

The species tends to assume a bushy habit, and is obviously too slow-growing to be of any potential value as a source of timber. However, it is well suited to the cool, dry climate of the western Transvaal, and the fact that its lower branches remain green in the shade suggests that it might make a good hedge.

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Juniperus virginiana Linn.

Family.

PINACEAE.

Common Name.

Pencil Cedar, Eastern Red Cedar.

Natural Distribution.

A native of the eastern and central United States and eastern Canada, where it has a very wide distribution reaching from Nova Scotia and New Brunswick to Georgia and eastern Texas. It occurs on dry, gravelly slopes and rocky ridges at low to medium altitudes. It is often found near the sea but never on the mountains of New England nor on the upper reaches of the southern Alleghanies. In the south and middle west it often forms almost pure, scrub forests of considerable extent over low, rolling, limestone hills (Sargent, 1922).

Provenance.

Nothing is known of the origin of the seed stocks used either at Lichtenburg or Potchefstroom.

Description of the Species in its Native Habitat.

A tree up to 100 feet (30 m.) in height, though usually no more than 40 to 50 feet (12 to 15 m.) tall, with a trunk 3 to 4 feet (90 to 122 cm.) in diameter. Its crown is compact and narrowly pyramidal in shape, becoming broader and round-topped with age (ibid.)

Economic Importance in Countries of Origin.

The tree yields a light, close-grained, soft and rather brittle, though durable wood of a pinkish or reddish colour. This is the most suitable of all known woods for the manufacture of casings for lead pencils, besides which it is used for poles and for lining chests to protect the

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contents from attack by moths. Shavings and dust from the pencil factories are distilled for the fragrant oil which the wood contains, while decoction of the fruit and leaves is used in medicine. The species is sometimes planted as a hedge in the United States.

Trials in the Arboreta at Lichtenburg and Potchefstroom.

Two plots were established in the Arboretum at Lichtenburg. For the first of these plants raised from seed were used, and for the other cuttings which had been rooted in the nursery.

The first plot was planted up in 1907/08, when 122 transplants 18 months old and 6 inches (15 cm.) high were set out at an espacement of 6 x 6 feet (2 x 2 m.).

The trees made very poor growth. Although untouched by frost and drought, they seemed to be affected almost from the start by competition from a neighbouring stand of eucalypts. By 1935 their appearance was moribund, and in 1938 a 50 per cent thinning was carried out, to which they showed little response.

In 1959 the stand still had a mean height of only 8 feet (2 m.) The trees were bushy in habit and were branched right down to the ground. Many had dead tops and their general appearance was unthrifty.

The second plot was established in 1912, when 115 rooted cuttings 3 years old and 12 inches (30 cm.) high were put out at the same espacement as before.

The young trees suffered very much from drought the year after they were put out, and only 29 of them survived. These, however, were relatively vigorous, and did not again suffer in the least from drought or from frost.

In 1959, 25 trees still remained on the plot, Of these the average D.B.H. was 5.2 inches (13 cm.) and the average height 21 feet (6 m.). They were of very much better



JUNIPERUS VIRGINIANA : POTCHEFF'S BOOM

form than those raised from seed, having single, erect stems, but many had dead tops. Their branches were long, with a distinct, upward sweep, and remained green almost to the ground.

The trial at Potchefstroom was commenced in 1908, 81 plants 51 months old and 9 inches (23 cm.) high being set out at the same espacement of 6 x 6 feet (2 x 2 m.)

The young stand proved very resistant to frost and made steady growth, reaching a height of 8 feet (2 m.) in 1914. This had increased to 15 feet (5 m.) 5 years later, and the appearance of the trees was healthy.

In 1923, the stand seemed to be suffering from drought, but made a rapid recovery and went on to attain a height of 18 feet (6 m.) in 1927. At this stage the full complement of 81 trees still remained on the plot. A thinning seems to have been undertaken subsequently, however, for only 32 trees (equivalent to a stocking of 478 stems per acre (1,180 per hec.) were left in 1959. These were still healthy and measured 6.3 inches (16 cm.) in diameter and 34 feet (10 m.) in height. They had an attractive, shapely habit, although some were a little crooked, and their crowns cast a fairly deep shade.

#### Discussion of Results.

The species clearly has no economic potentialities in the western Transvaal (nor, for that matter, anywhere else in South Africa) because of its slow growth. It is, however, hardy to frost and drought and would, like other junipers, be suitable for clipped hedges since its crown persists nearly to the ground.

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Maclura pomifera (Raf.) Schneider(Syns.) M. aurantiaca Nuttall, Toxylon pomiferum Raf.)Family.

MORACEAE.

Common Name.

Osage Orange.

Natural Distribution.

This species has a very restricted natural distribution, occurring only in southern Arkansas, southern Oklahoma and north-eastern Texas. It is found chiefly on rich bottom-lands, reaching its largest size in the valley of the Red River in Oklahoma (Harlow and Harrar, 1937; Sargent 1922).

Provenance.

Some of the plants used to establish a plot in the Lichtenburg Arboretum were supplied by the Irene Nursery and may have been raised from seed purchased of Messrs. Vilmorin-Andrieux. The rest were grown locally using seed collected at the old race course in Pretoria.

Description of the Species in its Native Habitat.

A tree up to 50 or 60 feet (15 or 18 m.) tall and 2 or 3 feet (60 or 90 cm.) in diameter, with a short bole, stout, erect (though later spreading) branches and a handsome, round-topped head. Its fruits, which are 4 to 5 inches (10 to 13 cm.) in diameter and orange in colour, are ornamental (Sargent, 1922) but of no food value.

Economic Importance in Country of Origin.

The wood of large specimens is exceedingly hard, heavy, strong and durable, though coarse-grained. On exposure it changes in colour from bright orange to brown. It is used for fence posts and railway sleepers, and was at one time favoured by the Osage and other Indians for bows and

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war clubs. The bark of its roots contains a yellow dye, while that of the trunk is sometimes used for tanning leather. In recent times the species has been extensively planted in the prairie regions of the Mississippi basin as a hedge plant (ibid.)

Trial in the Arboretum at Lichtenburg.

The plot was established over two growing seasons, 5 rows being planted up with nursery stock 2 years old and 18 inches (45 cm.) high in 1906 and the other 8 rows with stock 1 year old and 6 inches (15 cm.) high the following year. An espacement of 6 x 6 feet (2 x 2 m.) was adopted throughout.

The young trees stood up initially to the harsh climate but made very little progress. Four of them died as a result of either frost or drought in 1921, and 8 more succumbed a year later. The rest, though healthy, had a low, bushy habit.

In 1935 it was reported that the trees were beginning to die off, and less than half of them survived until 1959. These varied in height from 4 to 23 feet (1 to 7 m.) and were bushy in form, with several stems. Many bore evidence of having died back extensively in the past.

Discussion of Results:

The species is much esteemed in America for live fences and hedges, but its use even for this purpose in the western Transvaal cannot be recommended except under particularly favourable circumstances because it has not proved sufficiently hardy to frost and drought.



MACIURA POMIFERA : LICHTENBURG

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Melia azedarach Linn.

Family.

MELIACEAE

Common Name.

Syninga, Persian Lilac.

Natural Distribution.

Probably indigenous to Baluchistan and Kashmir, but long cultivated throughout India and the Middle East, usually as a roadside or garden tree though sometimes in the form of small stands (Streets, 1962).

Provenance.

The seed used to raise plants for trial at Potchefstroom was probably collected in South Africa from trees growing at Barberton.

Description of the Species in its Native Habitat.

A tree up to 50 feet (15 m.) high, with a short bole and handsome, spreading crown, Its fragrant, lilac flowers and yellow fruits much enhance its value for ornamental purposes.

Economic Importance in Country of Origin.

The tree grows quite rapidly and yields a very serviceable, reddish timber which is useful for the manufacture of furniture and cigar boxes. It also makes a good fuel, burning readily even before perfectly dry.

Trial in the Arboretum at Potchefstroom.

The plot was established in January, 1909, at an espacement of 6 x 6 feet (2 x 2 m.), using 81 plants 1 year old and 9 inches (23 cm.) high.

The young trees escaped injury from frost and drought for the first three years after planting out, but tender, new growth was affected by unseasonable cold in the spring of 1913. By 1914 their average height was 7 feet

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(2 m.) but their form was bushy and they had many stems.

In 1918, several trees were cut to the ground by frost but commenced to sprout again. The rest of them were trimmed that same year to a single stem. Frost damage recurred in 1920 and 1921, and although the stand was not again visibly affected by either frost or drought its general condition seems to have deteriorated.

Only one, rather poor specimen remained when the plot was last inspected in 1959. This had attained a height of 30 feet (9 m.) but had 3 stems.

#### Discussion of Results.

Nowhere in Southern Africa has Melia azedarach shown any real promise as a plantation tree, although it is widely used for shade and ornament. It is very drought-resistant but evidently not sufficiently hardy to frost to be worth planting in the western Transvaal except in very sheltered situations.

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Morus alba Linn.

Family.

MORACEAE

Common Name.

Mulberry

Natural Distribution.

Probably indigenous to China, but now naturalised in most warmer-temperate and sub-tropical parts of the world (Streets, 1962).

Provenance.

The origin of the plants used to establish plots in the Lichtenburg and Potchefstroom Arboretum can no longer be ascertained.

Description of the Species in its Native Habitat.

A tree up to 50 feet (15 m.) tall, with a spreading crown (ibid.)

Economic Importance in Country of Origin.

The species is cultivated for its fruit and as a food plant for silk-worms. It also yields a timber of good quality, which is used for boats, furniture, turnery, sports goods and sundry other purposes (ibid.)

Trials in the Arboreta at Lichtenburg and Potchefstroom.

The plot at Lichtenburg was established in January, 1907, when 122 plants were put out at an espacement of 6 x 6 feet (2 x 2 m.)

Early spring growth was caught by frost in 1909, but otherwise the trees seem to have suffered little as a result of climatic agencies. They were, however, very bushy and made poor growth, having a height of no more than  $3\frac{1}{2}$  feet (1 m.) in March, 1913. Later that same year they began to have an unthrifty appearance. No improvement in their condition took place as time passed, and by 1927 practically all of them had died off.

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At Potchefstroom, the trial was commenced in 1908, using plants 1 year old and 2 feet (60 cm.) high, of which 81 were set out at an espacement of 6 x 6 feet (2 x 2 m.).

The young trees were repeatedly injured by late frosts between 1909 and 1913, as a consequence of which they developed a bushy habit. Drought in 1913 and 1916 added to the damage already caused by frost, despite which the condition of the trees was by no means moribund for they bore heavy crops of fruit from about 1914 onwards. Although growth was very slow, the mean height of the stand being only 10 feet (3 m.) in 1927, survival was remarkably good since 77 of the original 81 trees still remained on the plot that year.

Further progress was compromised by a decision to use the trees as a source of cuttings for sale to the public, and in 1959 only coppice re-growth remained. Half of the plot was vacant, but the stools on the other half seemed healthy and had sent up shoots to a height of 13 feet (4 m.)

#### Discussion of Results.

This useful tree is evidently not quite as hardy as is often supposed, and should not be recommended for planting in the western Transvaal except in sheltered situations and in places where it can be watered, if need be, during periods of prolonged drought.

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M. alba f. tartarica (Pallas) Seringe,  
(Syn. M. tartarica Pallas)

Common Name.

Russian Mulberry

Natural Distribution.

A reputedly hardy form of the species found in Russia, which differs little from the type in botanical characteristics (Bailey, 1947).

Provenance.

Seed was supplied by Thomas Meehan and Son and may have been collected in the United States, where the trees have been cultivated for some time.

Description of the Form in its Native Habitat.

As commonly encountered, a low, bushy, almost flat-topped tree with small, lobed leaves.

Trial in the Arboretum at Potchefstroom.

The trial was commenced in August, 1908, when 81 plants 2 seasons old and 2 feet (60 cm.) high were put out at a 6 x 6-foot (2 x 2 m.) espacement.

The young trees came through their first winter very well, but early growth was caught by frost towards the end of September the following year. The damage recurred in 1912 but did not much affect the vigour of the trees, which were laden with fruit a year later and reached an average height of 8 feet (2 m.) in 1914.

For a time the trees continued in a very thrifty condition and bore an abundance of fruit. In 1919 they were reported to be suffering from drought but the following year had quite recovered. By 1925, although their height had increased to about 15 feet (5 m.) it was observed that they had started to become stag-headed. From this time onwards their health seems to have declined quite rapidly, for in 1929 most of them were either moribund or dead.

Nothing was left of the stand in 1959.

Discussion of Results.

The form tartarica is evidently slightly more cold-resistant than the species itself, though not, by any means, proof against late frost in the western Transvaal. It also grows more vigorously at first under harsh conditions than the type, but seems to have an appreciably shorter span of life.

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Pinus arizonica Engelm.

(Syn. P. ponderosa Dougl. ex Laws. var. arizonica Shaw.)

Family.

PINACEAE.

Common Name.

Arizona Pine

Natural Distribution.

A native of the United States and Mexico, where it occurs fairly abundantly at an elevation of 6,000 to 8,000 feet (1,825 to 2,438 m.) on flats, rocky slopes and canyon walls from southern Arizona and New Mexico to Durango. It is essentially a tree of high, cool, mountain regions, reaching its best development in the southern part of its range in localities with a rainfall of 20 to 35 inches (500 to 890 mm.) a year. On deep, sandy soils it sometimes forms pure, fairly dense stands, but on stony ground and on hillsides it is associated with other species such as P. engelmanni and P. leiophylla (Loock, 1950: Sargent 1922.)

Provenance.

Seed for the trial at Lichtenburg was supplied by one Mr. Gooding and was probably collected in Mexico.

Description of the Species in its Native Habitat.

A large tree, commonly 80 to 90 feet (24 to 27 m.) tall and 2 to 3 feet (60 to 90 cm.) in diameter but occasionally reaching a height of 120 feet (37 m.) and a diameter of 4 feet (122 cm.) It develops a massive, symmetrical, somewhat tapering bole, sometimes free of branches for one-half of its total length. Its limbs are thick and spreading, and form an open, round-topped or pyramidal head (Harlow and Harrar, 1937; Sargent 1922).

Economic Importance in Countries of Origin.

The tree yields a light, soft, fine-textured but rather brittle wood with a pinkish heart, and is used to a limited extent in the United States for lumber.

Trial in the Arboretum at Lichtenburg.

The plot was established in March, 1912, when 127 plants aged 18 months, which had been raised in the Irene Forestry Nursery, were set out at an espacement of 6 x 6 feet (2 x 2 m.)

The young stand came through its first two winters without suffering any casualties, but a year later seems to have been affected by drought. From this it soon recovered and for several years made steady, if slow growth, some of the trees reaching a height of 8 feet (2m.) in 1918. Sixty-six trees died from frost and drought in 1920. Thirteen more were defoliated by locusts but recovered fairly rapidly. Growth, however, continued to be slow, for the largest trees measured a mere 15 feet (5 m.) in height and 6 inches (15 cm.) in diameter in 1930. Two years later, only seventeen living trees were counted on the plot, and by November, 1933, these had all died.

Discussion of Results.

P. arizonica is an exceedingly frost-resistant species, having survived at such centres as Belfast and Harrismith where the winters are more severe than in the western Transvaal. It is therefore reasonable to conclude that drought, rather than frost, was primarily responsible for the failure of the plot at Lichtenburg. Be this as it may, the species is evidently unsuited to conditions in the western Transvaal, besides which its low rate of growth, even in the more humid parts of the country, renders it of little or no value for afforestation purposes.

Pinus canariensis Sm.Family.

PINACEAE

Common Name.

Canary Pine.

Natural Distribution.

Endemic in the Canary Islands, where it was formerly widespread but is now practically confined to the moister, more westerly isles of the group. It occurs chiefly on dry, exposed, volcanic slopes at an altitude of between 3,700 and 6,600 feet (1,127 and 2,011 m.) Here it still forms quite extensive forests on Tenerife, Palma and Grand Canary. Its full altitudinal range is from sea level to 8,000 feet (2,438 m.) Mean, monthly temperatures fluctuate from 40°F. (4°C.) in winter to 75°F. (24°C) in summer, while the rainfall varies from 16 to 25 inches (40 to 63 mm.) a year, occurring mainly during the winter months. Summers are hot and dry, and the climate is thus of the Mediterranean type (Dallimore and Jackson, 1961; Streets, 1962).

Provenance

Seed for the trial at Potchefstroom was purchased from the French firm of seed merchants, Messrs. Vilmorin-Andrieux.

Description of the Species in its Native Habitat.

A large tree, usually 80 to 100 feet (24 to 30 m.) tall and 10 feet (3 m.) in diameter but in exceptional cases attaining a height of 135 feet (41 m.) Young specimens have a typically erect, rather narrow crown, but mature trees are more spreading and may have a somewhat weeping habit.

Economic Importance in Country of Origin.

The species yields one of the strongest and most

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durable of all softwood timbers. The heartwood, which is of a reddish-brown colour and very distinct from the yellowish sapwood, has remarkable lasting qualities. In the dry climate of the Canary Islands, objects fashioned from it remain sound after exposure to the weather for as much as 200 years. Supplies, however, are scarcely sufficient to meet the local demand, and none is available for export. The soft foliage of the tree is gathered off the ground and used for packing bananas (Dallimore and Jackson, 1961).

Trial in the Arboretum at Potchefstroom.

The plot was established in February, 1908, when 81 plants 2 years old and 9 inches (23 cm.) high were put out at an espacement of 6 x 6 feet (2 x 2 m.)

The young trees stood the winter of 1908 well, but their leaders were cut back by frost several times during the next few years. In 1913 they appeared to be slightly affected by drought. Nevertheless, their average height in 1914 was 10 feet (3 m.) and this had increased to 20 feet (6 m.) by 1918, when they were pruned to 6 feet (2 m.)

Light frost damage recurred, and in 1923 it seemed at one stage that the whole plot would "go off with drought" unless rain fell within a few weeks. The trees recovered, however, and resumed their satisfactory growth, reaching an average height of 35 feet (11 m.) in 1927.

A thinning appears to have been carried out subsequent to this, for, of the 78 trees which stood on the plot in 1929, only 26 (equivalent to a stocking of 388 stems per acre) (958 per hec.) were left in 1959. These had a mean D.B.H. of 9.7 inches (25 cm.) and a height of 67 feet (20 m.) Their form was very good and their appearance healthy but for the fact that a few had dead tops. They had light and, in most cases, extremely short branches, although



PINUS CANARIENSIS : POTCHEFSTROOM

their stems were clothed with epicormic shoots.

#### Discussion of Results.

This hardy and versatile species has been planted on a fairly large scale under a remarkably wide range of conditions in South Africa, primarily for the production of telephone and transmission poles. Originating from a part of the world which experiences a Mediterranean-type climate, it is not naturally fitted to the summer rainfall area, though such is its adaptability that it has been used extensively for afforesting rather dry sites in the eastern Cape Province. Conditions in the western Transvaal are evidently marginal for it, however, since the plot at Potchefstroom was affected by both frost and drought. The rate of growth of the species in the area is also too low for economic pole production (as might be expected), although its form there is up to the required standard.

P. canariensis is very seldom seen in the western Transvaal and, all things considered, cannot be recommended for planting in the area except for shade and ornament in situations where it can be given some attention.

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Pinus cembroides Zucc.Family.

PINACEAE

Common Name.

Mexican Nut Pine

Natural Distribution.

Widely distributed in Mexico from Sonora and Chihuahua to Vera Cruz, Puebla and Lower California, whence its range extends northwards to Arizona and Texas in the U.S.A. It occurs mainly at elevations of from 6,000 to 8,000 (1,828 to 2,438 m.). The climate is fairly cool, and the rainfall between 15 and 20 inches (380 and 500 mm.) per annum. The tree is found both in pure, open forests and in mixture with scrub oaks, yucca and junipers (Loock, 1951; Sargent, 1922).

Provenance.

The seed used at Potchefstroom was seemingly collected by Mr. Leslie Gooding in Mexico, but the record of that supplied to Lichtenburg is hopelessly confused.

Description of the Species in its Native Habitat.

A small, somewhat bushy tree, usually only 10 to 25 feet (3 to 5 m.) tall but sometimes reaching a height of 40 feet (12 m.) or more, with a bole up to 1 foot (30 cm.) in diameter. Its crown is rounded and rather spreading, and is supported by stout, slightly ascending branches.

Economic Importance in Country of Origin.

The tree is of little or no economic value other than for its large, oily seeds, which are an important article of diet in northern Mexico and are sold in considerable quantities in the towns (Sargent, loc cit.)

Trials in the Arboreta at Lichtenburg and Potchefstroom.

Two, small plots of the species were established in the Lichtenburg Arboretum in 1913, of which one is purported to represent the variety edulis but consists, in fact, of a mixture of uncertain identity. The remarks below are therefore confined to the other, pure stand, which was planted up at the very close espacement of 4 x 4 feet (1.2 x 1.2 m.) The 248 plants used for it were raised at Belfast and were 2 years old and 4 to 6 inches (10 to 15 cm.) high at the time when they were put out.

A good many failures occurred during the first winter. The remaining trees looked healthy, but their growth was very slow at first and only a few of them had reached a height of 2 feet (60 cm.) by 1917. Therefore their vigour improved somewhat, for in 1923 their mean height was 8 feet (2 m.) and by 1929 it had increased to 15 feet (5 m.) The stand retained its healthy appearance and seemed to be completely unaffected by frost or drought.

Growth continued steadily, if slowly, and in 1959 the remaining 84 trees on the plot had a mean D.B.H. of 4.8 inches (12 cm.) and a height of 28 feet (9 m.) Their stems were straight and their branches light, but several of them were forked.

At Potchefstroom, the trial was commenced in January, 1909 when 81 plants 10 months old and 6 inches (15cm.) high were put out at an espacement of 6 x 6 feet (2 x 2 m.)

As before, a number of blanks occurred during the first winter. The initial growth of the trees was again very slow, and the tallest of them had reached a height of 2 feet (60 cm.) by October, 1912. Their appearance was healthy, however, and their vigour gradually improved, for in 1920 they had an average height of 7 feet (2 m.) This had risen



PINUS CEMBROIDES : LICHTENBURG

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to 12 feet by 1927.

In 1959, 24 trees were left on the plot, representing a stocking of 358 stems per acre (884 per hec.). These had a mean D.B.H. of 6.4 inches (16 cm.) and a height of 40 feet (12 m.) Their appearance was particularly pleasing, for they had an erect, graceful habit and regular shapely crowns. Only a few of them were forked and the whole stand still seemed very healthy.

#### Discussion of Results.

The economic limitations of this species are obvious, for it is far too slow-growing to be of any use for timber production. It does, however, make a delightfully attractive little tree, with erect trunk, long, slender, graceful branches and quaintly tufted, short needles. Its nuts are remarkably palatable. Bearing in mind its exceptional resistance to drought and frost, there need be no hesitation in recommending it for ornamental use in the western Transvaal.

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Pinus engelmanni Carr.

(Syn. P. macrophylla Engelm.)

Family.

PINACEAE

Common Name.

Engelmann's Pine.

Natural Distribution.

Confined to the mountains of northern Mexico and the southern U.S.A. In Mexico it is found in the States of Zacatecas, Durango, Sinaloa, Sonora and Chihuahua and in the U.S.A. in New Mexico and Arizona. It occurs mostly in the temperate-colder zone at an elevation of between 7,000 and 8,000 feet (2,134 to 2,438 m.), more especially in localities with a predominantly summer rainfall of from 20 to 30 inches (500 to 760 mm.) a year. It is most common on dry, stony sites, where it seldom exceeds a height of 60 feet (18 m.) On better soils it becomes considerably larger. Although often found in pure, open stands, it usually occurs in association with other species such as P. arizonica, P. durangensis and P. leiophylla (Loock, 1951; Streets, 1962).

Provenance.

Seed for the trial at Lichtenburg was collected by Mr. Leslie Gooding in Mexico.

Description of the Species in its Native Habitat.

A large tree 100 feet (30 m.) or more in height and 36 inches (90 cm.) in diameter on favourable sites, where it develops a straight bole free of branches for up to 50 feet (15 m.) surmounted by a large, roundheaded crown (ibid.)

Economic Importance in Country of Origin.

The wood of this species is yellowish-white in colour and rather soft, but otherwise of good quality. It

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is used for constructional purposes and for the manufacture of boxes (ibid.)

Trial in the Arboretum at Lichtenburg.

A very small plot was established in March, 1913, when 26 plants 12 inches (30 cm.) high, but already 4 years old, were put out at the unusually close espacement, even for those times, of 4 x 4 feet (1.2 x 1.2 m.)

The young trees were quite untouched by frost and had a healthy appearance right from the start, but periodic losses were caused by drought. Thus, 4 trees died off in 1916, one in 1920, one in 1922 and yet another in 1923. In spite of these failures the rest were described as "looking well" in 1925, and had an average height of nearly 10 feet (3 m.)

Ten years later, the number of trees left on the plot had decreased sharply to 8, and the appearance even of these was no longer very promising. By 1938 two more failures had occurred. Only one, solitary specimen survived in 1959. This was 15 feet (5 m.) tall and 5.6 inches (14 cm.) in diameter. Its bole was erect and straight but its crown, although still healthy, was rather coarsely branched.

Discussion of Results.

P. engelmanni is clearly unable to stand the dry climate of the western Transvaal. It is, in any case, a slow-growing species, and therefore of little practical value even in the more humid parts of the country.

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Pinus halepensis Mill.Family

PINCEAE

Common Name

Aleppo Pine

Natural Distribution

Widely distributed in the Mediterranean region, where it occurs in Portugal, Spain, south-eastern France, Italy, Greece, Morocco, Algeria, Asia Minor and the Levant. Towards its eastern limit, particularly on the island of Cyprus, the typical form of the species is replaced by the variety brutia, which is usually a much larger and silviculturally more desirable tree. The species occurs from sea level up to an altitude of 5,000 feet (1,520 m.) but is most common in the coastal plain and on the foothills of the mountains. It is exceedingly drought-resistant, thriving in areas with a rainfall of only 15 inches (380 mm.) a year (little or none of which occurs during the long, hot summer) and is found on a wide variety of soils (Streets, 1962).

Provenance.

The seed used for the trial at Potchefstroom was obtained from Messrs. Vilmorin-Andrieux of Paris, but nothing definite is known with regard to the origin of that sent to Lichtenburg.

Description of the Species in its Native Habitat.

A medium-sized tree, usually no taller than 50 to 60 feet (15 to 18 m.) though occasionally 80 feet (24 m) in height and 12 to 15 feet (4 to 5 m) in girth. Its bole is often rather crooked, and it has a thin, but lightly-branched crown (ibid.)

Economic Importance in Countries of Origin.

The tree is planted extensively within its native

habitat, chiefly in the form of windbreaks and for the purpose of sand fixation. Its timber is of rather poor quality, being coarse-grained and resinous. The wood is, however, employed for poor-class joinery, telegraph poles, firewood and charcoal. In Algeria and Greece the tree is tapped on a large scale for resin.

Trials in the Arboreta at Lichtenburg and Potchefstroom.

The plot at Lichtenburg was established in 1906 at an espacement of 6 x 6 feet (2 x 2 m.) using plants 12 months old and 6 inches (15 cm.) high.

The young trees made rather irregular growth but were not in the least affected by frost or drought until 1914, when their foliage showed the effects of the long, dry winter. Their recovery was complete, however, and no losses occurred. Again, in September 1919, they appeared to be suffering very much from drought, but the following year they regained their former vigour.

A light thinning was carried out in 1923, but a year later it began to be noticeable that, although the outer rows of trees were healthy, the centre of the stand was becoming unthrifty. At this stage, the plot began to be visibly affected by competition from an adjoining stand of Eucalyptus polyanthemus. Several trees died in 1925, and in spite of the fact that at least one more thinning was undertaken, persistent losses occurred thereafter.

Only 9 trees survived until 1959. These had a mean D.B.H. of 10.3 inches (26 cm.) and a height of 55 feet (17 m.) The plot was completely bare in the centre and on the side adjacent to the eucalypts. The trees which remained all had a fairly heavy lean towards the south, though their boles were reasonable straight and their branches light, if numerous. A compartment of the species nearby in the plantation was much more evenly, but again sparsely stocked.



PINUS HALEPENSIS : LICHTENBURG

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The trial at Potchefstroom was commenced in 1908, in which year 81 plants 18 months old and 9 inches (23 cm.) high were put out at the same espacement at Lichtenburg.

The young trees did not seem to suffer at all from drought and escaped injury from frost until 1910, in which year the tops of most of them were badly "scorched." By 1914 their average height was 14 feet (4 m.) and they were in a vigorous condition. However, 8 trees in the centre of the plot started to go off the following year, and two failures occurred both in 1917 and in 1918.

A light thinning was administered in 1918, but despite this 4 trees died of drought a year later. Five more succumbed to drought in 1922, and yet 5 more in 1924. A second thinning was carried out in 1927, after which only 28 trees, whose average height was 40 feet (12 m.) were left. Notwithstanding the reduced competition, another tree died in 1929.

In 1959, 9 trees (equivalent to a stocking of 134 stems per acre (330 per hec.) remained on the plot. The average D.B.H. and height of these were, respectively, 14.6 inches (37 cm.) and 78 feet (24 m.) Their form was reasonably good and their appearance still healthy, for they had lofty boles and lightly-branched but dense crowns.

#### Discussion of Results.

Like all other species from the Mediterranean region, P. halepensis is not really suited to the climate of the western Transvaal, where it suffers during the long, winter drought. Single specimens, which do not have to compete with other trees for moisture, succeed fairly well in the area, but the species cannot be recommended for farm woodlots or even for shelterbelts.

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Pinus leiophylla Schl. et. Cham.Family.

## PINACEAE

Natural Distribution.

Widely distributed throughout central Mexico, where it is found in the States of Chihuahua, Coahuila, Durango, Zacatecas, Nayarit, Jalisco, Michoacan, Guerrero, Mexico, Hidalgo, Morelos, Tlaxcala, Puebla, Vera Cruz and Oaxaca. From Mexico, its range extends northwards into Arizona and New Mexico in the southern United States and southwards into Guatemala. It reaches its best development at an altitude of 7,000 to 8,500 feet (2,134 to 2,590 m.) in Durango and parts of Chihuahua, where fairly severe frosts and frequent falls of snow are experienced in winter. Typically it occurs in mixture with P. durangensis, P. engelmanni and other cooler-temperate species, but in the warmer-temperate and sub-tropical zones it is associated with P. michoacana, P. montezumae and various oaks (Loock, 1951; Streets, 1962).

Provenance.

Plants used for the trial at Potchefstroom were raised in the Irene nursery, outside Pretoria, from seed supplied by Messrs. Vilmorin-Andrieux of France.

Description of the Species in its Native Habitat.

A large tree up to 100 feet (30 m.) in height and 36 inches (90 cm.) in diameter. In dry localities on the edge of the main forest belt and on shallow, stony soils it remains, however, a small to medium-sized tree 70 to 80 feet (21 to 24 m.) tall, usually of rather poor form (Loock, loc.cit.)

Economic Importance in Country of Origin.

The species yields a hard, heavy resinous timber

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with a yellowish sapwood and pinkish heart. Young trees are commonly employed for hewn railway sleepers, but the larger logs are marketed with those of other pines and used as structural timber or for box manufacture.

#### Trial in the Arboretum at Potchefstroom.

The plot was established in March, 1915, 81 plants 18 months old and 6 inches (15 cm.) high being set out at a 6 x 6 foot (2 x 2 m.) espacement.

During the ensuing winter the young trees suffered considerably from drought, and 20 failures occurred. The rest of them had a promising appearance one year later, however, and were making vigorous growth.

In 1919 the trees shed their needles as a result of drought, but by 1920 their recovery was complete and they had attained an average height of 18 feet (5 m.) This cycle was repeated, for in 1922 they were again reported to be feeling the drought very much, yet in 1927 the 58 of them that remained had regained their vigour and had increased in height to 35 feet (11 m.) The improvement was short-lived, however, for only 35 were still alive in 1929, and most of these were stag-headed.

In 1959 the plot was vacant.

#### Discussion of Results.

The species is evidently not sufficiently drought resistant to be planted in the western Transvaal, although a stand at Groenkloof Plantation just outside Pretoria, where the average rainfall is only 7 inches (180 mm.) a year more than at Lichtenburg, made satisfactory growth and reached maturity, shallow soil notwithstanding.

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Pinus michoacana MartinezFamily

PINACEAE

Natural Distribution.

Mainly confined to the temperate-warmer and subtropical regions of southern Mexico, where it occurs at an altitude of 6,000 to 8,000 feet (1,828 to 2,438 m.) in localities with a rainfall of 35 inches (890 mm.) or more a year. It is most abundant in the State of Michoacan, growing on the foothills and lower slopes of the mountains in rather open formation with P. leiophylla, P. montezumae and other pines, but it is also found in Nayarit, Jalisco, Oaxaca and Chiapas. Although encountered on poor as well as on more favourable sites, it is on deep soils of a somewhat sandy nature that it reaches its best development (Loock, 1951).

Provenance.

The plot at Lichtenburg was established from seed supplied by Messrs. Vilmorin-Andrieux, but nothing is known with regard to the provenance of that used at Potchefstroom.

Description of the Species in its Native Habitat.

A large tree up to 80 feet (24 m.) in height and 36 inches (90 cm.) in diameter, with an erect bole, somewhat heavy branches and a dense, rounded crown (ibid.)

Economic Importance in Country of Origin.

The tree has a fairly hard, heavy, yellowish-white, resinous wood, which is said to be of good quality (ibid.)

Trials in the Arboreta at Lichtenburg and Potchefstroom.

At both centres the species was established under the name "P. montezumae var. lindleyi", though incorrectly, for London apparently first applied this designation to a

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taxon with shorter needles and cones than those of  
P. michoacana.

The trial at Lichtenburg was commenced in March, 1913, when 248 plants 2 years old and 4 to 6 inches (10 to 15 cm.) tall, which had been raised in the Belfast Forestry Nursery, were put out at the unusually close espacement of 4 x 4 feet (1.2 x 1.2 m.)

A good many blanks occurred during the first winter, and in September, 1914, the young trees seemed to be suffering from drought. In March, 1916, the blanks were rather belatedly filled, but by the end of the winter all the new plants, as well as some of the older ones, had succumbed to drought.

Only a few trees still looked healthy in 1918, and within the next year many died of drought. Thirty-four more failures occurred in 1920, after which there remained only 5 trees on the plot. In 1921 their number dwindled to 3, and even these had a very sickly appearance.

The 3 remaining trees were defoliated by locusts in 1924, but recovered and reached a height of 12 feet (4 m.) a year later. Their condition, however, remained poor, and in 1959 the plot was vacant.

At Potchefstroom, the plot was established in 1917 at an espacement of 6 x 6 feet (2 x 2 m.), using 81 plants 1 year old and 12 inches (30 cm.) high.

Later that year the young trees were reported to be progressing favourably, but most of them were killed by frost or drought the following winter. By 1920 only 12 were left, the rest having succumbed to drought.

Eight trees remained in 1927, by which time their average height was 20 feet (6 m.) Only 3 of these (equivalent to a stocking of 45 stems per acre (111 per hec.) were still in existence in 1959. They had reached

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comparatively large size, for their average D.B.H. was 20 inches (51 cm.) and their height was 67 feet (20 m.) Their form was also fairly good, but only one of them still looked healthy.

Discussion of Results.

The results of these trials are disappointing, for at Groenkloof Plantation, near Pretoria, the species has grown more vigorously than any other pine although planted on soil of no great depth. However, the outcome can be considered almost inevitable since the tree occurs naturally in areas with a rainfall in excess of 35 inches (890 mm.) a year. It is clearly too susceptible to drought for planting in the western Transvaal, and further trials in the area are unlikely to be any more successful.

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Pinus montezumae Lamb.Family

PINACEAE

Common Name

Montezuma Pine

Natural Distribution

Widely distributed in Central America from the State of Coahuila in northern Mexico to Guatemala, reaching its best development under warmer-temperate conditions at altitudes of about 8,000 or 9,000 feet (2,438 or 2,743 m.) and in localities with a rainfall of 35 inches (890 mm.) more per annum. It attains its greatest size on deep, alluvial soils, and is usually associated with other pines such as P. leiophylla and P. michoacana (Loock, 1951).

Provenance

The plants used at Lichtenburg were raised in the Belfast Forestry Nursery from seed supplied by Messrs. Vilmorin-Andrieux, but there is nothing on record concerning the origin of the stand at Potchefstroom.

Description of the Species in its Native Habitat

A large tree up to 100 feet (30 m.) in height and 36 inches in diameter, with a straight bole free of branches for 40 feet (12 m.) or more and a dense, spreading crown (Loock, loc. cit.)

Economic Importance in Countries of Origin.

A forest tree of considerable importance, for, besides yielding a good, strong, rather heavy, resinous timber, it is also used for resin tapping (Streets, 1962).

Trials in the Arboreta at Lichtenburg and Potchefstroom.

The plot at Lichtenburg was established in March, 1913, at an espacement of 4 x 4 feet (1.2 x 1.2 m.), using plants 2 to 3 years old and from 4 to 6 inches (10 to 15 cm) high.

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An estimated 20 per cent of the young trees failed during the first winter, and a belated attempt to blank the stand 3 years later was totally unsuccessful. In 1914, the trees were visibly affected by drought, but made surprisingly good growth and reached an average height of 18 feet (5 m.) by September the following year. The cycle was repeated in 1917, for again the trees were badly hit by drought but recovered and resumed their vigorous growth. The respite which followed was brief, however, for 145 of them died off in 1920 and many more began to look very sickly. Further losses occurred in 1922 and 1923, and in 1924 the rest were defoliated by locusts. Three years after this the few survivors had sunk into a complete moribund condition and were cut out.

The trial at Potchefstroom was initiated in 1917, in which year 81 plants 12 months old and 8 inches (20 cm.) high were put out at an espacement of 6 x 6 feet (2 x 2 m.)

The young trees looked very promising after their first winter but 40 of them were suffocated by weed growth or else succumbed to frost the following year. In 1919 only 9 still remained alive, and these were suffering from drought.

The surviving trees made little growth and were continually affected by drought. Their numbers had decreased to 2 by 1927, and they were still no more than 10 feet tall. Although they lingered on for several years longer, in 1959 no trace of them was left.

#### Discussion of Results.

*P. montezumae* is a potentially useful timber tree in the moister parts of the summer rainfall area, although its rather heavy crown has so far discouraged planting on a very large scale. It is, however, obviously unsuited to very dry areas such as the western Transvaal.

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Pinus muricata D. Don.Family

PINACEAE

Common Name

Bishop Pine

Natural Distribution

A native of the coastal ranges of California, U.S.A. where it occurs in widely separated localities from Mendocino Country in the north to the Cedros Islands off the coast of Lower California in the south. It attains its greatest size in the northern parts of its range. Although it often forms pure stands, it is never found in sufficient abundance to be of more than local importance. In places it grows on exposed, rocky headlands, at one point in association with P. radiata, but in general it shows a preference for swampy sites and peat bogs (Harlow and Harrar, 1937; Streets, 1962).

Provenance.

The plants used at Lichtenburg were raised in the Irene Forest Nursery, but nothing is known with regard to the origin of the seed.

Description of the Species in its Native Habitat.

A medium-sized to large tree, usually 40 to 50 feet (12 to 15 m.) tall but sometimes reaching a height of 90 feet (27 m.), with a trunk 2 to 3 feet (60 to 90 cm.) in diameter. Its branches are somewhat thick, in youth forming a regular, pyramidal crown which, however, develops at maturity into a dense, compact, round-topped head (Sargent, 1922).

Economic Importance in Country of Origin.

The tree yields a light, hard, very strong, rather coarse-grained wood of a white to light brown colour,

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Although occasionally used for lumber, it is of little economic importance (Sargent, loc. cit.)

Trial in the Arboretum at Lichtenburg.

The trial was commenced in 1913, when 248 plants 8 to 12 inches (20 to 30 cm.) tall were put out at an espacement of 4 x 4 feet (1.2 x 1.2 m.)

About 60 per cent of the young trees were killed by frost during their first winter, and a year later the remainder seemed to be feeling the drought. Only a few still survived in 1915, though these had a more healthy appearance and were making some growth. Blanking was undertaken in 1916 but was a complete failure, and the stand again seemed to be suffering from drought. The trial was finally abandoned in 1923, all but 10 of the trees having succumbed to frost and drought.

Discussion of Results.

The species is quite unsuited to conditions at Lichtenburg, coming, as it does, from a maritime climate of the Mediterranean type and having a preference for moist sites. Its failure, therefore, is no cause for surprise.

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Pinus palustris Mill.(Syn. P. australis Mich.)Family

PINACEAE

Common Name.

Long-leaf pine

Natural Distribution

A native of the coastal plains and hills of the south-eastern United States, where its range extends from Virginia to the Florida Everglades and thence along the gulf of Mexico to Texas. It occurs from sea level to an altitude of 1,900 feet (580 m.) (in Alabama), but the climate throughout is warmer-temperate to sub-tropical, with a long growing season and high humidities. The tree grows best on well-drained, sandy soils, but tolerates a wide variety of sites, including those in which hardpan occurs near the surface. Such sites may be covered in spring by shallow pools of standing water yet become extremely dry during summer. The rate of growth under these conditions is very low, but the species nevertheless maintains itself over extensive areas in almost pure stands (Harlow and Harrer, 1937; Streets, 1962).

Provenance.

The seed used for the trial at Lichtenburg was received from Messrs. Vilmorin-Andrieux, but the place of collection is not known.

Description of the Species in its Native Habitat.

A fairly large tree, typically from 80 to 120 feet (24 to 37 m.) tall and 2 to 2½ feet (60 to 76 cm.) in diameter though occasionally attaining a height of 150 feet (46 m.) and a diameter of 4 feet (122 cm.) It develops a long, clean bole and a small, open crown.

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Characteristically its needles occur in tufts at the ends of the branchlets. Underground, it forms a very deep taproot (soil conditions permitting) and many, wide-spreading laterals (Harlow and Harrar, loc. cit.)

#### Economic Importance in Country of Origin.

The most important of the "Southern Pines", the species yields the "American Pitch Pine" of commerce. Its wood is very hard, heavy and durable, and is preferred to that of almost any other pine for heavy constructional work, ship-building, masts, sleepers, flooring and similar purposes. Besides this, the tree is also the chief source of resin in the United States (Streets, 1962).

#### Trial in the Arboretum at Lichtenburg.

Plants for the trial at Lichtenburg were raised in the Irene Forest Nursery and were put out in March, 1912, at an espacement of 6 x 6 feet (2 x 2 m.) when 12 to 18 months old and 6 to 9 inches (15 to 23 cm.) high.

Sixteen blanks were filled a year after the plot was established, and several more trees died - apparently from drought - the following year. Twenty-two more losses occurred in 1916, notwithstanding which the more vigorous trees made tolerably good progress and reached a height of 7 to 9 feet (2 to 3 m.) two years later. In 1919, however, half of their number was said to be failing as a result of drought, and the following year only 8, unhealthy specimens remained alive. By 1922 the number of survivors had decreased to 3, and the last of these succumbed in 1926.

#### Discussion of Results.

Although this species enjoys a reputation in the United States for considerable drought-hardiness, in South Africa it has suffered more during years of abnormally low rainfall than any other pine used for commercial afforestation

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in the eastern Transvaal. With this in mind, its failure from drought at Lichtenburg might well be regarded as a fore-gone conclusion.

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Pinus patula Schlecht. et. Cham.Family

PINACEAE

Common Name

Patula Pine.

Natural Distribution

The species has a comparatively limited range in central Mexico and Guatemala, occurring, in the former, only in the States of Queretaro, Hidalgo, Puebla and Vera Cruz. It abounds in the temperate zone at altitudes of between 6,000 and 10,000 ft., (1,828 to 3,048 m.) forming dense, pure stands in areas where the rainfall averages 40 inches (1,000 mm.) or more a year and where mist is frequent. It reaches its best development in ravines and on flats with deep moist, well-drained, loamy soil. In drier localities and on poor, gravelly or shallow soils it is usually replaced by other pines and broad-leaved species (Loock, 1951; Streets, 1962).

Provenance.

The seed supplied to Lichtenburg for trial in the Arboretum was received from Messrs. Vilmorin-Andrieux, but no record exists of the origin of that used at Potchefstroom.

Description of the Species in its Native Habitat.

A large tree 100 feet (30 m.) or more in height and 36 inches (90 cm.) in diameter, with a straight bole free of branches to about 50 feet (15 m.) and a more-or-less rounded crown (Loock, loc. cit)

Economic Importance in Country of Origin.

The tree yields a soft, light, brittle, yellowish-white timber which is used mainly for the manufacture of boxes, though the outer shell (with more closely-spaced rings) is considered suitable for flooring (ibid.)

Trials in the Arboreta at Lichtenburg and Potchefstroom

The plot at Lichtenburg was established in March, 1913, when 248 plants 2 years old and 4 to 6 inches (10 to 15 cm.) high, which had been raised in the nursery at Belfast, were put out at an espacement of 4 x 4 feet (1.2 x 1.2 m.)

A good many of the young trees failed during their first winter and by September, 1914, 30 had been killed by drought. Heavy losses were again caused by drought in 1916, after which only 12 trees survived. By 1920 the plot was vacant.

The trial at Potchefstroom was commenced several years later, 81 trees 12 months old and 10 inches (25 cm.) high being planted out in 1917 at an espacement of 6 x 6 feet (2 x 2 m.)

Many of the young trees died off that same year, and by 1922 all but 47 of them had succumbed to drought. The rest went on to make surprisingly good growth, reaching a height of 30 feet (9 m.) in 1927, but their appearance was unhealthy and only 10 of them lived to 1933. All trace of them had finally disappeared in 1959.

Discussion of Results.

*P. patula* is essentially a tree for the cooler and more humid parts of the summer rainfall area, particularly those in which mists are experienced at intervals throughout the year. It is not at all suited to the western Transvaal, being much too susceptible to drought, and is not recommended for planting in the area.

Pinus pinaster Aiton.

(Syn. P. maritima Poiret.)

Family

PINACEAE

Common Name

Cluster or Maritime Pine

Natural Distribution

A tree of the Mediterranean region, where its range extends from the Atlantic seaboard of southern France, through Portugal, Spain, Corsica and Italy, eastwards as far as Greece. In North Africa it is found along the coast of Algeria and Morocco. It is chiefly abundant at low elevations near the sea, more particularly on well-drained, sandy soils. The climate throughout is fairly mild, with a temperature range of about 25<sup>o</sup> to 95<sup>o</sup> F (-4<sup>o</sup> to 35<sup>o</sup>C). The annual rainfall is between 25 and 50 inches, (635 and 1,270 mm.), most of it occurring during the winter (Streets, 1962).

Provenance.

The seed used for the trial at Potchefstroom seems to have been supplied by Messrs. Volmorin-Andrieux of France.

Description of the Species in its Native Habitat.

A moderately large tree up to 120 feet (37 m.) tall and 14 feet (4 m.) in girth, with a long, clean bole at maturity (ibid.)

Economic Importance in Countries of Origin.

A valuable timber tree, yielding a fairly heavy, hard, coarse-grained, resinous wood which is used for building construction, joinery, box-making, pit props and pulp. It is not naturally durable in contact with the ground, but after impregnation may be used for railway sleepers and telegraph poles. The tree is one of the chief commercial sources of resin, in addition to which it is used

very extensively for the reclamation of coastal sand dunes.  
Trial in the Arboretum at Potchefstroom.

The plot was established in 1908, when 81 plants 9 inches (23 cm.) high and 18 months old were out out at an espacement of 6 x 6 feet (2 x 2m.)

The young trees stood their first winter well but made slow growth, and two of them failed a year later. By 1914 they had attained a height of 6 feet (2 m.) and seemed to be in a more healthy condition. Another tree died in 1917 without apparent reason. The following year the stand presented a very uneven appearance, some of the trees being 20 feet (6 m.) tall and others only 6 feet (2 m.)

Several trees commenced to die back from the top in 1920, In 1922 five more failures occurred, notwithstanding the fact that the stand now had an average height of 25 feet (8 m.) From then onwards the condition of the survivors deteriorated rapidly for only a few remained healthy 2 years later. No trace of them was left in 1959.

#### Discussion of Results.

The outcome of this trial conforms with Hutchin's predictions regarding the improbability of trees from the Mediterranean region succeeding in the summer rainfall area. Nowhere in South Africa outside the Cape Province has *P. pinaster* proved really successful as a timber tree, although in the coldest parts of the eastern mist belt it can be grown to maturity. Everywhere else in the Transvaal it is subjected to attack by the fungus Diplodia pinea when injured by hail. This would account for the fact that at Potchefstroom the trees developed antendency to die back in the crown. Quite apart from its liability to fungal infection following hail, the species has not proved particularly drought-hardy even in the winter and constant rainfall areas. For this reason alone it should be considered unsuitable for planting in the western Transvaal.

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Pinus pinea Linn.(Syn. P. maderiensis Ten.)Family

PINACEAE

Common Name

Stone or Umbrella Pine

Natural Distribution

A native of southern Europe and Asia Minor, where its range extends from Portugal and Spain, through France, Corsica, Italy and Greece, to Turkey, finally penetrating a short distance into Russia south-eastern of the Black Sea. The species has, however, been cultivated so long for the sake of its edible seeds and for ornament that the precise limits of its natural distribution are not easy to determine.

Provenance.

No indication is given in the records as to the source of the seed used to raise plants for trial in the Arboretum at Potchefstroom.

Description of the Species in its Native Habitat.

A fairly large tree, sometimes attaining a height of 80 to 100 feet (24 to 30 m.) and a girth of 20 feet (6 m.) Its habit is strikingly picturesque, for at maturity it develops a broad, umbrella-shaped head supported by massive, forked limbs.

Economic Importance in Countries of Origin.

As a timber tree the species is of little value, yielding a rather hard, heavy, coarse-grained wood similar in quantity to that of P. pinaster but less resinous. It is, however, widely cultivated on account of its agreeably flavoured nuts and its characteristic, highly ornamental habit.

Trial in the Arboretum at Potchefstroom.

The trial was commenced in February, 1908, when 51 plants 2 years old and 10 inches (25 cm.) high were set out at a 6 x 6-foot (2 x 2 m.) espacement. The number of plants available not being sufficient to complete the plot, 17 more were added 3 years later, bringing the total to 68.

The young trees proved exceedingly hardy to frost and drought, and made quite good growth. By 1914 they had attained a height of 8 feet (2 m.) and for several years remained very healthy. Although in 1919 they seemed to suffer from drought, they soon recovered, and by 1927 had reached a height of 25 feet (8 m.)

Between 1927 and 1959 the stand evidently received a thinning, for only 23 trees (equivalent to a stocking of 343 stems per acre (847 per hec.) were left when it was last inspected at the end of that period. These, with the exception of one which was dead and another which was moribund (but suppressed), were still healthy and had attained a height of 57 feet (17 m.) and a mean D.B.H. of 10.3 inches (26 cm.) From a silvicultural point of view their form was poor, for almost all were forked and heavily branched, and some were slightly sinuous at the base. For all that, however, they had an attractive appearance, and their crowns were dense and healthy.

Discussion of Results.

The species has succeeded a good deal better than might have been expected considering that it comes from the Mediterranean area. While it is practically useless from the point of view of timber, it is unquestionably one of the most desirable of the pines for ornamental planting. In the latter connection a note of warning might be sounded, however, for only after half a century or more do trees begin to assume the typical form of the mature adult, until which time their appearance is unlikely to attract favourable notice.

Pinus ponderosa Dougl.Family

PINACEAE

Common Name

Western Yellow Pine

Natural Distribution.

The most widely distributed pine of western North America, occurring from British Columbia in the north to California in the south, and from the coast inland to the Rocky Mountains and the Black Hills of South Dakota. Some authors, taking a broader view of the species and including with it the P. arizonica complex, consider that its range extends into Mexico. It is found in the summer and in the winter rainfall zones. The annual precipitation varies between 18 and 25 inches (457 and 635 mm.) in the north and between 17 and 30 inches (425 and 760 mm.) in the south. The tree is most frequent on cool, dry, mountain slopes, forming pure forests on the Sierra Nevada and southern Cascade Mountains but mingling with Douglas Fir and other species on moister sites. While it grows on a wide variety of soils, it reaches its optimum development on those which are deep and well-drained. The variety scopulorum Engelm., which differs from the type in minor respects botanically, is considered to be the most drought-resistant form of the species (Streets, 1962).

Provenance.

The plants used to establish plots in the Arboretum at Lichtenburg were raised at Ermelo from seed collected in the Cape.

Description of the Species in its Native Habitat

One of the largest pines of North America, P. ponderosa becomes a massive, straight-boled tree 125 to 140 feet (38 to 43 m.) - and occasionally 250 feet (76m.)

tall and up to 8 feet (2.4 m.) in diameter, with a long, narrow, open crown.

#### Economic Importance in Countries of Origin

A timber tree of the greatest importance, yielding a hard, strong, resinous wood much used for building, joinery, railway sleepers, boxes, fence posts, mining timber and fuel. It is also tapped for resin, though not on a very large scale (ibid.)

#### Trial in the Arboretum at Lichtenburg.

Two plots of the species were established in the Arboretum in March, 1913, one of which was purported to be of the typical form and the other of the variety scopulorum. No differences, either botanical or silvicultural, are discernible between the two plots, however, and the remarks which follow, although relating primarily to the former, apply equally well to the latter.

The plants were set out at the very close spacing of 4 x 4 feet (1.2 x 1.2 m.), 246 of them being used. These were 2 years old and 14 inches (35 cm.) high at the time of planting out.

A few blanks occurred over the first two winters and the trees made little growth, but appeared healthy. Gaps in the stand were filled in 1916 but the replacements failed on account of drought.

For a number of years the stand changed little in appearance. The trees continued to look healthy and withstood the frost and drought well, but grew very slowly. Eight failures occurred in 1923, evidently as a result of drought, but the rest of the trees still seemed healthy and reached a height of 7 to 8 feet (2 to 2.4 m.) and a diameter of 3 to 4 inches (7 to 10 cm.) in 1930.

Thirty-two trees succumbed to drought in 1931,

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PINUS PONDEROSA : LICHTENBURG

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and although the balance of them looked as healthy as before, further losses became almost an annual occurrence. By 1959, only 44 dwarf specimens remained alive on the plot, which was completely open at the centre. The trees were erect, straight and symmetrically branched, but averaged only 11 feet (3 m) in height and 3.2 inches (8 cm.) in diameter. Their crowns were a vivid green and persisted almost to the ground, with the result that their appearance was both healthy and exceedingly attractive.

#### Discussion of Results

P. ponderosa has proved a very disappointing introduction. This is surprising in view of its tremendously wide natural distribution, which suggests an exceptional degree of adaption to different growing conditions. Only at one or two plantations in the south-eastern Orange Free State has its vigour been such as to warrant further planting on a modest scale for timber production. The poor results obtained at Lichtenburg clearly indicate that it is unable to withstand severe drought when planted in stand form, although it appears to be perfectly hardy to frost. As a small, ornamental tree its use might be considered, but its slow growth and diminutive size in the western Transvaal are not likely to commend it for any other purpose.

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Pinus radiata D. Don.

(Syn. P. insignis Dougl.)

Family.

PINACEAE

Common Name

Monterey or Insignis Pine

Natural Distribution

A native of North America, where its occurrence is limited to isolated localities on the coast of California in the vicinity of Monterey, Swanton and Cambria. A binary or two-needled form of the species (only lately introduced into South Africa) is found on the island of Guadalupe, off the Mexican coast. The climate is of Mediterranean type, modified by high humidities in summer and frequent sea fogs. The mean annual rainfall on the mainland varies from 15 to 35 inches, (380 to 890 mm.) of which some 75 per cent occurs during the winter. Altitudinally, the range of the species lies between sea level and 1,000 feet (300 m.), and the temperature fluctuates between an absolute minimum of 20°F. (-7°C.) and an absolute maximum of 110°F. (43°C.) The tree grows best on deep sandy soils but is found on many different soil types, including loams derived from granite and calcareous formations (Streets, 1962).

Provenance.

The stock used to plant up a plot at Lichtenburg was raised from seed supplied by the Conservator of Forests, Cape Colony. Nothing is known with regard to the provenance of the stand at Potchefstroom.

Description of the Species in its Native Habitat.

A large tree, sometimes 130 feet (40 m.) tall and 20 feet (6m.) in girth but much smaller on exposed sites near the sea (ibid.)

Economic Importance in Country of Origin.

The tree yields a soft, brittle, light wood weighing 25 to 28 lb. per cubic foot (0.40 to 0.45 gm/cu.cm.) with a white sapwood and pale brown heart. It is of little commercial value in the United States, where superior timbers such as Oregon are readily available. The tree is consequently valued mainly for amenity purposes.

Trials in the Arboretum at Lichtenburg and Potchefstroom.

The plot at Lichtenburg was established in March, 1913. Plants 2 to 3 years old and 12 to 15 inches (30 to 38 cm.) high, which had been transferred from Belfast Plantation, were set out at an espacement of 8 x 8 feet (2.4 x 2.4 m.)

Some 60 per cent of the young trees was destroyed by frost during the first winter, but those that survived looked healthy and made good growth. Blanking was carried out in 1916, but more than half of the replacements died of drought later in the year.

Two more trees succumbed to frost in 1920 and the rest also suffered to some extent. Although they soon recovered their former, healthy appearance, their subsequent growth was rather disappointing, and their average height in 1929 was still no more than 25 feet (8 m.) Their numbers, also, steadily dwindled, and only 24 of them remained in 1932.

One tree survived in 1953. This still measured 25 feet (8m.) in height and had a diameter of 6 inches (15 cm.) Its appearance was sickly and it was dying from the top. By 1959 the plot was vacant.

The trial at Potchefstroom was commenced in February, 1908, 81 plants 19 months old and 9 inches (23 cm.) high being put out at an espacement of 6 x 6 feet (2 x 2 m.)

In marked contrast to the stand at Lichtenburg, that

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at Potchefstroom stood the first few winters very well and all grew fairly rapidly, reaching a mean height of 14 feet (4 m.) by October, 1914. It had a vigorous appearance and was given a light thinning 4 years later.

A few, suppressed trees died back in 1921 and two more succumbed to drought the following year. In 1927 the stand was thinned down to 35 stems, by which time it had an average height of 50 feet (15 m.) In spite of the fact that competition had been much relieved two further losses occurred the following year and three more trees seemed to be going off the year after that. This steady depletion of the growing stock evidently continued, for no trees survived in 1959.

#### Discussion of Results.

Notwithstanding its extremely restricted natural distribution (the suggestion has even been made that the species was only rescued from extinction by the intervention of man) P. radiata has assumed tremendous economic importance as an exotic in several countries in the Southern Hemisphere. In South Africa it has been planted extensively in the winter and all-the-year-round rainfall zones for the production of sawtimber and poles. Its extraordinarily rapid growth under correct conditions and excellent timber qualities render it a most desirable species for afforestation purposes. Unfortunately, its use almost throughout the summer rainfall has had to be discontinued because it is liable to infection by the fungus Diplodis pinea when injured by hail. To what extent this disease made its appearance in the stands at Lichtenburg and Potchefstroom can no longer be determined, though it is significant that at both centres the typical systems of die-back were observed. At all events, P. radiata is clearly unsuited climatically to conditions in the western Transvaal, and its use there cannot be recommended.

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Pinus roxburghii Sarg.(Syn. P. longifolia Roxb.)Family

PINACEAE

Common Name

Chir or Longifolia Pine

Natural Distribution

A tree of the outer ranges and principal valleys of the Himalaya, where it occurs chiefly at altitudes of between 1,500 and 7,500 feet (460 and 2,286 m.) above sea level, sometimes forming pure forests of large extent but elsewhere growing in association with evergreen oaks and other temperate or sub-tropical hardwoods. The annual rainfall varies from about 35 to over 100 inches (890 to over 2,540 mm.) a year, and is largely restricted to the summer months. Snow is experienced only towards the upper limits of its distribution. Temperatures range from below freezing to over 100°F. (38°C.). The tree prefers deep, well-drained, porous soils, but also tolerates rocky sites and hot, dry slopes (Streets, 1962).

Provenance.

The seed used to raise plants for trial in the Lichtenburg Arboretum was apparently obtained from Messrs. Vilmorin-Andrieux, but no record can be found of the origin of that supplied to Potchefstroom.

Description of the Species in its Native Habitat.

A large tree 150 to 180 feet (46 to 55 m.) tall and 7 to 11 feet (2 to 3 m.) in diameter, with a fairly spreading crown at maturity. Although normally evergreen, its foliage is deciduous or partly so in arid areas or in very dry seasons (Dallimore and Jackson, 1961).

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Economic Importance in Country of Origin.

An important timber tree, yielding a fairly hard, rather coarse-grained, very resinous wood, which is used for building purposes, sleepers, boxes and general carpentry as well as for charcoal and firewood. The species is also one of the principal sources of resin in India, comparing favourably in terms of yield with P. wallichiana, and P. khasia, though not in terms of quality (Streets, 1962).

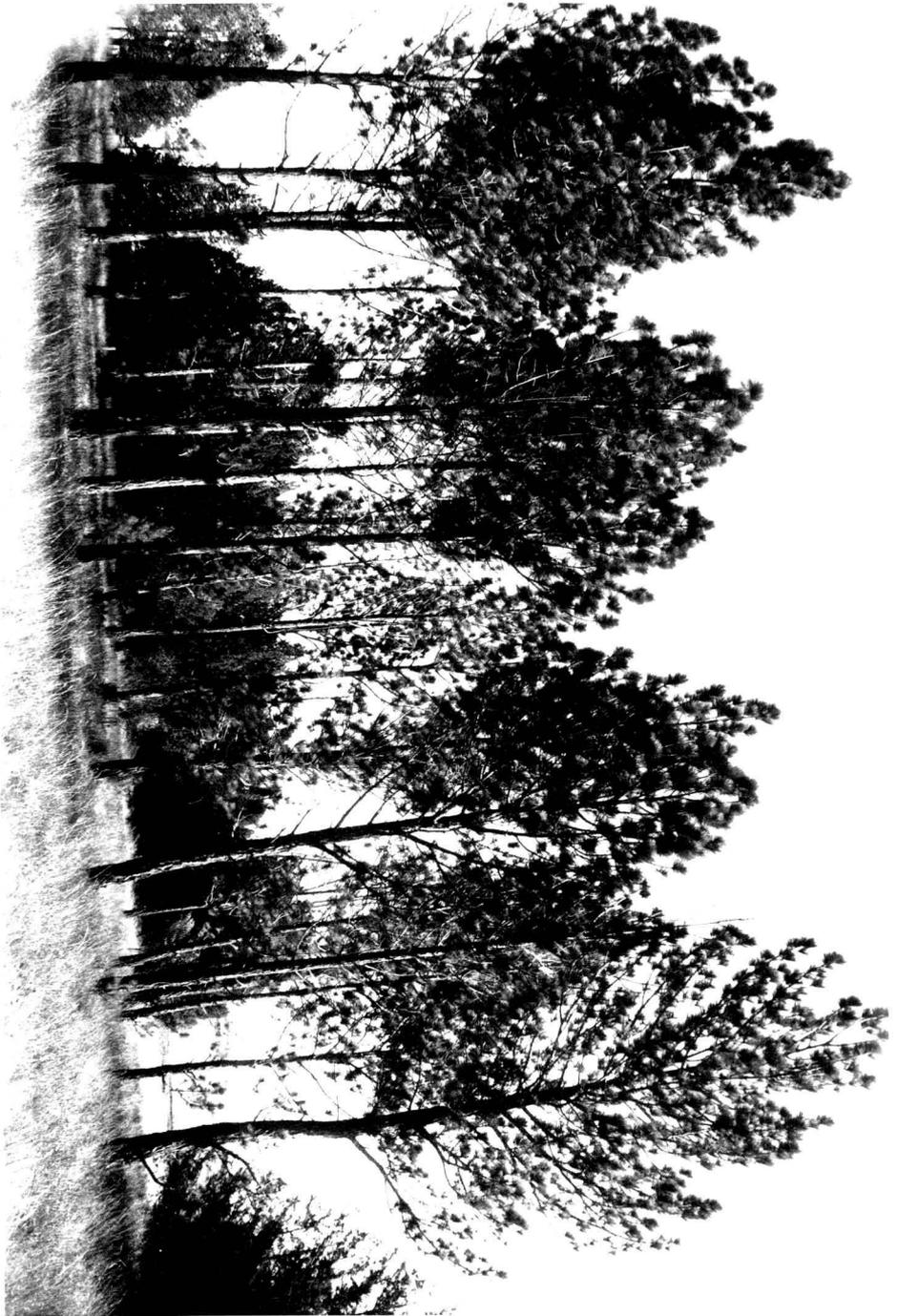
Trials in the Arboreta at Lichtenburg and Potchefstroom.

The trial at Lichtenburg dates from 1912, when 127 plants 9 inches (23 cm.) high and 18 months old, which had been raised in the Irene Nursery, were put out at an espacement of 6 x 6 feet (2 x 2 m.)

The young trees suffered badly from frost during their first two winters but escaped injury in 1915 and commenced to make some growth. In 1916 it was reported that most of the plants used to blank the stand (presumably earlier that year) had failed, but that the older trees looked healthy. Quite 50 per cent of the stocking was cut back by frost again the following year, and further damage occurred during the winters of 1920 and 1921, though no trees died. Only in 1919 and 1922 did the stand appear to suffer from drought.

The trees continued to make steady, if slow growth. In 1924 they were defoliated by locusts but soon recovered. A thinning was carried out in 1929, after which 50 trees remained on the plot, the diameters of which ranged from 4 to 6 inches (10 to 15 cm.). The following year their heights were given as being between 20 and 30 feet (6 and 9 m.). Their appearance was healthy and they were said to be resisting drought well.

Further thinnings were undertaken in 1938 and 1953, with the result that only 32 trees were left on the plot in 1959.



PINUS ROXBURGHII : LICHTENBURG



PINUS ROXBURGHII : POTCHEFSTROOM

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These had an average D.B.H. of 9.5 inches (25 cm.) and a height of 43 feet (13 m.) Their condition was none too healthy, for several had dead tops, but their form was fairly good. Most of them were relatively straight apart from having a slight basal sweep (a characteristic defect of this species), and had fairly light branches. The stand looked deceptively open and gave the impression of being somewhat drought-stricken on account of the trees having very sparse crowns. The stocking was rather uneven and one sizeable gap was noticed, although the centre of the plot was still fairly well occupied - indicating a considerable measure of drought-hardiness.

At Potchefstroom, the plot was established in 1908, using 81 plants "two seasons" old and 9 inches (23 cm.) high, which were set out at the same espacement as was adopted at Lichtenburg.

In contrast to the trees at Lichtenburg, those at Potchefstroom, stood their first winter well, though the tender, spring shoots were caught by late frosts in 1909 and 1910. Their growth was also more vigorous, and by 1914 they had attained an average height of 12 feet (4 m.)

Light damage was again caused by frost in 1914, but the trees were not noticeably affected by drought and continued to grow well, reaching an average height of 50 feet (15 m.) in 1927. At this stage the plot still carried its original complement of trees, and the urgent need for thinning was commented on.

Thirty-one trees were still left on the area in 1959, representing a stocking of 448 stems per acre (1,106 per sec.) These had a mean D.B.H. of 13.3 inches (33 cm.) and a height of 73 feet (22m.) But for a tendency to kink at the base, their stems were straight and had little taper.

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Their crowns were somewhat sparse, but in other respects they compared well with trees of this species in moister parts of the country.

Discussion of Results.

*P. roxburghii* is an exceedingly valuable species for afforestating hot, dry sites, but is liable to injury by severe frost. Unfortunately, it has also fallen into disfavour latterly because of a tendency to spiral grain, which severely curtails the usefulness of its timber.

Both on account of spiral grain and susceptibility to frost, the species cannot be unreservedly recommended for farm woodlots in the western Transvaal. It is, however, an exceedingly handsome tree and might well be used more extensively for avenues and shelterbelts in the area, especially in situations where it is not exposed to the full force of cold winds in winter.

Pinus wallichiana A.B. Jackson(Syn. P. excelsa Wall.)Family

PINACEAE

Common Names

Bhutan or Himalayan Blue Pine

Natural Distribution

Widely distributed in the temperate regions of the Himalaya from Nepal to Afghanistan, where it is found at an altitude of 4,000 to 12,000 feet (1,220 to 3,651 m.) in localities with a rainfall of between 40 and 75 inches (1,000 and 1,900 mm.) a year. The temperatures under which it occurs range from 20° to 100°F. (-7° to 38°C) and the climate is monsoonal, with a rather dry spring and heavy falls of snow in winter. The trees tolerates a wide variety of soils abut does not thrive on those which are either very dry or very wet (Streets, 1962).

Provenance.

The seed used for the trial at Potchefstroom was probably imported direct from India, but nothing further is known about its origin.

Description of the Species in its Native Habitat.

A tree of elegant habit, attaining a height of between 50 and 150 feet (15 to 46 m.). Often when growing alone it is feathered with branches right to the ground (Dallimore and Jackson, 1961).

Economic Importance in Countries of Origin.

The tree furnishes a fairly light, hard, resinous, durable wood of good quality, which works and finishes well and is used for building construction, joinery, furniture, tea chests and railway sleepers. It also yields a superior resin, which has been exploited in the past for the production of turpentine (Streets, loc. cit.

Trial in the Arboretum at Potchefstroom.

The trial was commenced in 1909, when 81 plants 2 years old and 9 inches (23 cm.) high were put out at an espacement of 6 x 6 feet (2 x 2 m.).

For the first few years the young trees made almost no growth and in 1913 were reported to have suffered a good deal from frost, most of them losing their leaders. The following year their average height was still only 3 feet (1 m.) but their general appearance was a little more promising.

In 1919 the stand was badly affected by drought, and three trees were reported dead a year later. Several others looked yellow and unhealthy, but by 1921 these had quite recovered. The effects of drought were again discernible in 1923 and 1924, but once more the condition of the 66 remaining trees seems to have improved, for their average height had increased to 16 feet (5 m.) in 1927. This recovery was short-lived, for 8 of them died of drought the following year and the rest seemed very unthrifty. Many more succumbed in 1929, and by 1959 there were no survivors.

Discussion of Results.

P. wallichiana has made quite good growth in the moister and cooler parts of South Africa, including the eastern Transvaal highveld. There it has proved very resistant to cold, and some doubt thus exists as to whether the trees at Potchefstroom were affected so much by frost as by drought in 1913. In any case, the species is clearly unsuited to areas as dry as the western Transvaal, where its use cannot be recommended.

Prosopis juliflora (Swartz) DC.

Family

LEGUMINOSAE (MIMOSOIDEAE)

Common Names

Mesquite, Algaroba Bean.

Natural Distribution

A native of the drier parts of Central America, where its range extends from Texas and New Mexico in the United States southwards through Mexico to Columbia and Venezuela. It is now widely cultivated throughout the tropics and sub-tropics and has become naturalised, inter alia, in the West Indies, Brazil and Argentina (Sargent, 1922; Streets, 1962).

Provenance.

Seed for the trials both at Lichtenburg and Potchefstroom was supplied by Thomas Meehan and Son of the United States.

Description of the Species in its Native Habitat

A low tree, with a long taproot penetrating to a depth of perhaps 40 or 50 feet (12 to 15 m.) and a trunk 6 to 8 inches (15 to 20 cm.) in diameter dividing a short distance above the ground into many, irregularly arranged, crooked branches. Besides the taproot, it also develops a number of horizontally radiating laterals, which bear a dense mass of rootlets (Sargent, ibid.)

Economic Importance in Countries of Origin.

The tree is valued chiefly on account of its pods, which supply the local Indians and Mexicans with a nutritious food and are greedily devoured by most herbivorous animals. Its wood is heavy, close-grained, of a rich, brown colour and almost indestructible in contact with the ground. The larger pieces are used for furniture,

railway sleepers, the underpinning of buildings and for paving city streets, while smaller material is utilised as fencing posts or fuel (Sargent, ibid.)

Trials in the Arboreta at Lichtenburg and Potchefstroom.

The plot at Lichtenburg was planted up over a period of two years, the work commencing in 1906. Plants 18 months old and 12 inches (30 cm.) high were used, and were probably put out at an espacement of 6 x 6 feet (2 x 2m).

The young trees were not at all affected by drought or frost for some years and had a healthy appearance, though their growth was slow and their habit bushy. They commenced flowering in 1915 but otherwise made little progress.

In 1921 the stand suffered very badly from late frost, and 5 trees died right back. Nine more losses were experienced the following year, apparently as a result of drought. At this stage the whole stand began to develop a very unhealthy appearance, and its height was still no more than 4 feet (1.2m.) in 1930.

A thinning was evidently carried out subsequently to this, for in 1953 it was reported that most of the trees had been cut down and were coppicing vigorously. Those which had not been so treated were up to 10 feet (3 m.) tall and 3 inches (7.6 cm.) in diameter.

In 1959 the plot was still almost fully stocked but for one, rather conspicuous, bare patch. The trees remained shrubby in habit and had made practically no growth since 1953.

At Potchefstroom the trial was commenced in August, 1908, when 81 plants 18 months old and 14 inches (35 cm.) high were put out at the same espacement of 6 x 6 feet (2 x 2 m.)

Early the following spring the new foliage was badly caught by late frost, but no losses occurred.



PROSOPIS JULIFLORA : LICHTENBURG

Flowering commenced in 1910, and the general condition of the stand was quite good although, as at Lichtenburg, growth was very slow.

A repetition of the frost damage of 1909 occurred in 1912, by which time the trees had developed a scraggy, leaning habit. Their height a year later was 6 feet (2 m.) and a year after that had increased to 8 feet (2.4 m.)

In 1918 several trees were reported to have dead crowns in consequence of damage by frost, and in 1921 cold weather destroyed the crop of pods. By 1929 the crowns of most of the trees contained a good deal of dead wood and were in a very poor condition.

Only about 15 struggling, badly-formed trees survived in 1959, the tallest of which was about 20 feet (6 m.) high. The plot had become suppressed on one side by a neighbouring stand of eucalypts and presented a wretched appearance.

#### Discussion of Results.

The species is evidently not hardy to frost in the western Transvaal, neither is it suited to the poor, shallow soil of the Lichtenburg district, which affords little scope for the development of a strong taproot. Although exceedingly drought-resistant it should be confined, in the interests of satisfactory growth, to deep, light soils and to low-lying situations where the water table is within reach of its roots.

Quercus ilex Linn.Family

FAGACEAE

Common Name

Evergreen or Holm Oak.

Natural Distribution.

Widely distributed in Europe and Asia, where its range extends along the shores of the Mediterranean from Portugal and Morocco to Syria and the Lebanon and thence east to the arid, inner valleys of the north-western Himalaya. It occurs from sea level up to an altitude of about 9,000 feet (2,743 m.), growing in areas with a predominantly winter rainfall of between 17 and 40 inches (425 and 1,000 mm.) a year. It is resistant to both frost and drought and tolerates a wide variety of soils, occurring on siliceous and calcareous formations as well as rocky sites (Streets, 1962).

Provenance

The origin of the plants used to establish a plot in the Arboretum at Potchefstroom is not known.

Description of the Species in its Native Habitat.

An evergreen tree up to about 65 feet (20 m.) in height and 13 feet (4 m.) in girth, with a long, clean bole and broad, dense crown (ibid.)

Economic Importance in Countries of Origin.

The tree yields a very hard, close-grained, durable timber, which is utilized for building construction, agricultural implements, turnery and fuel. Its bark is employed, for tanning leather and its acorns make good pig feed. The species is used within its natural habitat for afforesting impoverished and eroded land, upon which its leaf-litter has a beneficial effect. It is also planted for shelter and shade, particularly at the coast (ibid.)

Trial in the Arboretum at Potchefstroom.

The plot was planted up in 1914, but no other details relating to its establishment are recorded.

The young trees grew quite strongly for a number of years, the tallest of them reaching a height of 10 feet (3 m.) in 1921. Thereafter, however, they began to have a stunted appearance, turning yellow in 1924, and further progress was very slow.

Alternate rows of trees were removed in 1949, when superfluous stems were also cut out. The remaining trees were pruned to a height of 6 feet (2 m.)

Seventy trees, representing a stocking of 1,045 stems per acre (2,580 per hec.) were found in 1959, almost all of the stumps apparently having coppiced. These had a mean D.B.H. of 6.3 inches (16 cm.) and a height of 26 feet (8 m.) Their form was poor, for they had become multistemmed once more and some were sub-fastigate in habit. One had died and was removed, but the rest were healthy and had extremely dense, dark green crowns. The species is evidently exceptionally tolerant since, despite the heavy stocking and the density of the canopy, there seemed to be little tendency for small, suppressed individuals to die out.

Discussion of Results.

The extraordinary drought-hardiness of this species is already well known in South Africa, where some of the finest specimens are to be found in dry areas such as the Karroo. It makes an exceedingly fine shade tree, developing a dense, spreading crown when given adequate room for development. Unfortunately its growth is very slow.

Rhus lancea L.f.Family

ANACARDIACEAE

Common Name

Karree

Natural Distribution

Widespread in Southern Africa and indigenous to all the four Provinces of South Africa. Although present in the belt of moist country which lies between the eastern escarpment and the Indian Ocean, it is in the drier parts of the interior that it becomes a truly characteristic element of the vegetation, occurring abundantly along the banks of streams and in patches of bush. It is very hardy to drought and frost, resists termite attack and grows on a great variety of soils, including those derived from dolerite, sandstone and limestone (Palmer and Pitman, 1961; Schonland, 1930)

Provenance

The seed used to establish a plot in the Lichtenburg Arboretum was collected locally.

Description of the Species in its Native Habitat

An evergreen shrub or small tree, seldom exceeding a height of 20 feet (6 m.) in South Africa but growing to almost three times this size near Salisbury in Rhodesia. Its dense, rounded crown and pendulous foliage call to mind the Weeping Willow, but its gnarled, heavily leaning limbs have a character all their own (ibid.)

Economic Importance in Countries of Origin.

The species yields a hard, tough, reddish-brown, durable wood which was at one time in great demand for fence posts, roof spars and wagon tents. In certain districts its foliage is looked upon as a good fodder. Its

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fruits are said to be an excellent poultry feed. However, it is as a shade and ornamental tree that the Karree is most esteemed, being regarded by some as without rival among the native species of these parts.

#### Trial in the Arboretum at Lichtenburg

The plot was established in the summer of 1907/08 using 12-month-old plants 12 inches high, which were put out at an espacement of 6 x 6 feet.

The young trees grew well for the first two years, reaching a height of 3 to 4 feet by August, 1909. Their shape, however, was very bushy, most of them having five or six leaders, which were thinned out to one that same year.

The plot was badly frosted in 1912, and the trees once more became very bushy. They made little growth and still averaged only  $5\frac{1}{2}$  feet in height in 1913. In 1918 the number of stems per tree was brought down once again to two, but this only stimulated the prolific development of epicormic shoots from near ground level. Progress continued to be slow, for in 1937 the general level, of the canopy was still no more than 12 feet.

In 1959 the plot was still almost fully stocked, indicating an exceptional degree of drought hardness, but the canopy level had not advanced beyond 20 feet and the diameter of the larger limbs was only 3 to 8 inches at a point  $4\frac{1}{2}$  feet from their base. The trees had a very picturesque habit, however, consisting of one or more heavily leaning limbs, each radiating out in a different direction and crossing those of neighbouring trees. Branching was from ground level, and the inclination of the limbs was such that it was impossible to move about the plot freely.



RHUS LANCEA : LICHTENBURG

### Discussion of Results

The hardiness of this species in the western Transvaal is beyond question. Its usefulness, however, is somewhat limited, though it is suitable for low windbreaks and for ornament. Moreover its limbs can be used for fence posts and fuel. As a street tree in the town of Lichtenburg, where it possibly receives a certain amount of water from nearby gardens, it has succeeded very well, and its modest size at maturity, pleasingly rounded, dense crown and reputed longevity cannot but commend it for this and similar purposes.

Rhus viminalis Vahl.Family.

ANACARDIACEAE

Common Name.

Karree.

Natural Distribution

Endemic in the Cape Province, where it occurs on the banks of streams and near marshy ground in Namaqualand, Bushmanland and Griqualand West, giving its name to the Karree Bergen and many farms in the area. It is also found at Clanwilliam and at Graff-Reinet. The climate throughout the area is arid or semi-arid, and the tree is able to subsist only where seepage moisture is available in the soil, brak though this may be. Summer temperatures are exceedingly high and severe frost is experienced in winter at the higher elevations (Schonland, 1930).

Provenance.

Seed for the trial at Potchefstroom was supplied by a certain Mr. Grenfell, whose place of business is not recorded.

Description of the Species in its Native Habitat

A small tree up to 30 feet high (9 m.) much resembling R. lancea in its Willow-like habit but with slightly broader leaflets.

Economic Importance in Country of Origin.

The species is of little economic importance at the present day but was formerly used extensively for fence posts and fuel in rural areas. It is now valued more for shelter and ornament than for its wood, and is much planted for these purposes.

Trial in the Arboretum at Potchefstroom.

The plot was established in February, 1908, using 81 plants "two seasons" old and 18 inches (45 cm.) high,

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which were put out at an espacement of 6 x 6 feet (2 x 2 m.)

The young trees stood the harsh climate exceedingly well and by October, 1909, were already 5 feet (1.5m.) tall. A year later the block was still complete, but in 1911 a serious infestation of aphid occurred which left the trees in an enfeebled and somewhat dried-out condition. Superfluous stems were removed at this stage and growth re-commenced in 1912.

The stand seemed to suffer a little from drought in 1913 but by October the following year it had reached a height of 8 feet (2.4 m.) As a result of the cleaning operation carried out two years previously, vigorous epicormic shoots made their appearance. These sprang from the base of each tree and reached straight up to its crown, apparently flourishing at the expense of the main stem.

The trees made steady, though rather slow progress, and appeared healthy. In 1915 it was remarked that they would provide excellent shelter for small stock. Neither frost nor drought had any noticeable effect on them except that in 1921 they lost all their foliage, apparently as a result of the cold.

Fifty trees (equivalent to a stocking of 746 stems per acre (1,842 per hec.) remained on the plot in 1959. These were still healthy and had a mean D.B.H. of 6.2 inches (16 cm.) and a height of 31 feet (9 m.) The suckers mentioned in 1914 had evidently been removed, for each tree had a single, though inclined stem and a rather spreading crown. The canopy was continuous and cast a moderately deep shade.

#### Discussion of Results.

Like R. lancea, this species is exceedingly resistant to drought as well as frost. While, from an economic point of view, its value is negligible, it is, nevertheless, a most useful tree for shelter and ornament in dry areas.

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RHUS VIMINALIS : POTCHEFSTROOM

Robinia pseudo-acacia Linn.Family

LEUGUMINOSAE (PAPILIONACEAE)

Common Names.

Black Locust, False Acacia.

Natural Distribution

A tree of the Appalachian Mountains and their environs in the eastern United States, where its range extends from Pennsylvania to Georgia and thence westwards to Illinois, Indiana and Arkansas. It is nowhere common but occurs most plentifully and attains its largest size at altitudes of less than 3,000 feet (910 m.) on the western slopes of the Alleghenies in West Virginia. The rainfall over most of its range is between 40 and 55 inches (1,000 and 1,397 mm.) a year, of which the greater part occurs in summer. In cultivation it tolerates much drier conditions, however. Mean annual temperatures vary between 50° and 60°F., (10° and 16°C.) and both frost and snow are common, particularly in the north. The tree does best on moist, rich loamy soils, but is very cosmopolitan and occupies a great variety of sites, frequently colonizing old fields and other clearings. It is now cultivated very extensively in North America, not only within but also outside its natural habitat. Besides this it is used for afforestation on a large scale in other temperate areas of the world, particularly Europe (Harlow and Harrar, 1937; Streets, 1962).

Description of the Species in its Native Habitat.

A medium-sized, deciduous tree, usually 40 to 60 feet (12 to 18m.) tall and 1 to 2 feet (30 to 60 cm.) in diameter but occasionally reaching a height of 100 feet (30 m.) and a diameter of 4 feet (122 cm.) On good sites it develops a clean, straight bole surmounted by a narrowly oblong head

(ibid.)

Economic Importance in Country of Origin.

The tree yields an exceedingly hard, heavy strong, close-grained wood of a brownish, or rarely, greenish colour, with a pale yellow sapwood. It is very durable in contact with the ground. In former times it found a ready application in the ship-building industry, especially as "tree-nails", on account of the fact that it swells and contracts little with changes in moisture content. Present-day uses for it include all manner of constructional work, railway sleepers, turnery and fuel. The tree is of value for preventing and controlling soil erosion because it throws up numerous suckers when its roots become exposed. Like most legumes, it improves soil fertility through the agency of nitrogen-fixing bacteria present in the nodules on its roots (ibid.)

Trials in the Arboreta at Lichtenburg and Potchefstroom.

The trial at Lichtenburg was initiated in 1905, when plants 12 months old and 3 feet (90 cm.) high were put out at an espacement of 6 x 6 feet (2 x 2 m.)

The young trees made good progress and were pruned to single stems in 1909. That same year early spring growth was cut back by late frost, and the damage was repeated 3 years later. Although, by March, 1913, the average height of the trees had risen to 10 feet (3 m.) frost damage recurred the following spring and again in 1915, 1916 and 1917.

It gradually became apparent that the trees were making no more growth, and in 1920 12 of them died off. Thirty more failed in 1923, and a year later the interior of the plot was in a moribund state.

The situation remained unchanged for several years, but in 1933 a good many more trees began to die off. This retrogression continued until, by 1959, only one stump remained

alive, supporting coppice re-growth 6 feet high (2 m.)

At Potchefstroom, 81 plants 1 season old but already 4 feet (1.2 m.) high were put out at the same espacement as at Lichtenburg in August, 1908.

Growth was very rapid, for a year later the young trees had an average height of 9 feet (3 m.) and were pruned to single stems. Although slightly affected by late frost, the following year they stood 12 feet (4 m.) high. In 1913 there were unmistakable signs that they were suffering from drought, but they continued to make steady growth, reaching a height of 20 feet (6 m.) in 1917. Late frost destroyed the immature pods in 1921, but no other damage resulted.

Fourty-four trees, equivalent to a stocking of 657 stems per acre, (1,622 per hec.) lived on until 1959, when their average D.B.H. was 6.3 inches (16 cm.) and their height 29 feet (9 m.) Although their stems were moderately straight, almost all were forked. Their condition could no longer be described as thrifty since they had thin crowns and most of them had died back to some extent.

#### Discussion of Results.

The species suffered more severely from the cold at Lichtenburg than might have been expected, possibly on account of excessive exposure to wind. It is also by no means proof against drought in the western Transvaal when planted in stand form.

Nowhere in South Africa had the Black Locust grown sufficiently well to be of much use as a timber tree, though results have so far been best alongside a stream at Imperani Plantation in Orange Free State, where the climate is not very different to that at Lichtenburg and Potchefstroom. The use of the species in the western Transvaal for a stabilizing dongas and for ornament is therefore feasible in situations

which afford shelter from cold winds in winter and where a little moisture is present throughout the year in the deeper layers of the soil.

Schinus molle Linn.Family

ANACARDIACEAE

Common Names

Pepper Tree

Natural Distribution

Endemic in the more arid parts of the Andes in South America, growing as a bush in dry sand reaching tree size in the beds of seasonal rivers where soil moisture is available at depth. It is now widely cultivated for shade and ornament in the warmer-temperate parts of the world, and has become naturalised in several countries (Streets, 1962), including our own.

Provenance.

The origin of the seed used to raise plants for trial at Potchefstroom is not recorded.

Description of the Species in its Native Habitat.

A bush or small, evergreen tree with spreading crown and attractive, pendulous foliage (*ibid.*)

Economic Importance in Countries of Origin.

The species is of little value for timber, but yields a mastic which is used locally as a purgative, and its berries are ground for pepper (*ibid.*)

Trial in the Arboretum at Potchefstroom.

The plot was established in February, 1910, when 81 plants 8 months old and 9 inches (23 cm.) high were put out at an espacement of 6 x 6 feet (2 x 2 m.)

From the start the young trees stood the dry conditions exceedingly well but were repeatedly injured by frost. Their growth was at first slow, but by 1914 they had attained an average height of 12 feet (4 m.) Slight frost damage continued to occur almost annually up to 1921, and the trees began to have an increasingly unhealthy appearance. In 1929 several of them appeared to be dying.

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Thirty-two trees, representing a stocking of 478 stems per acre (1,180 per hec.) were still alive and healthy in 1959. These had a mean D.B.H. of 11.3 inches (28 cm.) and a height of 41 feet (13 m.) Judged from a silvicultural point of view their form was very poor, for their boles were crooked, forked, twisted and leaning, and their light, feathery crowns covered the greater part of their length. Nevertheless, the stand as a whole was aesthetically staisfying and made a delightful retreat from the sun.

#### Discussion of Results.

Not only in the western Transvaal but also in the Orange Free State and Cape Province, this species has amply demonstrated its ability to survive prolonged periods of drought. It is, however, less hardy to frost, which imposes by far the greater limitation upon its usefulness for shade and ornament.

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Tamari gallica Linn.Family

TAMARICACEAE

Common Name

French Tamarisk

Natural Distribution

Widely distributed in the warmer parts of Europe, where it is found in western France and along the Mediterranean coast, mostly on river banks near the sea. It is much cultivated in many different countries for the fixation of coastal sand dunes, for reclaiming saline soils and for ornament (Streets, 1962).

Provenance.

Plants were raised from cuttings for the establishment of a plot at Lichtenburg, but the source of these is not recorded.

Description of the Species in its Native Habitat

An evergreen shrub or small tree, with attractive, pink flowers, growing to a height of 10 feet (3 m.) in the northern parts of its range and to 30 feet (9 m.) in the south (ibid.)

Economic Importance in Countries of Origin.

The species is of value mainly for ornament and shelter and for the reclamation of coastal driftsands and saline flats, but its wood is used as fuel.

Trial in the Arboretum at Lichtenburg.

The plot was established in 1905, using plants 12 months old and 2 feet (60 cm.) high raised from cuttings. The usual espacement for that period of 6 x 6 feet (2 x 2 m.) was adopted.

From the very outset the plants did not look thrifty and made little growth. Almost every winter they

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suffered from frost, and in 1913 their average height was still only 3 feet (1 m.). Some years later they were killed to the ground by frost and then eaten off by termites. A few of them sprouted again and struggled on for a while longer, but by 1925 they were all dead.

Discussion of Results.

In inland districts this species is suitable only for planting as an ornamental shrub in gardens. Even for this purpose it is not to be recommended for use in the western Transvaal on account of being too tender to frost.

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Thuja orientalis Linn.

Family

CUPRESSACEAE

Common Names

Chinese Arbor Vitae

Natural Distribution

A tree of the more elevated parts of northern China and Korea, It has been long cultivated in Japan and other Asian countries as far west as Iron (Streets, 1962.)

Provenance

The seed used to raise plants for trial in the Arboretum at Potchefstroom seems to have been obtained from Messrs. Vilmorin-Andrieux of France.

Description of the Species in its Native Habitat

An evergreen shrub or small tree up to 40 feet (12 m.) high, often with several stems from the base and with a dense crown (ibid.)

Economic Importance in Countries of Origin.

The tree yields a close-grained timber, which is rather knotty, but fragrant and durable. It is used locally for furniture and fence posts (ibid.)

Trial in the Arboretum at Potchefstroom

The trial was commenced in February, 1911, but no details as to the size of the plants or planting distance have been preserved.

The young trees were quite unaffected by frost and drought, and made reasonably vigorous growth, reaching an average height of 5 feet (1.5 m.) in 1914. Two years later, however, the largest of them all died off, though the rest continued to thrive.

In 1919, the stand developed a yellowish, sickly appearance, which persisted for less than a year, but recurred at fairly frequent intervals thereafter. The growth



THUJA ORIENTALIS : POTCHEFSTROOM

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of the trees, too, was slower than it had been, and in 1927 their average height was still only 13 feet (4 m.)

In 1959, 45 trees were left on the area, representing a stocking of 672 stems per acre (1,660 per hec.) These had a mean D.B.H. of 4.2 inches (11 cm.) and a height of 29 feet (9 m.) Their form was rather indifferent, for forks were fairly numerous and a few of them crooked stems. Although not noticeably suppressed by other stands except on one side, they appeared unthrifty and their crowns were thin.

#### Discussion of Results.

Nowhere in South Africa has this species shown any promise as a timber tree, for its growth is invariably slow and it is inclined to be forked and branchy. Notwithstanding the fact that it is very hardy to drought and frost, it can only be recommended for ornament in the western Transvaal.

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Ulmus parvifolia Jacq.

Family

ULMACEAE

Common Name

Chinese Elm.

Natural Distribution

Indigenous to eastern Asia, where it has a very wide distribution in northern China, Korea, Formosa and Japan (Elwes and Henry, 1906 - 1913; Streets, 1962).

Provenance

The origin of the seed used to raise plants for trial at Potchefstroom is not recorded.

Description of the Species in its Native Habitat

A tree of small to medium size, occasionally attaining a height of 80 feet (24 m.) and a girth of 4 feet (122 cm.) with a rounded crown (ibid.)

Economic Importance in Countries of Origin.

The tree yields a hard, tough wood. This is difficult to cleave and, because of the smallness of the logs, is seldom worth sawing into boards (Elwes and Henry, loc.cit.)

Trial in the Arboretum at Potchefstroom

The plot was established in July, 1908, at an espacement of 6 x 6 feet (2 x 2 m.) using 81 plants 3 seasons old and 5 feet 6 inches (13 to 15 cm.) high, which had been raised in the Irene Forestry nursery.

A year later no failures had occurred and some of the trees were already approaching 8 feet (2.4m.) in height. In October the following year the stocking was still complete, but it was noticed that the tops of the trees had developed a tendency to lean over. This tendency became more pronounced, and some individuals assumed an ugly, drooping habit, which, however, was apparently corrected by judicious pruning.

The stand continued to be unaffected by drought and made good growth, reaching height of 12 feet (4 m.) in 1914. However, shortly thereafter it began to show signs of suppression on one side, where it adjoins a plot of Eucalyptus melliodora.

For some years more the trees remained healthy, and even those near the eucalypts put on some growth. However, in 1924 they started to become stag-headed. Although no further deterioration set in immediately, they made little further progress, averaging only 15 feet (5 m.) in height in 1926. At that stage the stand still comprised no less than 77 trees, and its condition would have been much improved by thinning. From 1928 onwards the trees became progressively more stag-headed, and in 1959 the plot was vacant.

#### Discussion of Results.

The Chinese Elm is a most useful ornamental tree, and is particularly suitable for street planting because its form is reasonably compact and its growth not too robust. It is exceedingly hardy to frost and will evidently stand a great deal of drought. The trial at Potchefstroom cannot be considered a fair test, for not only was thinning completely neglected but the stand was also exposed to competition on one side from a nearby stand of eucalypts. Consideration might well be given to the use of the species in streets, parks and gardens in the western Transvaal, more especially in situations where watering can be undertaken in time of drought, should this become necessary.

APPENDIX II

SPECIES RECOMMENDED FOR TRIAL

IN THE WESTERN TRANSVAAL.

Acacia pendula A. Cunn.

Family.

LEGUMINOSAE.

Common Name.

Weeping Myall.

Geographical Distribution.

Confined to the drier parts of New South Wales and Queensland, where it occurs west of the Dividing Range in areas where the rainfall is up to about 30 inches (800 mm.) a year. A constituent of savanna woodland, it is often found in association with Eucalyptus largiflorens. It frequently grows on heavy soils subject to periodic inundation, and is considered to be an indicator of good land.

Description of the Species in its Native Habitat.

A handsome tree with pendulous branches and ashy grey phyllodes, growing to a height of from 30 to 35 feet (9 to 11m.) and a diameter of between 12 and 18 inches (30 and 45 cm.).

Economic Importance in Country of Origin.

The foliage of the tree is relished by sheep to the extent that the species is threatened with extinction over much of its range. The tree also yields an exceedingly dark, hard, close-grained, beautifully marked richly coloured, fragrant and durable timber. This is prized for turnery, fancy ware and tobacco pipes. When used for fence posts it remains sound for half a century or more. It also makes an exceptionally good fuel.

Trials in South Africa.

The species has been planted experimentally with varied results and under widely differing climatic conditions. Trials at Lichtenburg and Machavie (Potchefstroom) Plantations apparently came to naught, though two trees planted for ornament at the former centre survived and have grown to fair size. Better results were obtained in the western Orange Free State, and the species merits further trial in the western Transvaal.

Acacia visite Griseb.

Family.

LEGUMINOSAE.

Geographical Distribution.

A native of South America, where it occurs, inter alia, in Argentina.

Trials in South Africa.

The species has been planted for shade and ornament along streets and in parks and gardens, more especially under semi - arid conditions on the sandy soils in the western Orange Free State. It is very hardy to frost and drought. In Bloemfontein it attains a height of approximately 30 feet (10 m.) and develops a pleasing, somewhat flat - topped spreading crown.

Ailanthus altissima (Mill.) Swingle.  
(Syn. A. glandulosa Desf.)

Family.

SIMAROUBACEAE.

Common Name.

Tree of Heaven.

Geographical Distribution.

Endemic in the mountains of Chilhi, northern China, though now cultivated throughout that country and the greater part of Asia. The rainfall in its native habitat is approximately 20 to 30 inches (500 to 750 mm.) per annum, and occurs almost entirely in summer.

Description of the Species in its Native Habitat.

A large, deciduous tree, sometimes attaining a height of 100 feet (30 m.) and a girth of 13 feet (4 m.). It has a massively branched, oval crown, which becomes flattened at the top with age.

Economic Importance in Country of Origin.

The tree yields a light, soft wood, which is of little value except for fuel although sometimes used for joinery or poles.

Trials in South Africa.

A. altissima has been sparingly cultivated for ornament in many parts of the country and has proved hardy to frost and drought. Whether it will prove hardy also in the western Transvaal must remain unknown until trials have been conducted in the area.

Casuarina lepidophloia F. Muell.

(Syn. C. cambagei R.T. Bak, C. cristata Miq.)

Family.

CASUARINACEAE.

Common Name.

Belah.

Geographical Distribution.

Indigenous to Australia, where it is the commonest member of the genus in the dry interior. It occurs abundantly on the lower, western slopes of the Dividing Range and on the western plains of Queensland, New South Wales and Victoria, where its range extends across the continent to the Eyres Peninsula in South Australia and the southern interior of Western Australia. During much of the year it is exposed to severe drought, though it usually occupies relatively moist, flats and depressions. Frost is experienced in winter. The tree avoids heavy clays, preferring rich brown, calcareous loams.

Description of the Species in its Native Habitat.

A small to medium - sized evergreen tree with erect, cylindrical bole and stiffly erect branches. In New South Wales it may obtain a height of 90 feet (27 m.) and a diameter of 24 inches (61 cm.), but in the interior of South Australia it is no more than about 12 to 20 feet (4 to 6 m.) tall.

Economic Importance in Country of Origin.

The tree yields a timber consisting of a wide band of cream - coloured sapwood and a cone of redish - brown heartwood. The latter is very heavy and has a fine, close grain, but is not very durable. It is very hard to cut, though fissile and not tough. The green branchlets, of the tree are fed to stock in times of drought.

Trials in South Africa.

C. lepidophloia has been planted experimentally at a number of centres, but only in Zululand has a stand of it been brought to maturity. The species is well worth a trial in the western Transvaal for fuel, fodder and shade, though it is unlikely to have any commercial value.

Cupressus arizonica Greene.

(True C. arizonica has probably not been tried in the <sup>N</sup>Western Transvaal, although C. glabra Sudn. has been planted under this name in the Arboretum at Pochefstroom — see Appendix I.)

Family.

## CUPRESSACEAE.

Common Name.

Arizonica Cypress.

Geographical Distribution.

A native of North and Central America. In the United States it is found in the mountains of Arizona, New Mexico and Texas, while in Mexico it grows in northern Sonora, Chihuahua and Coahuila. It is most common at altitudes of between 3,000 and 5,000 feet (900 and 1,500m.) At the lower elevations it occupies the bottoms of canyons and ravines<sup>S</sup>, but at the upper limits of its range it is found on slopes and ridges, particularly those with a cool aspect. For the most part it forms dense, almost pure groves<sup>YES</sup> of limited extent, but in some localities it grows in mixture with Juniperus pachyphlaea and various broad-leaved species.

Description of the Species in its Native Habitat.

<sup>Am</sup> ~~Am~~ evergreen tree of medium size, on the best sites reaching a height of from 50 to 80 feet (15 to 24 m.) and a diameter of up to 4 feet (122 cm.). In such situations it has a straight, rather rapidly <sup>a</sup>tapering trunk, a long, slender leader, large, horizontal branches and a sharply conical crown. On exposed or otherwise unfavourable sites it develops a lower, rounded or flattened crown.

Economic Importance in Country of Origin.

C. arizonica is of little significance as a timber tree since even the largest stands embrace only a few square miles. Its wood is pale brownish yellow, light in weight, moderately soft, straight-grained and faintly durable. Locally it is used to a limited extent for building purposes.

Trials in South Africa.

C. arizonica is scarcely known in South Africa, C. glabra having been planted under this name in nearly every instance. It may well prove as hardy in cold, dry areas as the latter species.

Cupressus forbesii Jepson.

(Formerly known locally as C. guadalupensis Wats.)

Family.

CUPRESSACEAE.

Geographical Distribution.

Indigenous to the United States and Mexico, where it is known only from two<sup>o</sup> localities in southern California and two in Baja California. These groves are situated in mountainous country at altitudes ranging from 1,500 to 5,000 feet (460 to 1,520 m.) above sea level. The rainfall is between 10 and 20 inches (250 and 500 mm.) a year, and occurs mostly in winter.

Description of the Species in its Native Habitat.

A small<sup>l</sup>, evergreen tree, usually 20 to 23 feet (6 to 7 m.) tall but sometimes reaching a height of 34 feet (10 m.) <sup>near</sup> ~~near~~ water in the bottoms of canyons. Its <sup>ai</sup> ~~main~~ trunk is about 12 to 20 inches (30 to 50 cm.) in diameter, but ~~but~~ soon divides into numerous, ascending <sup>m</sup> limbs. The bark on the trunk and <sup>m</sup> limbs exfoliate<sup>e</sup> like that of C. glabra, leaving a smooth, mahogany brown or cherry - red surface.

Trials in South Africa.

C. forbesii has been planted experimentally<sup>l</sup> at a number of centres, including three on the eastern Transvaal highveld. It appears to have no advantage over C. glabra, but might be tried in the Western Transvaal as an alternative to the latter for use in low shelter-~~belts~~ belts and hedges.

Eucalyptus albens Miq.

Family.

MYRTACEAE.

Common Name.

White Box.

Geographical Distribution.

Widely distributed in the eastern states of Australia. In New South Wales, it is most common for the eastern slopes of the Dividing Range, though it sometimes occurs on the tablelands, and in valleys to the east of the divide. From New South Wales its range extends to the Bunya Mountains in Queensland and to northern Victoria. It is also reported from South Australia. In the south it ascends to an altitude of 1,500 feet (460 m.) and in the north to 3,000 feet (910 m.). The annual rainfall is between 20 and 30 inches (500 and 760 mm.), most of which occurs in summer over the northern parts of its range. The tree is practically confined to rich well - drained, finable, loamy soils.

Description of the Species in its Native Habitat.

A tree of moderate size, sometimes 80 feet (24 m.) in height and 30 inches (76 cm.) in diameter, with attractive, dense, silvery foliage.

Economic Importance in Country of Origin.

The species yields a pale strong durable wood of excellent quality. This is useful for poles, posts and railway sleepers, and makes an exceptionally good fire wood. The leaves of the tree are relished by cattle, and its flowers are a particularly good source of nectar and pollen.

Trials in South Africa.

E. albens has been planted experimentally in South Africa and shows promise in the Western Orange Free State. As a general - purpose, utility tree, it might be a valuable introduction to the western Transvaal.

Eucalyptus blakelyi Maid.

Family.

MYRTACEAE.

Common Name.

Blakely ' s Red Gum.

Geographical Distribution.

Widespread on the tablelands and western slopes of the Dividing Range in New South Wales, and recorded also from the contiguous parts of Queensland. The climate is warm to hot in summer but cool in winter, with some frost. The rainfall is rather low, averaging from 18 to 30 inches (450 to 760 mm.) a year, and is not very reliable. The tree prefers moist, rather compact loams of moderately good quality, and forms an open savanna woodland with such species as E. albens, E. melliodora, E. polyanthemos and E. sideroxylon.

Description of the Species in its Native Habitat.

A small to medium - sized tree, sometimes reaching a height of 80 feet (24 m.) and a diameter of 2 to 3 feet (61 to 91 cm.).

Economic Importance in Country of Origin.

The tree yields a strong, fairly durable wood of a reddish colour, which is not distinguished commercially from that of E. tereticornis.

Trials in South Africa.

E. blakelyi has been rather neglected in South Africa. Of all the Red Gums it is the species best suited climatically to the interior plateau of this country, and one or more trials in the western Transvaal should prove rewarding.

Eucalyptus calcicultrix F $\frac{1}{2}$  Muell.

Family.

MYRTACEAE.

Common Name.

Black Mallee Box.

Geographical Distribution.

A native of the semi - arid to arid regions of South Australia and New South Wales.

Characteristics and Uses in its Native Habitat.

A semi - xerophytic mallee or small tree.

Economic Importance in Country of Origin.

The species is of no commercial value, but is useful for controlling sandy wastes in areas of very low rainfall.

Trials in South Africa.

E. calcicultrix has not been tried in South Africa, but should be suitable for low windbreaks on shallow, sandy soil in the western Transvaal.

Eucalyptus intertexta R. T. Bak.

Family.

MYRTACEAE.

Common Name.

Gum - barked Coolabah.

Geographical Distribution.

A species with a very extended range in the arid interior of continental Australia stretching from the western plains of New South Wales to Western Australia and from the drier parts of South Australia to the Northern Territory.

Characteristics and Uses in its Native Habitat.

A tree up to 80 feet (24 m.) tall and 3 feet (90 cm.) in diameter, though often considerably smaller and sometimes shrubby in habit.

Economic Importance in Country of Origin.

The tree has a hard, red, durable, non - fissile wood with an interlocked grain, which should be very suitable for round posts and poles.

Trials in South Africa.

E. intertexta has not yet been established in South Africa. On account of its hardiness to drought (and probably also frost) it might well prove a valuable species in the western Transvaal.

Eucalyptus microcarpa Maid.

Family.

MYRTACEAE.

Common Name.

Green - leaved Box.

Geographical Distribution.

Very widely distributed along the landward slopes of the ~~Dividing~~<sup>✓</sup> Range in Victoria and New South Wales, where its range extends into South Australia and Queensland. Its occurrence throughout is in rather dry areas, and it reaches its best development on heavy but well - drained clay or alluvium. Associated species include Callitris glauca, Eucalyptus camaldulensis, E. melliodora and E. sideroxylon.

Description of the Species in its Native Habitat.

A tree of small to medium <sup>i</sup>size, sometimes attaining a height of 80 feet (24 m.) and a diameter of 2 feet (61 cm.).

Economic Importance in Country of Origin.

The species yields a hard, strong, durable wood which is highly esteemed for railway sleepers, telegraph poles and fence posts.

Trials in South Africa.

E. microcarpa has been very little planted in South Africa, but has proved hardy both to severe <sup>s</sup>drought and frost. It well merits trial in the western Transvaal.

Eucalyptus papuana F. Muell.

Family.

MYRTACEAE.

Common Name.

Drooping White Gum.

Geographical Distributions.

Very widely distributed over the northern parts of Australia and found also on the inland of Papua. On the continent its range extends from the east coast of Queensland across the Northern Territory into northern Western Australia. The climate varies from tropical monsoon at the coast to semi - arid temperate in the interior. Near the coast high temperatures prevail throughout the year, but on the plateau and ranges winter frosts occurs. The rainfall varies from 10 to 60 inches (250 to 1,520 mm.) a year. The tree grows on a very wide range of topography and soils. Near the coast it is found in mixture with various tropical species, but in the deep interior it occurs as solitary specimens on hillsides and steep cliffs.

Description of the Species in its Native Habitat.

In the northern parts of its range the species becomes a tree 50 to 60 feet (15 to 18 m.) and 12 to 16 inches (30 to 41 cm.) in diameter, but in the interior it is half this size.

Economic Importance in Country of Origin.

The tree has a narrow, pale sapwood and a dark, red - brown heart. The timber is not very hard and is liable to termite attack, but is used in central Australia for building purposes where wood is scarce.

Trials in South Africa.

Seed of E. papuana has been brought to South Africa, but it is not known whether any plants were raised from it. If the species is tried in the western Transvaal particular care should be taken to select a suitable provenance since the trees are otherwise likely to be killed by frost and may even suffer from drought.

Eucalyptus salmonophloia F. Muell.

Family.

MYRTACEAE.

Common Name.

Salmon Gum.

Geographical Distribution.

Widespread in the southern, interior districts of Western Australia between ~~the~~ altitudes of 900 and 1,300 feet (270 and 400 m.). The climate is warmer-temperate, with hot to very hot summers and cool winters accompanied by several frosts a year. The rainfall is 8 to 20 inches (200 to 500 mm.) a year, and occurs mainly during winter. The tree reaches its best development ~~on~~ <sup>†</sup> fertile red clay - loams, ~~but~~ grows satisfactorily on <sup>Δ</sup> wide range of soils, including sand.

Description of the Species in its Native Habitat.

The largest and best of the trees of the Western Australian interior, <sup>†</sup> E. salmonophloia attains a height of 60 to 100 feet (18 to 30 m.) and a diameter of 2 to 3 feet (60 to 90 cm.). It is a particularly attractive species, having a smooth salmon-coloured bark and dense, glossy foliage.

Economic Importance in Country of Origin.

The tree yields a reddish, very strong, straight - grained durable timber which is used locally for constructional puposes, rail/way sleepers, telephone lines, mine props and fuel.

Trials in South Africa.

E. salmonophloia has been planted only sparingly in South Africa. It has proved hardy in the Western Orange Free State and also across the border at Lobatsi. Although it may suffer from frost in exposed situations, it merits a trial in the Western Transvaal.

Eucalyptus salubris F, Muell.

Family.

MYRTACEAE.

Common Name.

Gimlet Gum.

Geographical Distribution.

The species occurs under the same conditions as E. salmonophloia (q. v.), often in association with it.

Description of the Species in its Native Habitat.

A smaller tree than E. salmonophloia, E. salubris grows to a height of 40 to 80 feet (12 to 24 m.) and a diameter of 1 to 2½ feet (30 to 76 cm.). Unlike the former, its bole is often spirally fluted and unsound.

Economic Importance in Country of Origin.

The wood of E. salubris is pale brown, very hard, heavy, tough and strong. It is used mainly for mining timber and fuel, though sometimes it is employed for building, poles and fencing.

Trials in South Africa.

E. salubris has proved very hard<sup>y</sup> under dry conditions in the western Cape Province, but whether it would withstand the frost in the western Transvaal is by no means certain. It is a less desirable forest<sup>t</sup> tree than E. salmonophloia, and should therefore be tried only if the latter fails.

Eucalyptus transcontinentalis Maid.

(Syn. E. oleosa F. Muell. var. glauca Maid.)

Family.

MYRTACEAE.

Common Name.

Mofrel.

Geographical Distribution.

Very extensively distributed in the dry, inland regions of Australia from the western plains of New South Wales and Victoria to the southern interior of Western Australia. It reaches its best development on red, clay - loam<sup>m</sup> flats in association with E. salmonophloia.

Description of the Species in its Native Habitat.

A robust mallee or tree up to 70 feet (21 m.) in height.

Economic Importance in Country of Origin.

The tree yields a reddish - brown, hard, very tough, durable wood which is used for mining timber.

Trials in South Africa.

This species is all but unknown in South Africa and should succeed in the western Transvaal if seed of suitable provenance is procured.

Family.

PINACEAE.

Common Name.

Bristle - Cone Pine.

Geographical Distribution.

Widely scattered over the higher mountains of Colorado, Utah, Nevada, California, Arizona and New Mexico in the United States, where it grows at altitudes of up to 12,000 feet (3,660 m.). The climate is extremely severe, the number of killing frost a year being over 275 and the annual rainfall as little as 10 inches (250 mm.).

Description of the Species in its Native Habitat.

A small tree with a short bole, sometimes reaching a height of 40 feet (12 m.) and a diameter of 4 feet (122 cm.). The species is remarkable for its extraordinary lonievity. The age of several trees has been ditermined as over 4,000 years. These are claimed to be the oldest living orgunnus on earth.

Economic Importance in Country of Origin.

The species is extremely slow - growing and yields a wood of poor quality suitable only rough building constructions, mining timber and fuel.

Trials in South Africa.

P. aristata has not yet ben introduced to South Africa. Although very slow - growing, it might prove useful for low shelterbelts in dry areas with cold winters, such as the western Transvaal.

Pinus <sup>g</sup>erardiana Wall.

Family.

PINACEAE.

Common Name.

H<sup>m</sup>imalayan E<sup>b</sup>dible Pine.

Geographical Distribution.

A native of Afghanistan, northern Balu<sup>c</sup>ghistan and the arid, inner valleys of the north - western Himalaya, where it occurs at an altitude of 6,000 to 10,000 feet (1830 to 3,050 m.). The rainfall is scanty but the snowfall heavy, the total precipitation amounting to between about 15 and 30 inches (38 and 76 mm.) a year. The tree is capable of growing on very dry slopes where the soil is shallow. It is often associated with Cedrus deodara.

Description of the Species in its Native Habitat.

A much - branched tree with short bole, sometimes attaining a height of 80 feet (24 m.) and a diameter of 4 feet (122 cm.), though usually smaller.

Economic Importance in Country of Origin.

The tree yields<sup>s</sup> a hard, tough, very resinous wood which is used locally for general <sup>u</sup>pposes. Of more importance are its <sup>d</sup>seeds, which are eaten locally.

Trials in South Africa.

P. gerardiana has been planted experimentally without great success at a number of stations in South Africa. For trial in the western Transvaal it should be re - introduced from a suitable locality within its natural range.

Eucalyptus bridgesiana R.T. Bak.(Syn. E. stuartiana F. Muell.)Family.

MYRTACEAE.

Common Name.

Apple Box, But But.

Geographical Distribution.

Widespread along the western slopes of the <sup>D</sup>ividing Range and on the <sup>1</sup>northern Tablelands of New South Wales, where its range extends to the Stanthorpe Plateau in Queensland and the eastern half of Victoria. It is essentially a species of low to medium altitudes and of a temperate, somewhat dry climate. The summers are <sup>a</sup>warm but the winters are frosty. The rainfall is between 25 and 45 inches (635 and 1,140 mm.) a year. The tree is found mainly on heavy, alluvial soils in open <sup>v</sup>savanna woodland, where its associates are E. blakelyi, E. melliodora and E. sideroxylon.

Description of the Species in its Native Habitat.

A rather small tree, usually 40 to 70 feet (12 to 21 m.) in height and 1½ to 3 feet (45 to 91 cm.) in diameter, but larger under favourable conditions. It has a short, poorly formed bole and heavily - branched, umbrageous crown with pendulous branchlets.

Economic Importance in Country of Origin.

The tree is mainly useful for shelter, shade and ornament. Its wood is pale brown, soft and brittle, and suitable only for pulp and fuel.

Trials in South Africa.

E. bridgesiana is frequently encountered in the cooler and drier parts of South Africa, where its almost invariably satisfactory growth, hardiness to frost and drought and relative immunity to Snout Beetle attack <sup>9</sup>read it one of the best and <sup>a</sup>sest eucalyptus for farm woodlots and shelterbelts. The species can be expected to succeed in the Western Transvaal.

~~Pinus~~  
Quercus sabiniana Dougl.

Family.

PINACEAE.

Common Name.

Digger Pine.

Geographical Distribution.

Widespread in the central ranges<sup>s</sup> and the arid foothills of the Sierra Nevada in California, U.S.A., where it occurs at an altitude of about 400 to 4,000 feet (120 to 1,220 m.). It is very hardy to drought<sup>g</sup> and grows on dry shallow gravels, forming an open scrub - forest.

Description of the Species in its Native Habitat.

A short-boled tree with crooked branches, sometimes attaining a height of 80 feet (24 m.).

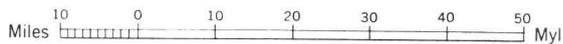
Economic Importance in Country of Origin.

Timber from this species is light, soft, brittle and very resinous, but is nevertheless used locally. The seeds are ~~edible~~. *edible*

Trials in South Africa.

P. sabiniana<sup>b</sup> is a rather slow growing species but is very hardy to frost and drought<sup>g</sup>. In the ~~Western~~<sup>w</sup> Transvaal it might prove useful for shelter.

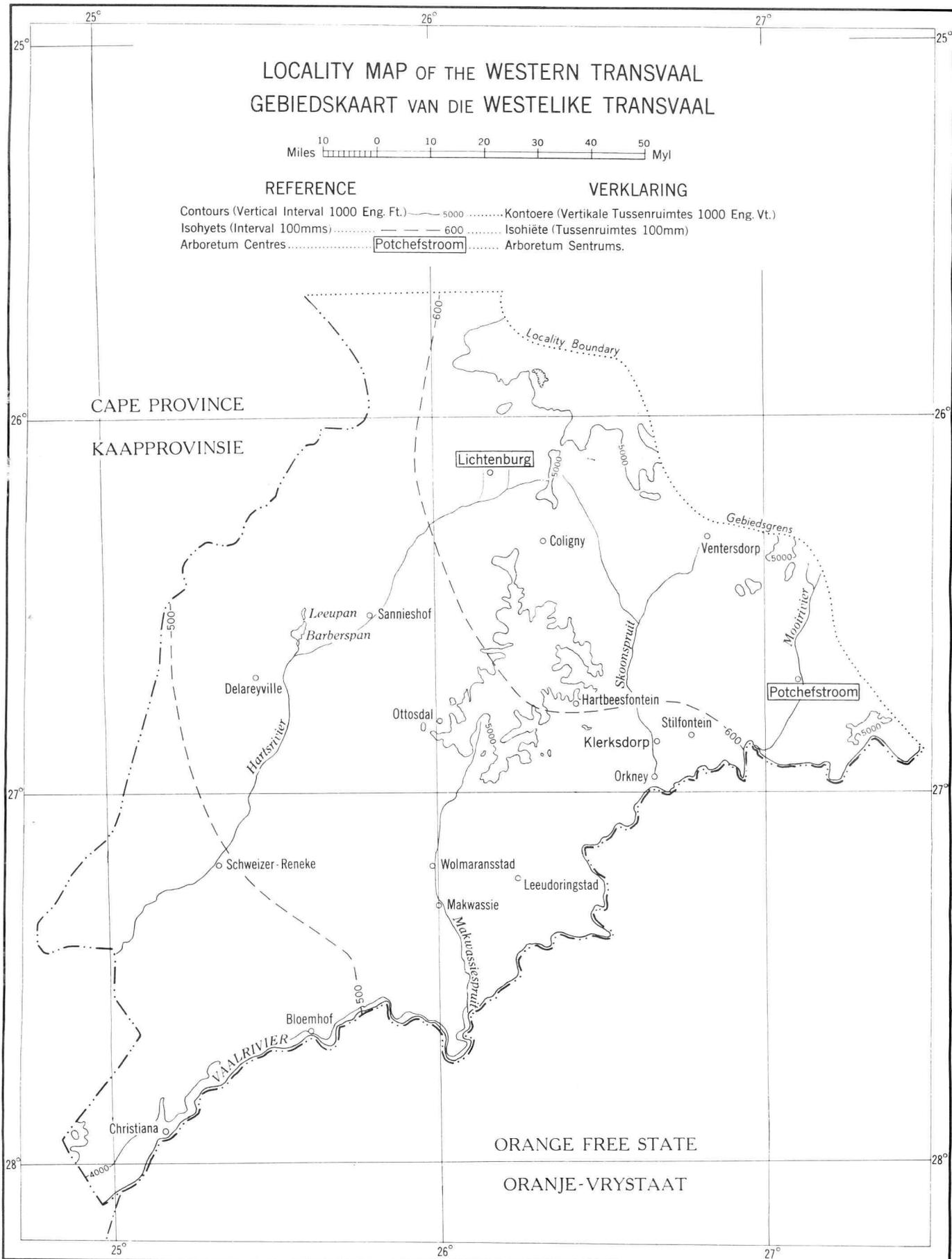
LOCALITY MAP OF THE WESTERN TRANSSVAAL  
 GEBIEDSKAART VAN DIE WESTELIKE TRANSSVAAL

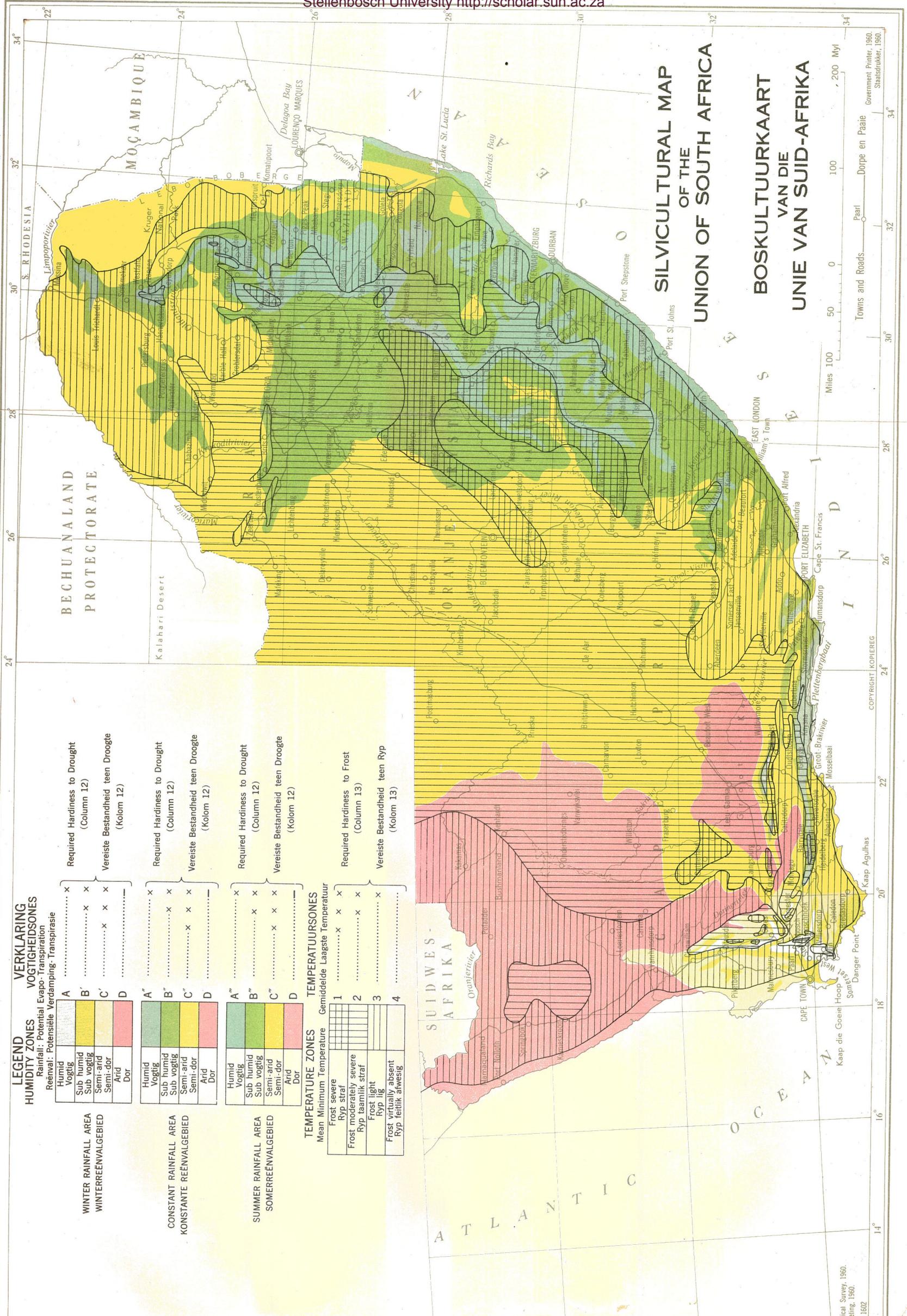


REFERENCE

Contours (Vertical Interval 1000 Eng. Ft.) ——— 5000 ..... Kontoere (Vertikale Tussenruimtes 1000 Eng. Ft.)  
 Isohyets (Interval 100mms) ..... ——— 600 ..... Isohiëte (Tussenruimtes 100mm)  
 Arboretum Centres ..... Potchefstroom ..... Arboretum Sentrums.

VERKLARING





**SILVICULTURAL MAP  
OF THE  
UNION OF SOUTH AFRICA**

**BOSKULTUURKAART  
VAN DIE  
UNIE VAN SUID-AFRIKA**

Miles 100 0 100 200 Myl  
Towns and Roads Paarl Dorpe en Paate  
Government Printer, 1960.  
Staatsdrukker, 1960.

**LEGEND**

**HUMIDITY ZONES**  
Rainfall: Potensiele Evapo-Transpirasie  
Reënval: Potensiele Verdamping-Transpirasie

Humid Vogtig	A	..... x	Required Hardness to Drought (Column 12)
Sub humid Sub vogtig	B'	..... x	Vereiste Bestandheid teen Droogte (Kolom 12)
Semi-arid Semi-dor	C'	..... x	Required Hardness to Drought (Column 12)
Arid Dor	D	.....	Vereiste Bestandheid teen Droogte (Kolom 12)

**CONSTANT RAINFALL AREA**  
KONSTANTE REËNVALGEBIED

Humid Vogtig	A''	..... x	Required Hardness to Drought (Column 12)
Sub humid Sub vogtig	B''	..... x	Vereiste Bestandheid teen Droogte (Kolom 12)
Semi-arid Semi-dor	C''	..... x	Required Hardness to Drought (Column 12)
Arid Dor	D	.....	Vereiste Bestandheid teen Droogte (Kolom 12)

**SUMMER RAINFALL AREA**  
SOMERREËNVALGEBIED

Humid Vogtig	A'''	..... x	Required Hardness to Frost (Column 13)
Sub humid Sub vogtig	B'''	..... x	Vereiste Bestandheid teen Ryp (Kolom 13)
Semi-arid Semi-dor	C'''	..... x	Required Hardness to Frost (Column 13)
Arid Dor	D	.....	Vereiste Bestandheid teen Ryp (Kolom 13)

**TEMPERATURE ZONES**  
Mean Minimum Temperature Gemiddelde Laagste Temperatur

Frost severe Ryp straf	1	..... x	Required Hardness to Frost (Column 13)
Frost moderately severe Ryp taamlik straf	2	..... x	Vereiste Bestandheid teen Ryp (Kolom 13)
Frost light Ryp lig	3	..... x	Required Hardness to Frost (Column 13)
Frost virtually absent Ryp feitlik afwesig	4	.....	Vereiste Bestandheid teen Ryp (Kolom 13)

Ordnance Survey, 1960.  
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