Mulga (*Acacia aneura* F. Muell.) in Queensland

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SUMMARY

Mulga (*Acacia aneura* F. Muell.) is described and figured. The common variety in Queensland is identified with *A. aneura* var. *latifolia* J. M. Black and four well-marked growth forms of this variety are described and illustrated. The distribution of the species in Queensland is shown on a map.

Climate, topography and soils in the mulga region are discussed and associated plants described briefly. Some notes are given on the life history of broad-leaved mulga.

Fodder value, palatability and methods of utilizing mulga are discussed and regrowth after different methods of treatment is described. Notes are also given on the effects of thinning on mulga forests and on the occurrence of soil erosion in the mulga country.

An appendix lists 256 species of plants collected in an area east of Wyandra and indicates the soil types on which they occur.

INTRODUCTION

Mulga (*Acacia aneura*) is one of the most important fodder trees in Queensland since it is plentiful in a region subject to recurring drought and is for the most part palatable to stock. According to the *Charleville Times* newspaper of July 17, 1947, mulga was first used to hand-feed sheep in Queensland in 1886. In that year, one Henry Riddell engaged men to cut mulga for 60,000 sheep in the Charleville district, and he maintained the flock during 2½ years of drought. Since then, mulga has been recognized as the principal reserve drought fodder in much of south-western Queensland.

Until fairly recently, the commonest method of using mulga was to chop down the trees and allow sheep and cattle access to the leafy tops. This treatment killed the trees. Some years ago concern began to be expressed at the depletion of the fodder reserves due to wholesale cutting of mulga. It was feared that eventually the mulga forests might be destroyed and that extensive sheet erosion might ensue. Some graziers sought means of utilizing mulga without killing it and without destroying the forests completely.

At irregular intervals in the period from 1937 to 1942, the writer made observations on mulga and its behaviour following different methods of treatment, mostly in the country about Charleville and Cunnamulla. It was suggested that some experimental work might be undertaken to ascertain the effect on mulga trees of different methods of lopping, and to determine to what extent mulga forests could be thinned out without serious depletion of the fodder reserves. In January, 1942, an experiment along these lines was begun at Bilbah Downs, Emmet, near the northern limit of the range of mulga. Nothing further was done on the problem until 1946, when the work was revived after the war. Observations were made in the Bollon, Wyandra and Charleville districts in August, 1946, and subsequently in March and July of 1947 and April, July and October of 1948. In June, 1947, the experimental area at Bilbah Downs was visited and notes made.

During these years much information concerning mulga was gleaned from graziers, drovers and others. Much of the material contained in this report was obtained from these sources. The report records what is at present known about mulga in Queensland and is intended to serve as a starting point for future work.

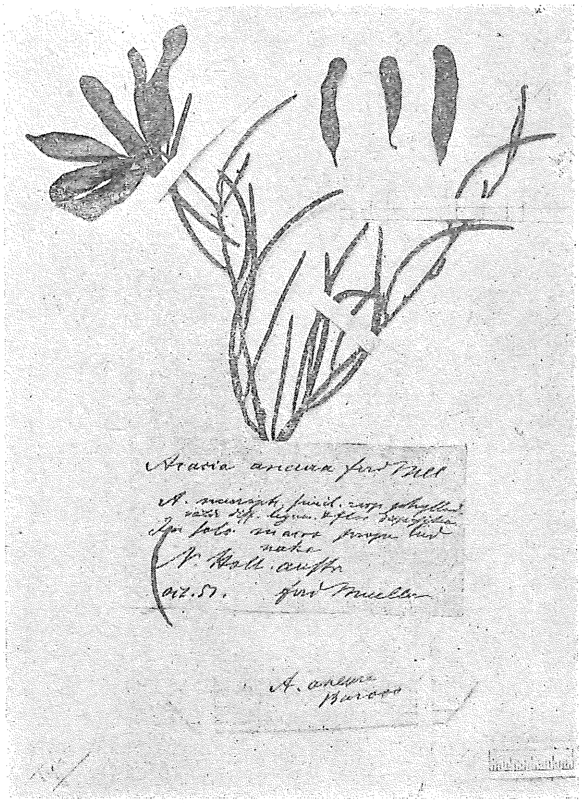


Figure 1.

Acacia aneura. F. Muell. Photograph of type specimen in National Herbarium, Melbourne.

DESCRIPTIONS OF MULGA VARIETIES

The name mulga is given to several species of *Acacia* with greyish-green leaves, dark grey or brownish-grey trunks, and obliquely ascending branches. Of the various species known as mulga, the most common in Queensland is *Acacia aneura.* In this State, only one other species has so far been found ; this is *A. brachystachya,* which is not common.

Acacia aneura was first descibed by Mueller (1855). The original description has not been seen by the writer, but a later description by Mueller (1863) has been studied. Through the courtesy of the Victorian Government Botanist it has been possible to examine the type specimen collected by Mueller at Lake Cudnaka in South Australia and illustrated in Figure 1.

The species is extremely variable, particularly in habit and in shape, size and texture of the leaves (phyllodes). Varieties are distinguishable in the field and in the herbarium, but varietal names based on leaf characters must be used with great caution, since leaves of strikingly different appearance may be found on the same tree.

The following description, drawn up from the type specimen and from material in the Queensland Herbarium, includes all varieties examined by the writer :—

Shrub or tree attaining a height of 12 metres under favourable conditions, usually 5-8 metres high : bark dark grey to brownish-grey, hard, finely fissured : wood straight-grained, dense and hard ; sapwood ivory-coloured ; truewood dark brown : branches numerous, slender, obliquely ascending except in small shrubs modified by grazing : leaves (phyllodes) very variable in size and shape, ranging from almost terete and 0.1 cm. broad to lanceolate and 1 cm. broad, varying in length from 3 cm. to 12 cm., straight or falcate, grey in colour, covered with a very short tomentum visible only with a lens, finely but very obscurely nerved except on some seedlings and " coppice " growth in which 3-7 parallel nerves are prominent : flowers bright yellow, in dense pedunculate spikes ; spikes 1-2 cm. long including the peduncle ; flowers 5-merous ; sepals free, 0.05 cm. long, membranous, narrowly spathulate, glabrous except for a small tuft of hairs on the back of the expanded tip ; corolla glabrous, campanulate, 0.15 cm. long, 0.1 cm. broad, lobes 0.07-0.1 cm. long, acute ; filaments numerous, flexuous, 2-3 times as long as the corolla, anthers 2-celled, 0.01 cm. long, 0.01 cm. broad ; ovary sessile, ovoid, 0.06 cm. long, 0.05 cm. broad, very shortly tomentose ; style excentric, elongated, 0.3 cm. long ; stigma small, capitate : pods often borne in great profusion, flattened and leaflike, covered with the same grey tomentum as the leaves, shortly stalked, 2-4.5 cm. long, 0.8-1.2 cm. broad, oblong, tapered at the base, apex sometimes rounded, sometimes very shortly acuminate, primary veins 2, diverging from the stipes and forming intra-marginal veins, or in the very narrow-leaved forms marginal veins, secondary veins reticulate between the primary veins ; seeds 3-6, transversely or obliquely placed and widely spaced in the pod, flattened, broadly elliptic to ovoid in outline, 0.3-0.4 cm. long, dark brown in colour ; funicle yellow, long, slender, with 2-3 folds, expanded into a cap-shaped aril 0.05 cm. diameter.

Varieties

In Queensland, there are two well-marked extreme varieties. Most common is the broad-leaved variety, which seems to be identical with *Acacia aneura* var. *latifolia* J. M. Black. This variety forms extensive forests in south-western Queensland and exhibits several growth forms, which are described in the next section. The mature trees are usually 5-8 metres high, but sometimes up to 12 metres. The leaves are slightly to markedly falcate, 0.3-1.0 cm. broad and 3-8 cm. long. " Coppice " leaves from grazed shoots and leaves on seedlings often have several prominent longitudinal nerves.

In the narrow-leaved variety, which occurs chiefly west of longitude 144 and towards the northern limits, the leaves are 0.1-0.15 cm. broad, straight or slightly falcate, 3-12 cm. long and very obscurely nerved. The pods of this variety are often slightly smaller than those of the broad-leaved variety and have the primary veins at or very close to the margins. There are many intermediates between the two extremes.

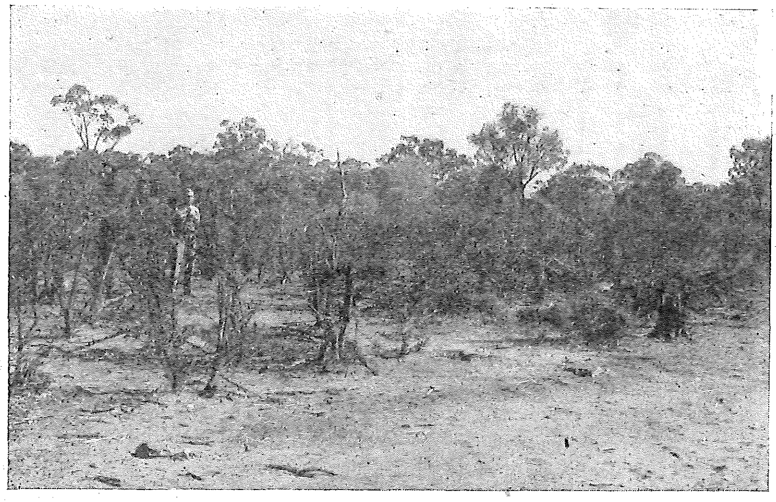
Most of the studies reported in this paper have been made with the broad-leaved variety and unless otherwise indicated any statements made apply to that variety.

Growth Forms

In the field, it has been found possible to distinguish four principal growth forms of the broad-leaved mulga. These forms are not varieties in the botanical sense, and trees of one form may assume other forms as they develop. They have been separated into categories, because each requires different treatment if it is to be utilized most efficiently.

Low Mulga

Low mulga is also known as " cattle mulga." Often it grows in very dense stands, sometimes of more than 5,000 shrubs per acre. It represents trees which have been modified by grazing. Francis (1925) drew attention to this form and the peculiar modification of its growth due to grazing. Individual shrubs consist of one or more erect stems, often somewhat crooked, with numerous short lateral branches bearing short spurs. On the spurs the leaves are borne close together, giving the plant a characteristic appearance. The leaves themselves are comparatively short and broad and often less glaucous than in other forms. Usually they have three or more prominent longitudinal nerves, and on the nerves and the margins there is a sticky resinous exudate, especially noticeable in new leaves following summer rain.



F gure 2.
Low mulga on stock route near Charleville, August, 1946. The tall trees in the background are *Eucalyptus populifolia*.

The tops are usually about 1.5 metres high and remarkably uniform in height, like a trimmed hedge. This is brought about by grazing principally by cattle. Where only sheep are depastured, low mulga grows out of reach of the animals after a few years.

Figure 2 illustrates a thick stand of low mulga and shows the characteristic trimmed tops. Figure 3 shows a small individual plant.

Whipstick Mulga

Whipstick mulga is a name given to immature trees which have not been modified by grazing and which occur in dense stands. Individual trees have one very slender central trunk. Lateral branches are thin compared with the trunk, and the lower laterals are usually dead. In the upper half of the tree there are numerous slender, obliquely ascending branches, which bear leaves mostly near the ends. The trees vary in height from about 1 metre to about 5 metres. Whipstick mulga grows in thickets and appears to be the normal form of young mulga

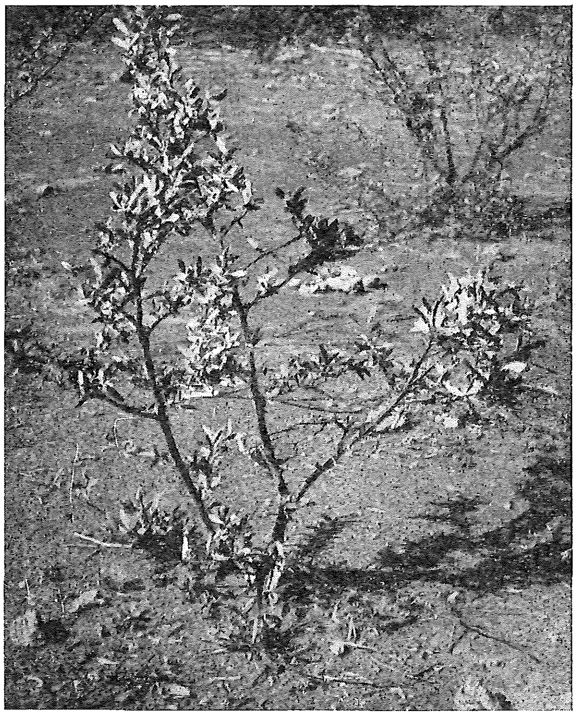


Figure 3.
Low mulga. Boatman Station, March, 1947.

growing thickly and unmodified by grazing. The scrubs of whipstick mulga in the Charleville-Wyandra area are said to have appeared after widespread fires followed by good summer rains.

Eventually some of the trees perish due to intense competition for water, and the remaining trees may grow up into umbrella mulga or tall mulga. Often it is difficult to decide whether particular trees should be called whipstick mulga or young umbrella mulga. Figure 4 shows an average stand of whipstick mulga.

Umbrella Mulga

The name umbrella mulga is given to trees of vigorous growth with an appearance suggesting an umbrella which has been blown inside out. The form occurs in a wide variety of situations and the trees vary in size according to age and soil conditions. Figure 5 shows an isolated umbrella mulga about 7 metres high. It consists of a stout central trunk, branched about 1.5 metres above the ground. The lateral branches are stout and are themselves repeatedly branched, the branches sloping obliquely upward. The ultimate branchlets are thin and very leafy.

Figure 4.
Whipstick mulga. Boatman Station, July, 1946.

In addition to the obliquely ascending branches, many umbrella mulga trees have several thin, almost horizontal branches in the lower part, either directly on the main trunk or on the underside of the main limbs. These divergent branches appear to be particularly important in regrowth of trees after lopping. This is discussed in more detail on page 123.

Figure 6 shows a closed forest of umbrella mulga. It is not often that mulga growing so thickly develops into such fine trees. This particular forest is in a slight depression which receives some run-off water from the surrounding slopes. Most good examples of umbrella mulga are fairly well-spaced in what can be described as a parkland community.

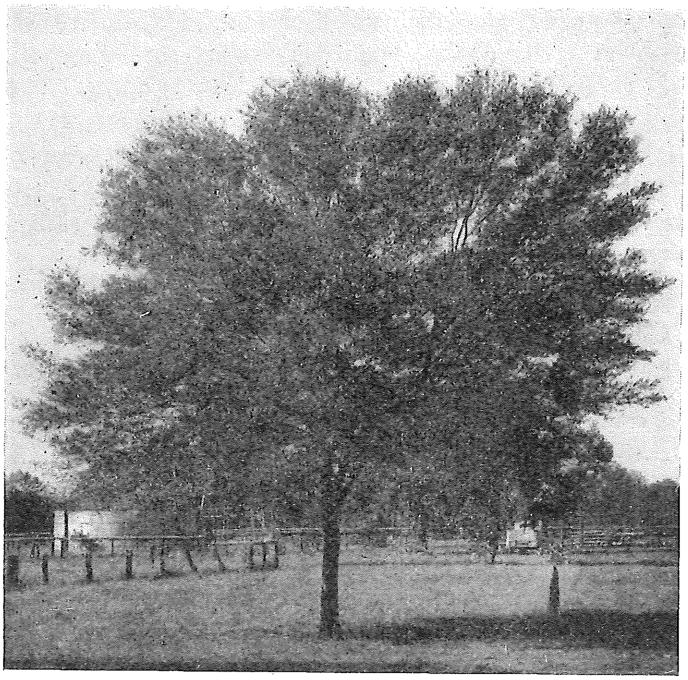


Figure 5.
Umbrella mulga. Boatman Station, July, 1947.

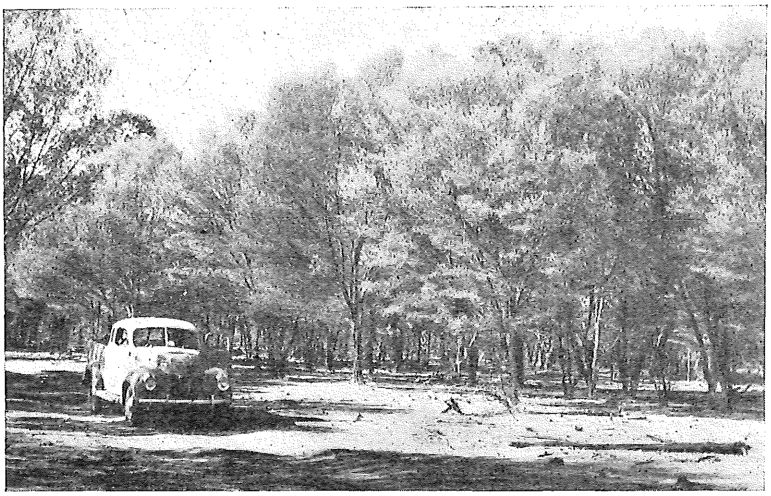


Figure 6.
Umbrella mulga forest. Boatman Station, August, 1946.

In South Australia, the name "umbrella mulga" is applied to *Acacia brachystachya.* West of Quilpie the name is also used for shrubs about 8 feet high, branched at ground level and with obliquely ascending, slender stems and spreading leafy crowns. These, too, probably represent *A. brachystachya.*

In umbrella mulga of the broad-leaved variety, the leaves are usually 0.5-1 cm. broad, 4-8 cm. long, and markedly falcate. They are often silvery grey in colour, particularly when young, and the name "silver-leaf mulga" is sometimes used instead of umbrella mulga. The trees flower whenever the season is favourable, and quite often produce ripe pods.

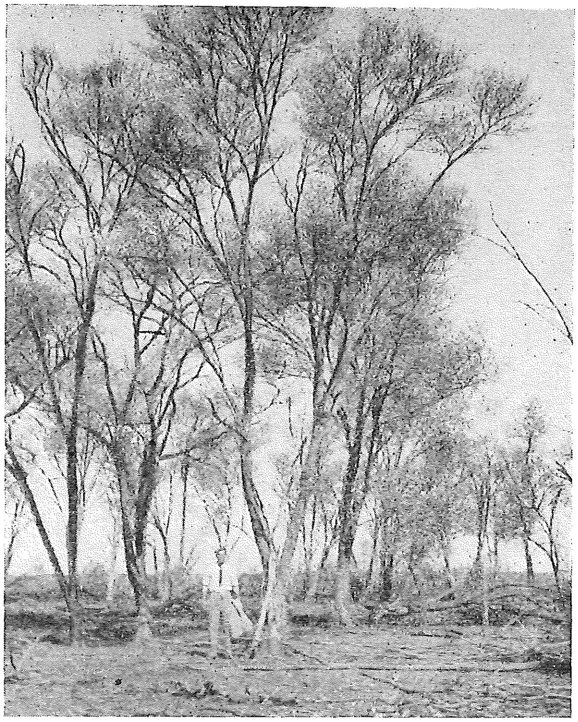
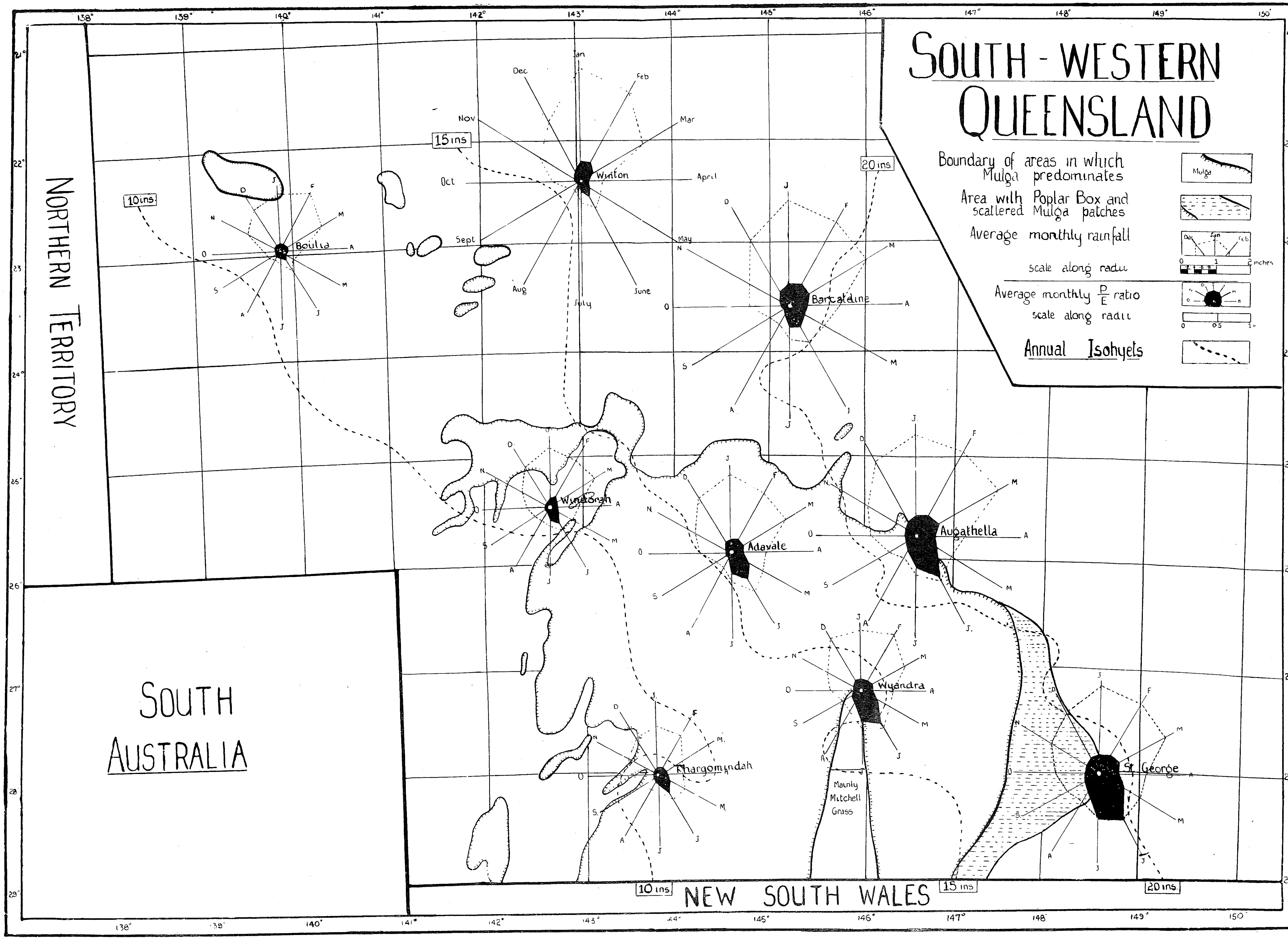


Figure 7.
Tall mulga. Sixteen miles west of Bollon, August, 1946.

Tall Mulga

Figure 7 shows some tall mulga. The trees are about 8-12 metres high, with erect trunks, unbranched except near the top. The branches are usually slender and obliquely ascending, though occasionally some are spreading or slightly pendulous. In the broad-leaved variety, the leaves of this form are usually narrower than those of umbrella mulga. Tall mulga flowers and fruits freely and apparently represents the fully mature tree. Some of the trees appear to be almost senile.

In 1947, it was very noticeable that seedlings were most numerous in the vicinity of tall mulga trees.



SOUTH - WESTERN QUEENSLAND
Boundary of areas in which Mulga predominates
Mulga
Area with Poplar Box and scattered Mulga patches
Average monthly rainfall
scale along radii
0 1 2 inches
Average monthly D/E ratio
scale along radii
0 0.5 1
Annual Isohyets
NORTHERN TERRITORY
SOUTH AUSTRALIA
NEW SOUTH WALES
Boulia
Winton
Barcaldine
Windorah
Adavale
Augathella
Wyandra
Thargomindah
St George
Mainly Mitchell Grass
10 ins
15 ins
20 ins
Jan
Feb
Mar
April
May
June
July
Aug
Sept
Oct
Nov
Dec
138° 139° 140° 141° 142° 143° 144° 145° 146° 147° 148° 149° 150°
21° 22° 23° 24° 25° 26° 27° 28° 29°

HABITAT

Geographical Range

Mulga occurs in Western Australia, South Australia, Northern Territory, New South Wales, and Queensland.

Figure 8 shows the present known distribution of mulga in Queensland. This is based on a vegetation map of western Queensland by Blake (1938) with some modification as a result of recent work. Mulga is not the only plant community within the boundaries marked on the map, but it occupies the greater part of the region. The tree forms forests or scrubs which are characteristic of the brown and red-brown fine sands and fine sandy loams of south-western Queensland. It occupies the western half of the Maranoa district, the greater part of the Warrego district, and smaller areas in the Gregory South, Mitchell and Gregory North districts.

East of the Warrego River, mulga is often mixed with poplar box (*Eucalyptus populifolia*) and other tree species. Towards the Maranoa River the eucalypts become increasingly numerous and mulga tends to occupy comparatively smaller and smaller areas, finally occurring as isolated trees or small communities within the eucalyptus forest formation. As yet, the western boundaries have not been studied in detail.

Climate

In Queensland, mulga occurs mainly between the 8-inch and the 20-inch annual isohyets. Though it is found north of the zero line on the P/E difference map (Farmer, Everist and Moule, 1947, p. 42), in such places it forms only small isolated communities, every one of which so far seen consists entirely of the narrow-leaved variety. Mulga is rare east of the 20-inch annual isohyet.

Table 1 gives monthly means for rainfall (P), temperature (T), evaporation (E) and precipitation/evaporation ratio (P/E) for 18 stations in western Queensland. Figures used and methods of calculation are the same as those used by Farmer, Everist and Moule (1947, p. 29). Table 2 gives mean monthly rainfalls for an additional 15 stations, together with figures for approximate evaporation estimated from the network of 18 stations in Table 1. Also included are P/E ratios computed from the actual rainfall and the estimated evaporation.

Included in Figure 8 are graphs of mean monthly rainfall and mean monthly P/E ratio for nine stations selected from Tables 1 and 2. On the graphs, months are represented by radii. Along each radius is plotted the mean rainfall (0.5 inch = 100 points) and the P/E ratio (1 inch = P/E of 1) for the month it represents. Monthly rainfall points are joined together by a broken line, P/E points by a continuous line. Stippled areas represent total rainfall for the particular station, black areas are those bounded by the line joining monthly P/E means.

Radial graphs such as these have certain disadvantages, but they do serve to present data in a compact form easily grasped. Visual comparison of one station with another is made easy because each graph is a closed figure of peculiar shape.

TABLE 1.—MEAN MONTHLY VALUES FOR RAINFALL (P), TEMPERATURE (T), EVAPORATION (E) AND PRECIPITATION/EVAPORATION RATIO (P/E) FOR 18 STATIONS IN WESTERN QUEENSLAND.

Station / Month		Boulia	Winton	Long-reach	Barcal-dine	Win-dorah	Isisford	Black-all	Tambo	Ada-vale	Charle-ville	Mitchell	Roma	Thargo-mindah	Cunna-mulla	Bollon	St. George	Surat	Goondi-windi
Jan.	P	1.63	3.22	2.15	3.11	1.37	2.44	2.78	2.79	2.31	2.45	2.86	3.05	1.45	1.27	2.26	2.57	2.62	2.97
	E	13.92	11.52	10.40	9.76	14.08	10.56	10.72	8.96	12.48	10.40	8.48	8.16	13.76	11.20	9.12	9.76	7.68	7.52
	T	88.4	87.0	86.0	84.6	87.4	86.4	85.6	82.1	85.7	83.5	80.0	80.9	85.8	83.9	83.2	83.3	81.3	80.4
	P/E	.12	.28	.21	.32	.10	.23	.26	.31	.18	.23	.34	.37	.11	.11	.25	.26	.34	.39
Feb.	P	1.85	2.96	3.42	2.79	1.62	2.80	3.20	2.98	2.01	2.62	3.05	2.91	1.36	2.06	2.02	2.37	2.98	2.51
	E	12.64	9.76	8.80	8.16	12.96	8.96	9.12	7.52	11.68	9.28	7.52	7.36	12.48	9.60	8.00	8.00	6.88	6.72
	T	87.4	85.5	84.5	83.0	86.4	84.7	84 1	81.0	85.1	82.6	78.8	80.0	85.0	82.7	82.2	81.1	80.4	79.2
	P/E	.15	.30	.39	.34	.12	.31	.35	.40	.17	.28	.41	.40	.11	.21	.25	.30	.43	.37
Mar.	P	1.48	2.16	2.48	2.57	1.60	2.72	2.68	2.64	1.89	2.31	2.83	2.64	.83	1.39	1.79	2.15	2.57	2.55
	E	11.04	8.96	7.84	7.84	10.72	8.16	7.84	6.72	9.28	7.68	5.92	6.24	10.24	8.00	6.40	6.40	5.60	5.76
	T	83.5	82.5	81.1	79.8	81.5	81.0	80.4	77.0	80.0	77.9	74.3	76.1	79.6	77.6	77.2	76.7	75.9	75.2
	P/E	.13	.24	.32	.33	.15	.33	.34	.39	.20	.30	.48	.42	.08	.17	.28	.34	.46	.44
Apr.	P	.58	.66	.95	1.42	.89	1.37	1.33	1.39	.98	1.35	1.36	1.29	.73	1.07	1.12	1.35	1.22	1.47
	E	8.96	8.00	6.72	6.24	7.84	6.56	6.56	5.60	6.56	5.92	4.32	4.80	6.88	5.76	4.48	4.76	4.48	4.16
	T	74.9	76.1	74.0	73.2	72.7	73.5	72.7	69.9	71.1	69.8	66.4	68.2	70.4	69.1	68.5	68.7	68.6	67.6
	P/E	.06	.08	.14	.23	.11	.21	.20	.25	.15	.23	.31	.27	.11	.19	.25	.23	.27	.35
May	P	.44	.64	.89	1.17	.77	1.01	1.38	1.38	1.06	1.23	1.26	1.34	.84	1.10	1.21	1.43	1.31	1.68
	E	6.08	5.76	4.96	4.64	4.96	4.64	4.16	3.68	4.32	3.68	2.88	3.04	4.32	3.68	3.04	3.36	3.04	2.72
	T	66.9	68.3	66.0	65.6	64.0	65.0	64.3	61.6	62.4	61.4	58.2	60.1	61.7	60.9	60.3	60.5	60.4	59.9
	P/E	.07	.11	.18	.25	.16	.22	.33	.37	.25	.33	.44	.44	.19	.30	.40	.43	.43	.62
June	P	.52	.82	.86	1.13	.81	1.11	1.25	1.29	1.25	1.38	1.66	1.55	.83	1.19	1.49	1.55	1.78	1.79
	E	4.16	4.16	3.20	3.20	3.36	3.36	2.88	2.40	2.72	2.24	1.76	1.92	2.88	2.40	1.92	2.08	1.92	1.76
	T	60.7	62.5	60.5	60.4	57.9	59.7	58.7	56.6	56.5	55.9	53.2	54.5	55.6	54.9	54.5	54.5	54.5	54.3
	P/E	.13	.20	.27	.35	.24	.33	.43	.54	.46	.62	.94	.81	.29	.50	.78	.75	.93	1.02
July	P	.28	.62	.78	1.00	.55	.93	1.12	1.20	.91	1.22	1.45	1.47	.48	.90	1.08	1.27	1.75	1.75
	E	4.16	4.16	3.52	3.36	3.36	3.52	3.04	2.56	3.04	2.40	1.92	1.92	2.72	2.24	1.76	1.92	1.76	1.76
	T	59.4	60.7	58.7	58.4	56.4	58.1	57.0	54.8	54.8	53.9	51.6	53.4	53.9	53.7	52.4	53.0	53.3	52.8
	P/E	.07	.15	.22	.30	.16	.26	.37	.47	.30	.51	.76	.77	.18	.40	.61	.66	.99	.99
Aug.	P	.28	.22	.27	.51	.40	.54	.62	.73	.47	.72	.93	.89	.50	.66	.88	.91	1.00	1.23
	E	5.76	5.76	4.80	4.64	5.12	4.80	4.32	3.68	4.32	3.84	3.04	3.04	4.32	3.68	2.72	3.04	2.72	2.56
	T	63.5	64.6	62.3	62.0	60.7	61.5	60.6	58.3	58.7	57.3	54.7	56.8	58.0	57.4	55.9	56.1	56.5	55.8
	P/E	.05	.04	.06	.11	.08	.11	.14	.20	.11	.19	.31	.29	.12	.18	.32	.30	.37	.48
Sept.	P	.31	.43	.59	.71	.48	.65	.79	.88	.67	.86	1.25	1.41	.54	.85	1.05	1.09	1.25	1.53
	E	8.48	8.16	6.88	6.56	7.52	6.40	6.24	5.76	6.40	5.60	4.64	4.48	6.56	5.60	4.32	4.32	4.16	4.00
	T	70.7	71.9	69.6	68.5	67.8	69.2	68.2	65.3	66.0	64.5	61.5	63.4	65.0	64.2	63.2	63.4	63.4	62.3
	P/E	.04	.05	.09	.11	.06	.10	.13	.15	.10	.15	.27	.31	·08	.15	.24	.25	.30	.38
Oct.	P	.46	.69	.91	1.13	.64	.98	1.39	1.38	1.03	1.26	1.47	1.74	.73	.89	1.30	1.31	1.77	1.75
	E	11.68	10.72	9.44	8.96	10.24	8.96	8.96	7.52	8.96	7.84	6.72	6.56	9.12	7.84	6.40	6.40	5.60	5.60
	T	78.3	79.2	77.2	75.9	75.7	76.6	75.9	72.6	74.1	72.5	69.0	70.7	72.7	71.6	70.9	70.6	70.4	69.4
	P/E	.04	.06	.10	.13	.06	.11	.16	.18	.11	.16	.22	.26	.08	.11	.20	.20	.32	.31
Nov.	P	.96	1.28	1.16	1.34	.92	1.35	1.52	1.82	1.25	1.66	2.18	2.18	1.01	1.02	1.49	1.72	1.84	2.25
	E	13.44	12.16	10.24	9.60	12.32	10.40	10.08	8.64	11.20	9.44	8.00	7.84	11.52	9.92	7.84	7.68	6.72	6.88
	T	83.8	83.8	82.2	80.6	81.8	81.8	81.2	77.8	80.0	78.6	75.1	76.8	79.5	77.9	77.6	77.0	76.0	75.3
	P/E	.07	.11	.11	.14	.07	.13	.15	.21	.11	.18	.27	.28	.09	.10	.19	.22	.27	.33
Dec.	P	1.39	1.89	1.88	2.31	1.38	1.95	2.49	2.59	1.84	2.41	2.83	2.56	1.30	1.58	2.22	2.08	2.75	2.95
	E	14.24	12 48	11 04	9.92	13.44	10.24	10.88	9.28	12.00	10.24	8.48	8.16	12.80	10.40	8.48	8.16	7.52	7.84
	T	87.0	86.7	85.0	83.5	85.3	84.4	84.2	80.7	83.6	81.8	78.5	79.6	83.3	81.5	81.1	80.3	79.7	78.6
	P/E	.10	.15	.17	.23	.10	.19	.23	.28	.15	.24	.33	.31	.10	.15	.26	.25	.37	.38
Year	P	10.18	15.59	16.34	19.19	11.43	17.85	20.55	21.07	15.67	19.47	23.13	23.03	10.60	13.98	17.91	19.80	22.84	24.43
	E	114.56	101.60	87.84	82.88	105.28	86.56	84.80	72.32	92.96	78.88	63.68	63.52	85.00	80.32	64.48	66.88	58.08	57.28
	T	75.4	75.7	73.9	73.0	73.1	73.5	72.7	69.8	71.5	69.9	66.8	68.4	70.9	69.6	68.9	68.8	68.4	67.6
	P/E	.09	.15	.19	.23	.11	.21	.24	.29	.17	.25	.36	.36	.11	.17	.28	.30	.40	.43

TABLE 2.—Mean monthly rainfall (p), estimated evaporation (e) and approximate precipitation/evaporation ratio (p/e) for 15 stations in Western Queensland.

Station / Month		Jericho	Alpha	Birds-ville	Jundah	Quilpie	Auga-thella	Morven	Mucka-dilla	Yuleba	Eulo	Wyandra	Boat-man	Dirran-bandi	Thallon	Talwood
January ..	P	3.10	3.58	.72	1.84	1.58	2.96	2.85	3.16	3.33	1.28	1.73	2.50	2.20	2.07	2.43
	E	9.0	8.5	16.5	12.4	13.2	9.6	9.5	8·3	7.5	12.3	11.1	10.2	9.5	9.0	8.5
	P/E	.34	.42	.04	.15	.12	.31	.30	·34	.44	.10	.15	.24	.23	.23	.28
February ..	P	2.81	3.04	.85	2.32	1.32	2.77	2.62	2.63	2.97	1.47	1.89	2.42	1.90	1.76	2.29
	E	7.7	7.4	15.5	11.5	12.2	8.5	8.5	7.4	6.8	10.7	9.7	8.8	8.5	8.0	7.5
	P/E	.36	.41	.05	.20	.11	.32	.31	.35	.44	.14	.20	.27	.22	.22	.30
March ..	P	2.24	2.27	.46	1.72	.77	2.73	2.62	2.34	2.77	1.25	1.52	1.59	1.90	1.67	1.88
	E	7.3	7.0	12.0	9.5	9.8	7.3	7.1	6.0	5.9	8.9	8.0	7.4	6.8	6.6	6.3
	P/E	.31	.32	.04	.18	.08	.37	.37	.39	.47	.14	.19	.22	.28	.25	.30
April	P	.92	1.42	.37	.91	1.01	1.38	1.24	1.12	1.34	.76	.90	.90	1.16	.86	1.07
	E	6.1	5.9	9.0	7.5	6.9	5.5	5.3	4.5	4.5	6.2	6.1	5.7	4.7	4.5	4.3
	P/E	.15	.24	.04	.12	.15	.25	.23	.27	.30	.12	.15	.16	.27	.19	.25
May	P	.86	1.01	.42	.90	.86	1.17	1.19	1.06	1.39	.82	.90	.92	1.26	1.24	1.45
	E	4.5	4.4	5.8	5.0	4.3	3.6	3.4	3.0	3.0	3.8	3.8	3.6	3.0	2.9	2.8
	P/E	.20	.23	.07	.18	.20	.33	.35	.35	.46	.21	.24	.26	.42	.43	.50
June	P	.90	1.52	.50	.85	.94	1.51	1.43	1.48	1.63	1.09	1.22	1.48	1.48	1.50	1.50
	E	3.2	3.1	3.8	3.3	2.8	2.3	2.1	1.9	1.9	2.6	2.3	2.1	2.1	2.1	2.0
	P/E	.28	.49	.13	.26	.33	.66	.68	.78	.86	.42	.53	.70	.70	.71	.75
July	P	.78	.97	.36	.67	.60	1.19	1.21	1.34	1.59	.81	1.11	1.07	1.08	1.21	1.31
	E	3.2	3.1	3.8	3.5	3.0	2.4	2.2	1.8	1.8	2.4	2.4	2.2	1.9	1.8	1.8
	P/E	.24	.31	.10	.19	.20	.50	.55	.74	.88	.34	.46	.49	.58	.67	.73
August ..	P	.27	.73	.18	.32	.40	.76	.94	.79	.96	.65	.66	.85	.84	.84	.89
	E	4.5	4.4	5.3	5.1	4.3	3.8	3.5	3.0	2.9	3.9	3.8	3 6	2.9	2.8	2.7
	P/E	.06	.17	.04	.06	.09	.20	.27	.26	.33	.17	.17	.24	.29	.30	.33
September ..	P	.55	.84	.24	.58	.54	.94	1.09	.93	1.24	.61	.96	.94	.96	.82	.93
	E	6.2	6.0	8.0	7.2	6.5	5.5	5.2	4.6	4.4	6.0	5.7	5.1	4.5	4.4	4.2
	P/E	.09	.14	.03	.08	.08	.17	.21	.20	.28	.10	.17	.18	.21	.19	.22
October ..	P	.90	1.21	.35	.89	.61	1.36	1.31	1.40	1.79	.75	.87	.91	1.12	1.05	1.46
	E	8.4	8.1	11.0	9.9	9.0	7.7	7.2	6.6	6.1	8.3	7.8	7.1	6.5	6.3	6.0
	P/E	.11	.15	.03	.09	.07	.18	.18	.21	.29	.09	.11	.13	.17	.17	.24
November ..	P	1.19	1.83	.56	.85	.80	1.83	1.89	2.12	2.56	.96	1.15	1.45	1.58	1.93	2.13
	E	9.5	9.2	13.0	11.8	11.4	9.0	8.8	7.9	7.3	10.5	9.7	9.0	7.7	7.5	7.3
	P/E	.12	.20	.04	.07	.07	.20	.21	.27	.35	.09	.12	.16	.20	.26	.29
December ..	P	1.85	2.66	.57	1.46	1.46	2.53	2.77	2.77	2.58	1.38	1.78	2.48	2.21	2.28	2.51
	E	9.5	9.2	15.0	12.7	12.4	10.0	9.6	8.3	7.8	11.1	10.6	9.9	8.4	8.2	8.0
	P/E	.20	.29	.04	.11	.12	.25	.29	.33	.33	.12	.17	.25	.26	.28	.31

Comparison between different periods of the year is also simple. It should be borne in mind that this type of graph tends to exaggerate the effect of increasing rainfall and P/E, since areas are proportional to the square of the radius.

The stations have been chosen to illustrate the shift in distribution of rainfall along the isohyets. Three graphs have been given along each of the 10-inch, 15-inch and 20-inch annual isohyets. They almost cover the geographical range of the mulga association in Queensland and extend beyond its boundaries.

At Boulia, Winton and Barcaldine, which lie north of the main mulga area, P/E ratios have higher values in the summer months than in winter. Though the other six stations also receive greater precipitation in summer than in winter, in each case P/E ratios are markedly higher in winter than in summer. This is brought about in two ways. The more southerly areas receive more rainfall in winter than those in the north, and in addition the evaporation is considerably less, mainly because of lower temperatures. The indications are that winter rainfall in the southern region is more efficient than summer rainfall in the same region.

For all stations within the mulga region, the rainfall-P/E graphs have the same peculiar shape. Rainfall curves show a large preponderance of summer rainfall, but P/E curves show comparatively small areas in summer and greater areas in winter. Graphs for 15 stations within the mulga area all show this characteristic shape.

Along the eastern edge of the mulga country the graphs are similar in shape to those for the more westerly stations, but total rainfall and P/E values are higher. It is possible that the higher rainfall inhibits the spread of mulga farther east. Under more humid conditions, competition from species better adapted to the climate is probably the most important factor limiting the spread of mulga. Temperature, too, may be a factor. Preliminary studies have indicated that mulga seeds require fairly high temperatures for germination. Figure 9 shows the mean screen temperatures for the hottest month (January). The eastern boundary of the mulga country conforms fairly closely to the shape of the isotherms and lies usually between the 82° F. and the 83° F. isotherms. This may be significant or it may be purely coincidental. Further work on the physiology of mulga is needed before any real basis can be found for the limitation of its spread by climate.

All graphs so far presented are based on mean figures, but rainfall is extremely erratic and it is difficult to define a "normal season." Rainfalls from Boatman Station (east of Wyandra), where many of the field observations were made, illustrate this variability. Table 3 gives precipitation at Boatman Station, month by month, from 1942 to 1947. Figure 10 presents graphs of five-year means from 1896 to 1945.

It is obvious that under such conditions mean values do not reflect accurately the climatic conditions governing the distribution of perennial plant species. For example, during a succession of favourable seasons a species such as mulga might become established in a region where normally the climate is unsuitable. Once established, it might be able to maintain itself until the next succession of good seasons. Conversely, a succession of unfavourable seasons might cause the destruction of most or all individuals in an area normally favourable to their growth. If existing trees were destroyed, regeneration could take place only from seed. If germination then took place on a large scale following favourable rains and drought again supervened, destroying the seedlings before they were established, the species might be eliminated from a particular region, despite the fact that "average" conditions as given by mean figures for rainfall, temperature, and evaporation are favourable.

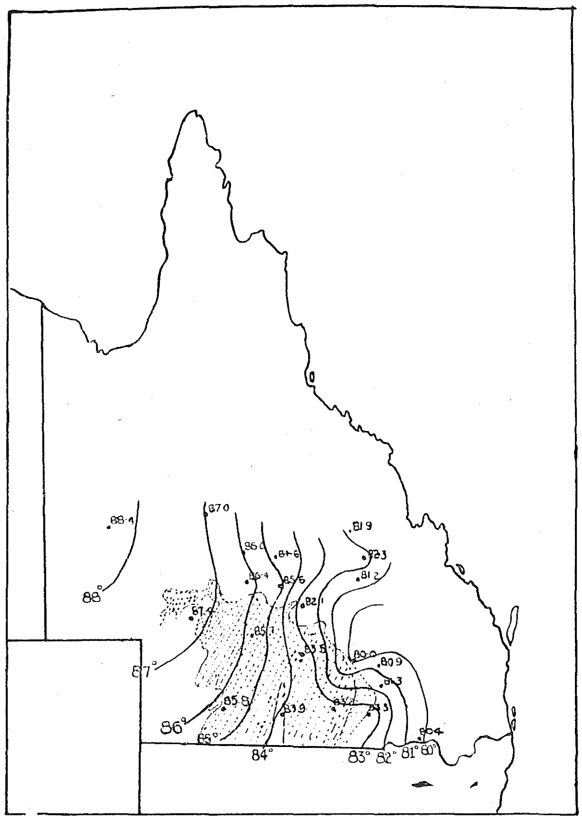
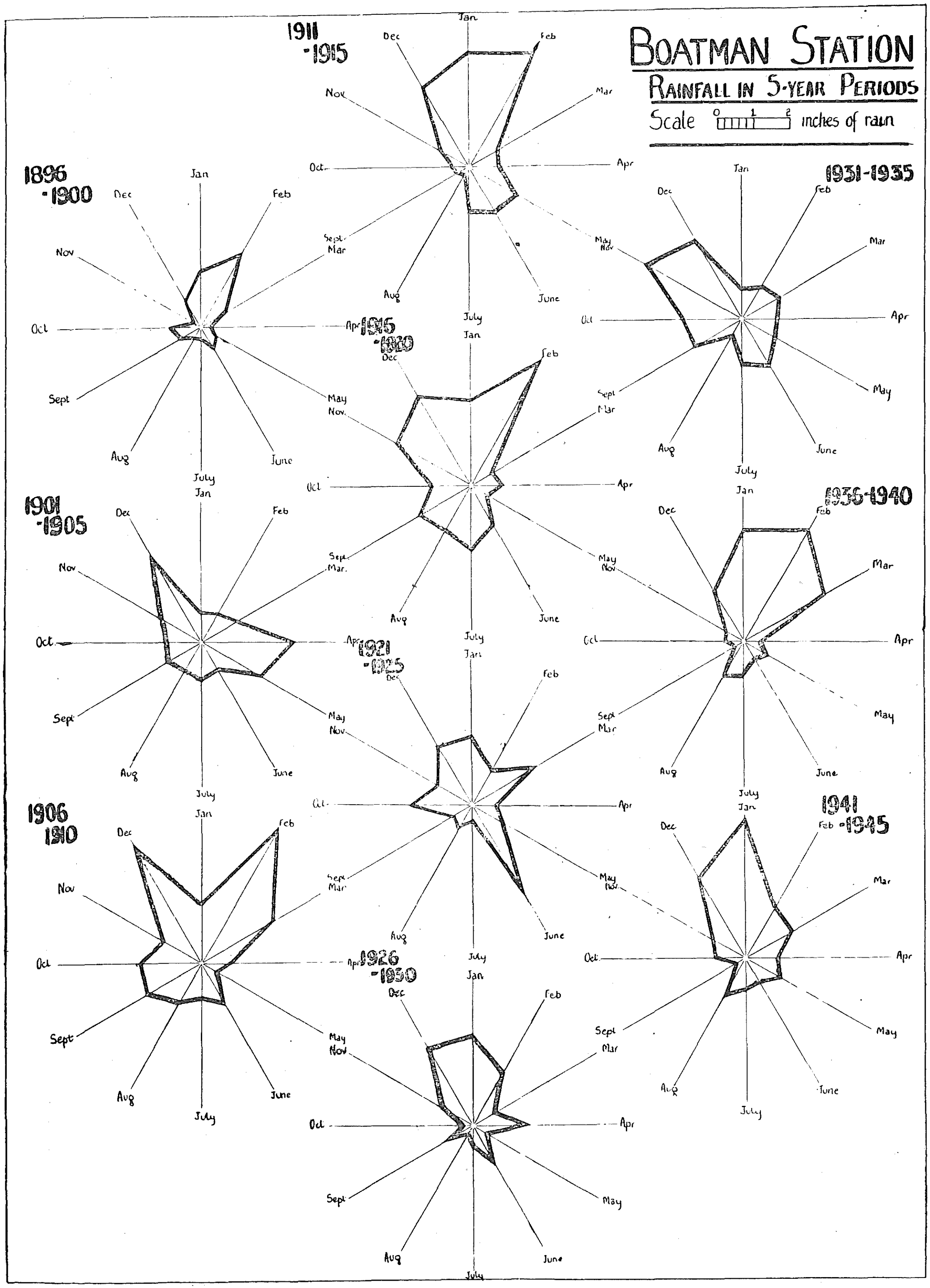


Figure 9.
Map of Queensland, showing isotherms of mean temperature for January in the south-western portion. Main mulga region superimposed.

This has an important practical bearing on the management of mature mulga and it emphasises the importance of the "time factor" in climate. In many cases, the sequence of changes in rainfall, temperature, and evaporation is as important as the actual values of those elements. Mathematical expression of this "time factor" appears almost impossible.

Until the environmental factors which govern germination, growth and survival of a particular species are known, it is not possible to deduce accurately the



BOATMAN STATION
RAINFALL IN 5-YEAR PERIODS
Scale 0 1 2 inches of rain
1896 -1900
1901 -1905
1906 1910
1911 -1915
1916 -1920
1921 -1925
1926 -1930
1931-1935
1936-1940
1941 -1945
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec

behaviour of that species in any area by studying climatic data. For mulga there is little real information on these points. The knowledge so far gained has been gathered from field observations and not from experimental work under carefully controlled conditions.

Table 3.

MONTHLY RAINFALLS AT BOATMAN STATION, 1942 TO 1947.

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total	Total wet days
1942	37	177	49	159	264	50	142	—	—	136	122	796	1932	41
1943	454	118	—	199	39	122	25	192	179	79	177	76	1660	36
1944	10	201	45	—	80	24	169	289	—	26	140	81	1065	28
1945	104	289	142	87	30	44	112	145	—	85	58	171	1267	37
1946	278	157	59	—	—	—	—	—	91	—	32	105	722	23
1947	26	965	248	—	190	16	36	133	181	140	153	188	2287	58

Soils

Though there is some variation in the surface soils where mulga grows, most of them are brown or red-brown fine sands or fine sandy loams, fairly friable when wet but hard and dusty when dry. They vary in depth from about 30 cm. to about 120 cm. and underlying them is a hardpan of one kind or another. Sometimes this hardpan is siliceous ; sometimes it is an horizon of closely packed limonite pebbles ; more often it is clay or clay loam. Often the clay subsoils contain small pellets of limonite, and many of them show a tendency to mottling, indicating that drainage is impeded in the lower horizons. It is commonly observed that the soil immediately above the hardpan retains moisture for much longer periods than that near the surface.

Topography

In most areas carrying mulga there is little physical relief. Slopes are gradual, with few steep hills. In some areas the crests of the hills consist of a siliceous horizon exposed by erosion and carry stunted mulga as well as other species of *Acacia*. Along creek frontages and on low-lying flats where the soil is deep, mulga may disappear altogether, particularly in the region near the eastern limit of its distribution.

Even small differences in slope and situation have an important influence on the texture of the surface soils and the vegetation. A feature of the red-brown " laterites " is the marked differences in texture between soils within short distances of one another. These can usually be correlated with the topography. Even though slopes are gentle and depressions very shallow, there is appreciable run-off from the one and accumulation in the other. The finer soil particles tend to accumulate in the depressions, giving the surface soils a characteristic loam or clay loam texture. On the crests of the ridges the soils are often shallow clay loams with a thin coating of fine sand. On mid-slope they are usually fine sandy loams, sometimes with a coating of fine sand. In the fine sandy loams mulga often grows in pure stands. In the depressions, there are frequently poplar box trees, either in pure stands or mixed with mulga and other species. Sometimes depressions may carry pure forests of mulga such as that shown in Figure 6. This appears to be due to the fact that there has been mass germination of mulga seeds followed by years favourable to the survival of mulga, the resulting growth being thick enough to exclude other species.

Associated Plants

Within the mulga forests and scrubs many species of grasses and herbage plants are found. Other trees and shrubs also form part of the plant community

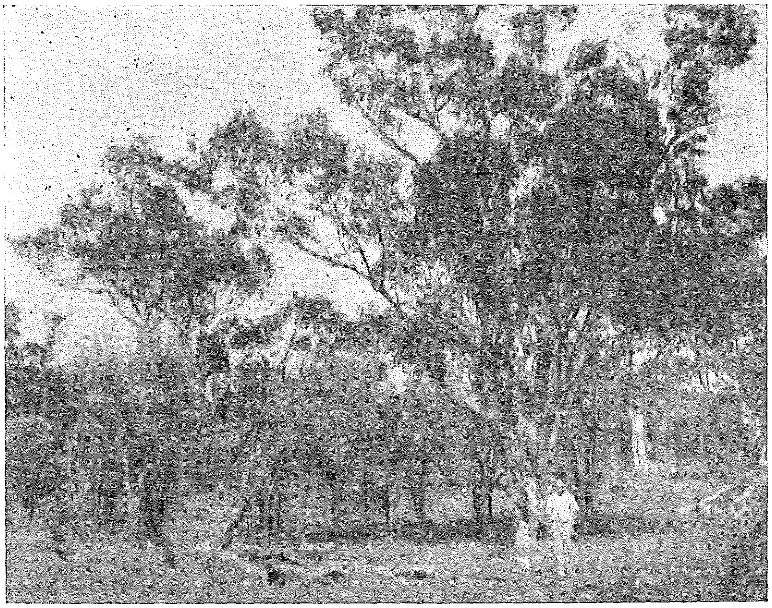


Figure 11.
Forest of poplar box (*Eucalyptus populifolia*) with under-storey of mulga. Boatman Station, March, 1947.

The position occupied by poplar box has already been discussed. Figure 11 shows a poplar box forest with an under-storey of mulga. It is not possible to say with certainty what factors govern the distribution of the various tree species within the mulga communities, but preliminary studies indicate that it may be bound up with the depth of the hardpan and the nature of the soil overlying it. For example, poplar box grows extensively on soils which have a clay horizon about 90 cm. below the surface. Silver-leaf ironbark (*Eucalyptus melanophloia*) flourishes in the fine sands where there is no hardpan, or where the hardpan is at a lower level, though this species is also found on loose sandy soils which are quite shallow and underlain by hard quartzite. Not enough soil profiles have been studied to permit a definite statement on these points, and further work is needed to elucidate the relationship between tree species and soil profiles.

Ironwood wattle (*Acacia excelsa*) is often a component of the mixed mulga forests, particularly on flats and in depressions where the soil is somewhat loamy. It is often associated with poplar box. Bloodwood (*Eucalyptus terminalia*) is also common on some of the hard ridges with tall mulga. In some areas near Charleville and Cunnamulla, corkwood (*Hakea ivoryi*) is a conspicuous member of the mulga community. Usually it favours partly eroded soils on the flat tops of ridges, but occasionally it is found on loamy flats with mulga and poplar box.

Budda or bastard sandalwood (*Eremophila mitchellii*) often occurs in patches as a second-storey shrub. It thrives along creek frontages and in mixed mulga-poplar box communities.

Lower-storey shrubs are plentiful in some areas, in other practically absent. A common shrub on stock routes and other severely grazed areas is *Eremophila gilesii*, locally known as turkey bush. *Cassia pleurocarpa*, known locally as firebush or mulga acacia, occupies somewhat similar situations, though it is usually found on eroded gullies or along roads. Also common in the mulga country, particularly in mixed mulga-poplar box communities, is the so-called black fuchsia (*Eremophila glabra*). *Dodonaea adenophora* occurs in patches, particularly on shallow eroded soils near the tops of ridges. Mint bush (*Prostanthera suborbicularis*) occurs fairly frequently, often on partly eroded slopes.

Ground vegetation is very varied and the floristic composition depends largely upon the amount of rain and the time of year when it falls. Most of the species are annual. Among the perennial grasses are the so-called mulga Mitchell grasses (*Neurachne mitchelliana* and *N. xerophila*). Other species often present are *Eriachne aristidea, E. helmsii*, mulga grass (*Amphipogon caricinus*), wallaby grass or mulga prairie grass (*Danthonia bipartita*), woolly-butt grass (*Eragrostis eriopoda*) and wire grass (*Aristida jerichoensis*). In some areas there are large stands of a love grass (*Eragrostis lacunaria*), and an unnamed species of *Eragrostis* is common in other places.

Wire grass is more common on the flats which carry a fair amount of poplar box and may increase in abundance after the trees are ringbarked. Kangaroo grass (*Themeda australis*) is common on flats and in small depressions. Another wire grass (*Aristida calycina*), usually known as No. 8 wire grass, often occurs on the deep, loose sandy soils which support a mixed forest of silver-leaf ironbark and mulga.

Annual species are numerous and often short-lived. Each season has its own characteristic pattern of annual plants. Sometimes large tracts of country are covered with a dense growth of one or two species. For example, after the drought broke in February-March, 1947, many thousands of acres in the Charleville-Wyandra area were covered with mulga nettle (*Halorrhagis odontocarpa*). Other large areas were covered with button grass (*Dactyloctenium radulans*) or with peethebed (*Velleia paradoxa*). In the corresponding period of 1948 none of these species was specially conspicuous.

An appendix lists all plants collected at Boatman Station, Elmina Station and Coniston Station during visits in March and July, 1947. It represents a fairly complete list of plants which grew in one section of the mulga country in a season of above-average rainfall, and consequently contains a greater number of ephemeral plants than would normally be encountered.

LIFE HISTORY

The study of the life history of mulga has so far been restricted to field observations, and there has been little opportunity for experimental work.

Germination

Studies in the field indicate that germination of mulga seeds takes place in summer following soaking rain. At Boatman and adjoining stations seedlings were observed in March, 1947. The first soaking rain for four years fell between February 6 and February 17, and there were further falls in late February and early March. On March 24 the first seedlings were noticed ; they appeared to be several days old. From then onward, numerous seedlings were seen in many places. Several features were noted :—

(*a*) Seedlings were more plentiful on hard, exposed, red-brown fine sandy loam than on softer soils carrying a greater amount of ground vegetation.

(*b*) Seedlings were found only in the vicinity of trees of umbrella mulga or tall mulga. Some were present in an area of low mulga, but scattered trees of tall mulga were also present in the community. All seedlings observed were near these trees.

(*c*) On the fringe of a charred area left by logs burnt in 1946, seedlings were more plentiful than in other parts of the same paddock.

(*d*) Seedlings were more plentiful on an area normally lightly stocked with sheep, and completely ungrazed since February, 1946, than on an adjoining area which carried sheep up till the time the rains came.

Subsequent inspections confirmed these observations. In addition, it was noted in July, 1947, that many seedlings were present in soft fine sandy loam with a dense ground cover of black crumbweed (*Chenopodium melanocarpum*) and mulga nettle (*Halorrhagis odontocarpa*), but only in and near charcoal and ashes left from logs burnt about November, 1946.

Tentatively, the following conclusions may be drawn :—

(*a*) Mulga seeds germinate following summer rain.

(*b*) For germination, soil temperature and/or air temperature at ground level must be high.

(*c*) Mulga seeds are not dispersed far from the parent tree.

(*d*) Fire hastens germination provided it is followed by soaking rain within a few months.

Seedlings

The youngest seedling seen bore two bipinnate leaves and one phyllode. The following description applies to seedlings collected at Boatman and adjoining stations in March, 1947.

First two leaves bipinnate, petiolate : pinnae 2, diverging from the petiole ; petiole 0.3-0.5 cm. long, terete or slightly flattened vertically ; leaflets 2-3 pairs on each pinna, 0.4-0.5 cm. long, very shortly petiolulate, oblong to obovate-oblong, obtuse, shortly mucronate, glabrous or with a few scattered appressed hairs ; third leaf either completely phyllodineous or consisting of a vertically flattened petiole 1-2 cm. long with two pinnae divergent from the apex ; petiole with numerous appressed silvery hairs and 3-5 prominent parallel nerves ; subsequent leaves completely phyllodineous ; phyllodes green, slightly falcate, 2-4 cm. long, 0.2-0.5 cm. broad, with 3-7 prominent longitudinal nerves, often with fainter longitudinal nerves between them and connected by still fainter reticulate veins ; phyllodes with scattered silvery-grey appressed hairs.

Young Trees

Trees of known age are difficult to find, but some young ones were studied on the Morven-Boatman road near Boatman Station in July, 1947. These were growing in the water-channel of the formed road. This water-channel was cut deeply with a power grader in 1941. Since the grading operation must have destroyed any trees which were present then, it is reasonable to assume that any young trees now present in the channel must have grown from seeds since that time. Examination of the Boatman rainfalls shows that little rain fell in the summer of 1942, though it is just possible that run-off into the water-channel may have provided enough moisture for germination. It is certain that in December, 1942, and January, 1943, enough rain fell to germinate the seeds. Information has been received from Mr. G. Allen, formerly on the staff of the Commonwealth Scientific and Industrial Research Organization, that in December, 1942, there was a very big germination of mulga seeds at Gilruth Plains, Cunnamulla. This lends weight to the suggestion that the young trees near Boatman also germinated at that time, and their age may be placed fairly confidently at 4½ years when examined in July, 1947.

All individuals were fairly uniform in appearance. They averaged 60 cm. in height, were intricately branched, and showed evidence of having been grazed. The diameter of the trunks at ground level ranged from 1 cm. to 2 cm.

It is noticeable that mulga, in common with other trees in the semi-arid regions, exhibits marked " steps " in size of young trees. Immature trees of different sizes may be observed, but not a continuous series. Usually only a few size classes are represented in a community, each class being made up of numerous individuals. It seems likely that this is due to two factors :—

(*a*) Conditions favourable for germination occur, not every year, but at irregular intervals.

(*b*) Even when germination does take place, survival may be nil if subsequent climatic conditions are unfavourable. Conditions for survival do not always follow those favourable for germination, so the spacing effect of erratic germination is accentuated by the lethal effect of harsh seasons.

Of the seedlings observed by Allen and marked by him in December, 1942, none survived the subsequent years of drought.

Melville (1947) recorded the same stepped appearance in the mulga of the Murchison District in Western Australia.

Rate of Growth

Observations indicate that there is a great deal of variation in the rate at which mulga grows. Rate of growth appears to depend largely on water supply and intensity of competition, as well as on grazing. Under ideal conditions, with ample soil moisture, plenty of room to develop, and protection from grazing, mulga will grow rapidly. Two examples of quick-growing trees may be cited, one at Bollon where a tree grew from seed to 12 feet in about 8 years, the other at No. 10 Bore, Boatman Station, where a tree grew from a small sapling stated to be about 1 inch in diameter to a tree 20 feet high and 8 inches in diameter in 14 years.

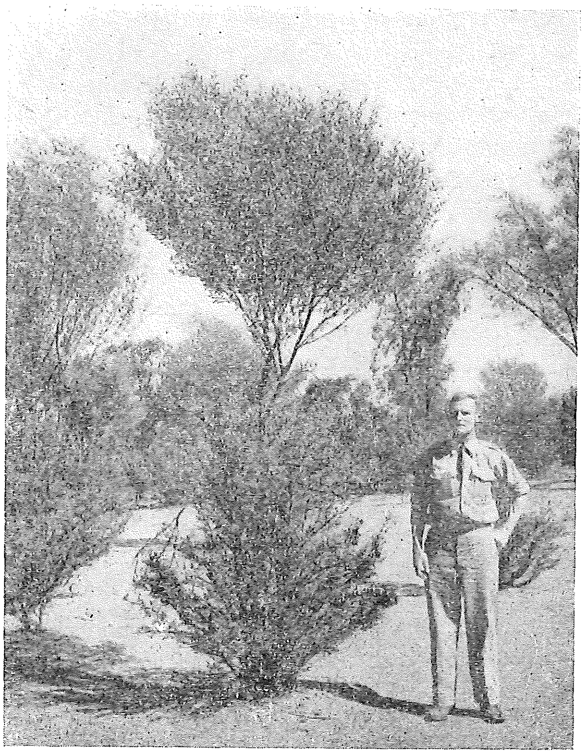


Figure 12.
Low mulga in which the central shoot has grown away. The clear region between the tops of the low shrubby part and the lowest branches of the upper part is characteristic. Boatman Station, August, 1946.

It is possible that under natural conditions many trees undergo a "suppression" period similar to that experienced by some trees in rain-forests. It appears that during such a period root growth continues, so that when conditions are favourable rapid growth of aerial parts takes place. Dwarfing may also be induced by grazing, and it is noticeable that low mulga in which the central shoot becomes inaccessible to animals grows away very rapidly into umbrella mulga (Figure 12). That grazing may keep trees small for many years is evidenced by the fact that the low mulga shown in Figure 2 is reputed to be more than 40 years old.

There are cases where thick stands of mulga show little or no apparent increase in size over a number of years and appear to have grown very slowly. On Boatman Station there are dense scrubs of mulga about 12 feet high and with individual stem diameters of about 4 inches. These plants are believed to have germinated in 1908. One such scrub is shown in Figure 13.

Observations at Boatman in March, 1947, indicated that under favourable conditions low mulga may produce new shoots in a very short time. Figure 14

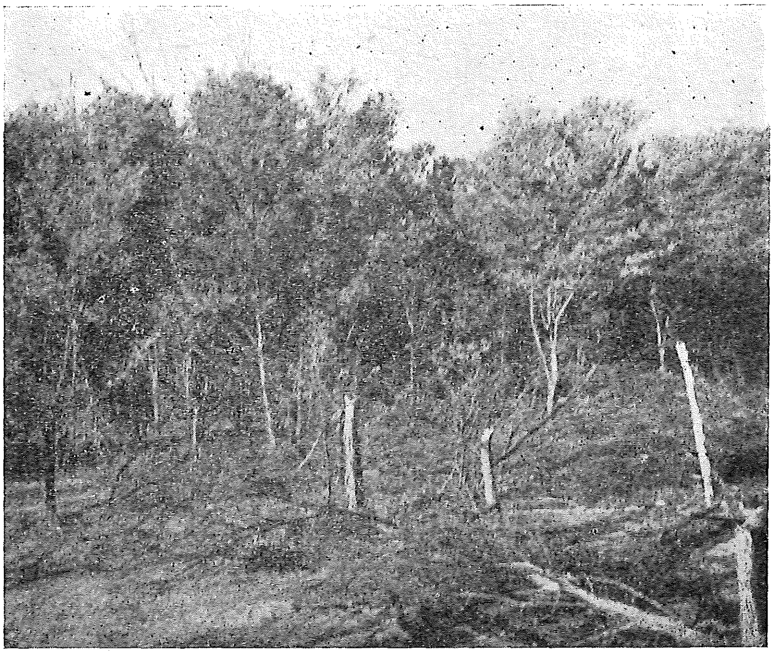


Figure 13.
Mulga believed to have germinated about 1908.
Boatman Station, March, 1947.

shows one such shrub photographed on March 21, 1947. This area had been unstocked since February, 1946. Growth could not have begun before February 11, 1947, and probably not before February 15 or 16. The longest new shoot actually measured was 115 cm. (46 inches). Others were 40 cm. to 70 cm. in length. At a subsequent inspection in July, 1947, no further increase in length was observed. Thus it seems possible that mulga makes most of its aerial growth in length in a few weeks following summer rains. During the remainder of the year it possibly makes increment of wood, and perhaps extends its root system. Further studies are needed on these points.

Development of Root System

In seedlings, root elongation appears to be rapid—more rapid than leaf development. Even very small seedlings have quite long roots. On a seedling 5 cm. high and about six weeks old there was a thin tap root 23 cm. long. The upper part of the root just below the hypocotyl was thickened. Older plants also showed this thickening and the development of a fissured, yellowish corky bark in the region below the hypocotyl.

As the plants develop, the root system becomes differentiated. Near the surface there is an extensive system of lateral roots. These run out for some

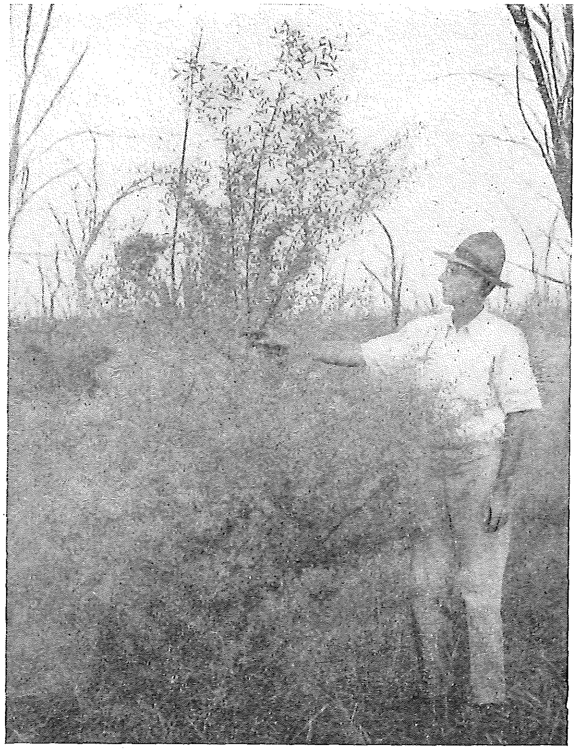


Figure 14.
Low mulga not stocked during the previous year. The shoots above the man's hand represent new growth growth between February 10 and March 21, 1947. Boatman Station.

distance and lie approximately in a plane parallel to and about 7 cm. below ground level. The tap root continues vertically downward and remains practically unbranched until it reaches a zone 15-30 cm. above the hardpan, where it divides into a branched system of fine roots with numerous root hairs. Some of these features may be seen in Figure 15. In one case, the tap root continued horizontally along the surface of the hardpan.

No facilities have been available for excavating any but very small plants, and the development of the roots of mature trees has not been studied. Observation of older trees whose roots have been partly exposed by erosion indicates that the dual root system is retained throughout the life of the tree.

It would appear that each of the two sets of lateral roots has a different role in the nutrition of the tree. The function of the surface roots is probably to utilize

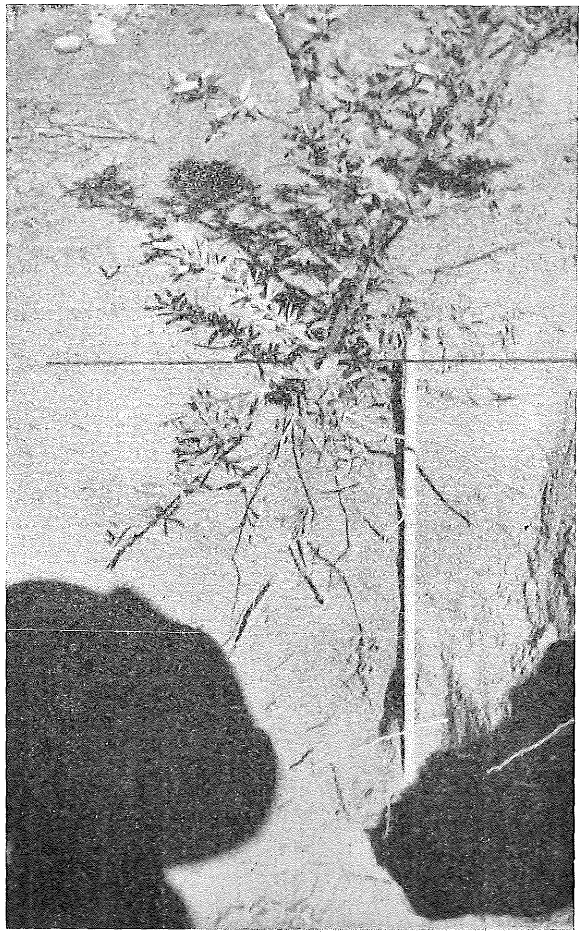


Figure 15.
Low mulga with root system partly excavated. The horizontal line is at ground level. The stick, which is 90 cm. long, is resting on the hardpan. Boatman Station, July, 1947.

water from small showers of rain which do not penetrate far into the soil. These surface roots usually cover a fairly wide area. Heavier rain would cause soaking of the soil to greater depth with a tendency to accumulation above the hardpan. The lower set of lateral roots is in a position to make best use of this " deep " water.

Flowering and Fruiting

So far, flowers have been observed only on umbrella mulga and tall mulga. The minimum age at which a mulga tree can produce flowers is not known.

Mulga does not flower every year. Flowering may take place at practically any time of the year, though the main flowering period is from about April to July. Few observations have been made on the ripening of seeds, but it appears that pods are normally shed between November and January.

No information is available on the weight of seeds produced by individual mulga trees. Little is known about the percentage germination of the seeds under natural conditions, nor about their keeping qualities in the ground. Allen has supplied the information that in tests at Gilruth Plains maximum percentages of germination were obtained from seeds taken from green pods and sown immediately. Germination from such seeds was of the order of 60 per cent. Seeds ripened on the trees had germination percentages of about 20. No increase in percentage germination was observed following such treatments as burning, scratching, and treatment with sulphuric acid or boiling water, though they hastened the germination of the hard seeds.

Age of Trees

Because of the difficulty of finding trees of known age, it is difficult to determine any criterion for deducing the age of trees. Samples of the trunks of the very small trees mentioned above (from the Morven-Boatman road) have been collected Preliminary examination of these indicates that growth rings may correspond to the years of the tree's age, but further study is needed to confirm this.

Table 4.

ANALYSES OF SAMPLES OF BROAD-LEAVED MULGA COLLECTED DURING AUGUST, 1946.

Lab. No.	Moisture	Water-free Material							Remarks
		Protein	Fat	Carbo-hydrates	Fibre	Ash	CaO	P_2O_5	
	%	%	%	%	%	%	%	%	
112	9.4	11.8	1.90	51.32	28.80	6.18	1.71	0.13	16 miles west of Bollon ; tall mulga on hard ridge.
113	10.2	16.0	1.42	53.65	23.48	5.45	1.07	0.26	Boatman Station ; umbrella mulga with pods ; watered by overflow from bore tank.
118	12.8	14.1	1.62	39.07	39.59	5.62	1.62	0.20	Boatman Station ; tall mulga growing in stand of low mulga represented by Lab. No. 119.
119	10.5	11.7	2.10	46.88	34.63	4.69	1.20	0.17	Boatman Station ; low mulga.

Table 5.

ANALYSES OF SAMPLES OF VARIOUS TYPES OF MULGA

Date Collected	Locality	Lab. No.	Moisture	Water-free Material: Protein	Fat	Carbo-hydrate	Fibre	Ash	CaO	P_2O_5	Remarks	
			%	%	%	%	%	%	%	%		
27/4/48	Boatman Station	2449	6.20	10.92	1.81	54.80	27.8	4.67	1.62	0.14	Umbrella mulga.	Broad-leaved variety
16/11/48	Boatman Station	2450	7.13	12.63	2.70	54.43	25.4	4.84	2.58	0.20	Low mulga: regrowth from plants completely defoliated 8/8/46 (Lab. No. 119).	
17/11/48	Dingwall Station, 15 miles south of Boatman Station ..	2455	7.74	13.85	0.80	49.20	30.0	6.15	1.96	0.17	Umbrella mulga, large tree on loose red-brown fine sand: unpalatable to sheep.	
17/11/48	Dingwall Station	2456	7.23	12.91	1.96	52.44	26.8	5.89	2.10	0.17	Umbrella mulga, in red-brown fine sandy loam: eaten readily by sheep and cattle.	
20/10/48	Comongin, 9 miles north of Quilpie	2451	6.50	11.33	2.83	47.66	33.5	4.68	1.50	0.16	Umbrella mulga: tree 21 feet high.	
21/10/48	Moble, about 40 miles S.W. of Quilpie	2453	6.83	9.39	3.20	51.60	29.0	6.81	2.60	0.15	Umbrella mulga: regrowth from tree lopped in 1937.	
22/10/48	Wambin, about 50 miles S.S.W. of Quilpie	2452	6.48	10.86	2.48	50.08	29.6	6.98	2.29	0.15	Umbrella mulga: regrowth from tree lopped in 1937.	
23/10/48	30 miles W.S.W. of Cunnamulla	2454	6.15	12.96	1.17	56.47	24.4	5.00	1.08	0.17	Umbrella mulga: tree about 15 feet high.	
21/10/48	Whynot, about 30 miles W.S.W. of Quilpie	2457	8.42	12.13	3.08	52.19	28.1	4.50	1.46	0.12	Young plants from seeds which germinated December, 1942.	Medium straight-leaved variety
22/10/48	Wambin	2458	9.36	8.78	1.93	53.87	30.9	4.52	1.63	0.19	Umbrella mulga: regrowth from tree lopped in 1927	
22/10/48	Wambin	2459	9.16	13.68	2.78	39.58	28.2	15.76	1.61	0.15	Umbrella mulga: regrowth from tree lopped in 1927 and again in 1937.	
20/10/48	Comongin	2460	9.02	11.96	2.97	42.43	28.6	14.04	1.99	0.16	Umbrella mulga: tree 23 feet high.	
21/10/48	Moble	2461	9.92	9.42	3.22	44.16	29.5	13.90	3.35	0.11	Umbrella mulga: tree about 25 feet high growing on loamy flat.	Narrow-leaved variety
22/10/48	Wambin	2462	8.60	11.87	3.08	41.91	26.4	16.74	4.82	0.17	Umbrella mulga: regrowth from tree lopped in 1927	
23/10/48	About 30 miles W.S.W. of Cunnamulla	2463	8.10	11.24	2.88	44.94	26.9	14.04	2.54	0.16	Umbrella mulga: tree about 18 feet high.	

FODDER VALUE

Few people doubt that mulga is a valuable fodder for sheep and cattle, but there is little information on its quality. No digestibility trials have been made with material from Queensland, though there are some chemical analyses of samples collected under known conditions. Table 4 gives analyses, made by the Agricultural Chemist of this Department in July, 1947, of material of broad-leaved mulga collected during August, 1946, near the end of a very severe drought. Further analyses of material of other varieties are given in Table 5.

From the figures, it will be seen that mulga is fairly rich in crude protein, values being two to three times as great as for Mitchell grass hay. It is not known definitely what percentage of this protein is digestible.

Nichols (1938) gave figures for mulga in Western Australia. He stated that average values for crude protein were 10.4 per cent. for edible types and 8.4 per cent. for inedible types. For each of the mulga forms examined in Queensland, crude protein values are higher, but more analyses are needed before any definite conclusions can be drawn.

Most graziers state that sheep begin to lose condition after about six months of an unvaried diet of mulga. Others report having fed sheep on mulga alone for periods up to three years without serious loss of condition. All Queensland graziers so far interviewed agree that ewes will not lamb successfully if fed exclusively on mulga.

Many factors may be involved in loss of condition, but the following seem to be those most likely to be responsible :—

(*a*) Food intake by the animals may be insufficient because not enough mulga is cut to keep them satisfied.

(*b*) Many observers report a reduction of intake after prolonged feeding on mulga alone.

(*c*) Consumption of too much fibrous material may cause impaction. Fibre balls are common in sheep fed on an unvaried diet of mulga, particularly if the animals consume much twiggy material.

(*d*) Excessive walking may be involved in searching for palatable types of leaf and/or walking to and from water.

(*e*) The mulga itself may be deficient in some essential requirement such as vitamin A. It may be significant that animals which receive small quantities of kurrajong (*Brachychiton populneus*) or bottle tree (*B. rupestris*) in addition to mulga remain in good condition for longer periods than those fed on mulga alone. Kurrajong at least is known to be rich in vitamin A. Further chemical work on mulga itself should elucidate this point.

(*f*) Weather conditions may affect the intake of leaf by the animals. It is commonly reported that a shower of rain will cause sheep to leave cut mulga. If the rain is too light to grow any herbage (as frequently happens during a drought), sheep may lose condition due to prolonged walking in search of non-existent vegetation and to reduction in food intake because of unwillingness to eat the cut mulga.

In addition to all these, the condition of the sheep at the beginning of feeding must be considered. It is well known that if animals are allowed to fall off in condition too far before supplementary feeding on mulga is begun, it is often difficult to maintain them for any length of time.

In all cases so far reported where sheep have been maintained on mulga for long periods, cutting was begun before the condition of the animals became low, distances to water were short, and sufficient mulga was cut to keep at least one whole day's supply of leaf ahead of the animals.

In Western Australia some remarkable results were achieved by controlled grazing of cut mulga. Nichols (1944) gives the following summary of this work :—

" Some 5,000 ewes were put into flocks of about 1,500 each and shepherded on to the cut mulga and on to the water. Men cutting in the morning felled enough, choosing good stands of the most edible varieties, for the flock to consume in the afternoon; cutting in the afternoon gave enough for the next morning's ration, and so on. On the best varieties the sheep soon settled down and needed very little supervision; they browsed only in the early morning and late evening, beginning at dawn and feeding till about 9 or 10 a.m.; then followed a resting period. The sheep began to move to water between 4 and 5 p.m. and then to feed again, carrying on till dark. Shepherding on the waters consisted in taking the sheep to and from the wells by the shortest routes. With this management their condition improved; during seven months the losses from the 5,000 were only 60—less than normal good season losses—while in other flocks, even those getting supplementary hand feeding during August, 1936-August, 1937, the losses were between 50 and 60 per cent. Further, the ewes were in such good condition that the rams were put in, with the result a 52 per cent. lambing; the condition of the control flocks was so poor that mating was impossible.

The wool returns are also of interest: sound, evenly grown wools were indeed rare in those years, but only 30 per cent. of the clip from the other station sheep was at all satisfactory, as opposed to 90 per cent. of wools from the mulga fed lots.

Finally, the cost—that most important practical consideration. To feed rations consisting of chaff and oats at the rate of ½ lb. each per head per day cost on this station 8d. per head per week; to follow the cut mulga and conserved energy system cost 2d."

It is interesting to note that in this case mating and lambing were successful even though the sheep were subsisting entirely on mulga. It is possible that the failure to produce lambs by ewes fed on mulga in Queensland could be overcome by more intensive methods of flock management during the period of scrub feeding.

Amounts Consumed by Sheep

No figures are available from Queensland as to the amount of mulga eaten by sheep. In Western Australia (Nichols, 1938), penned sheep hand fed with mulga consumed about 3 lb. per head per day for 15 days. During that time the average weight of the sheep increased from 70.8 lb. to 75.3 lb. In the succeeding nine weeks, sheep fed on mulga alone showed an average increase in weight of 11.7 lb. on a daily intake of just over 3 lb. of mulga per head. From September 13 to September 27, five sheep were given 4 oz. of wheat per head per day and in addition consumed 3.1 lb. of mulga. They showed an average increase in weight of 3.8 lb. During the same period, another five animals on mulga alone ate 3.3 lb. per head per day and made an average increase in live-weight of 2.2 lb.

It is probable that sheep moving freely in the paddock would not make the same gain in weight if they consumed the same quantities of mulga. It is also probable that free-ranging sheep would consume more than penned animals. The results given by Nichols (1944) and quoted above illustrate the value of confining sheep when scrub feeding.

Palatability

It has been stated (Melville, 1947), that in Western Australia seedling mulga is unpalatable to sheep and that stocking has probably little effect on mulga regeneration. It has been further stated that mulga less than 4 ft. high was not eaten at all, that from 4 ft. to 6 ft. the tips of the branches may be nibbled, and that even in trees 10-12 ft. high the edibility was still low. The greater abundance and perhaps different chemical nature of the exudate on the young leaves were believed to be responsible for the low palatability.

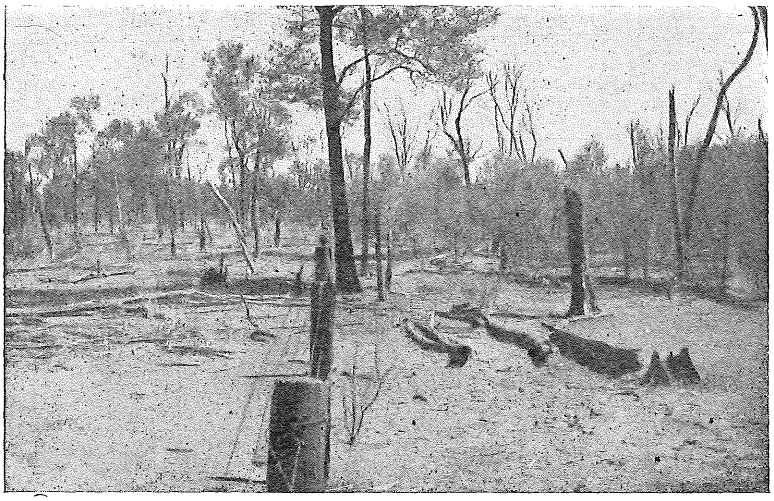


Figure 16.
Looking along a fence dividing horse paddock (right) and paddock stocked with sheep. Note large amount of young mulga in horse paddock and its absence from the other. Oakwood Station, October, 1940.

In the Charleville-Wyandra area, the experience of graziers has been exactly the reverse of that recorded for Western Australia. At Elmina Station in July, 1947, the writer observed mulga seedlings which germinated in February, 1947. Many of them had been nipped off by sheep, even though the paddock was lightly stocked and there was a plentiful supply of grass and herbage. Since then, the writer has seen many seedlings in a number of districts and they have been severely grazed wherever sheep have had access to them. In Queensland, most graziers interviewed have expressed the opinion that sheep will seek out mulga seedlings and eat them in preference to other feed. Certainly, in the mulga country it is noticeable that horse paddocks always contain large numbers of young mulga bushes, whereas in paddocks consistently stocked with sheep young mulga is often scarce or absent. This indicates that sheep can have a profound influence on mulga regeneration. Figure 16 shows the difference between a horse paddock and one normally stocked with sheep.

Opinions differ as to the palatability of different forms of mulga. Most graziers state that sheep eat tall mulga in preference to other forms, and some say that the older the tree the more palatable it becomes. This is in agreement with observations made by Melville (1947) in Western Australia. The greatest differences of opinion concern the palatability of umbrella mulga. There seems to be a considerable variation in the palatability of this form, and it may perhaps be correlated with soil conditions and the state of health of the tree. A common opinion is that vigorous " sappy " mulga trees are not eaten readily by sheep, particularly when they are growing on " soft " soils. Several people state emphatically that mulga trees watered by an overflow from a tank or trough are distasteful to sheep.

There is a possibility that palatability may vary from month to month or from season to season. It is commonly stated that both sheep and cattle eat much more mulga during winter than during summer, particularly when the winter months are wet. The whole question is probably bound up with the palatability of other pasture plants and the amounts which are available.

Many people state that mulga which has been burnt down is more palatable than that brought down by other means. This may be due to some chemical change in the leaves following burning, or it may simply be that the only trees which can be burnt down are tall, old individuals, which appear to be the most palatable in any case.

Mulga pods are much sought after by sheep, either on the trees or after they have ripened and fallen to the ground. Galahs (*Kakatoe roseicapilla*) and other parrots supply useful feed for sheep by cutting down many pods and leafy twigs when the trees are in fruit.

In most cases there is little difficulty in getting sheep to eat leaves of any mulga cut for them, but if tall mulga is being cut with other forms much energy may be wasted by the animals in running after the tall trees as they fall, then returning to the less palatable forms after the more attractive material has been consumed.

In Queensland, no detailed study of palatability has yet been made, nor have any shepherding experiments been conducted along the lines reported by Nichols (1944). It is possible that palatability may vary from district to district, as well as from season to season. The previous history and condition of the animals may also be an important factor.

METHODS OF UTILISING MULGA

Low Mulga

Cattle and sheep graze low mulga as part of their normal diet and no special treatment is needed to bring the leaves within their reach. From various reports it appears that continued grazing with cattle can keep mulga in the "low" form for very long periods. Several observers have reported that the low mulga illustrated in Figure 2 has been in the same condition for more than 40 years. The low mulga figured by Francis (1925, pp. 598-601) is in the same belt as that shown in Figure 2.

If grazed by sheep alone, or if the bushes become too wide for cattle to reach the central shoot, low mulga soon grows away from the centre and assumes the form shown in Figure 12. If when it reaches that stage the central shoot is cut

Figure 17.
Low mulga in which the central shoot has grown away and has been cut out to keep the plant in the shrubby condition. Bollon, August, 1946.

down with an axe, as shown in Figure 17, the bushes may be kept within the reach of sheep for a further period of about 2 years. Although low mulga is available to stock without any special treatment, its carrying capacity is low because the yield of forage is small. For example, during a drought in August, 1946, in a paddock unstocked since February, 1946, an area of low mulga 10 square yards in extent was completely defoliated by hand. The yield from this area was 1 lb. 14½ oz. green weight, representing only about 900 lb. per acre. Twelve shrubs were growing in the 10 square yards. Analysis of this sample is given under Lab. No. 119, Table 4.

It is possible that thinning would improve the quality of leaf produced by low mulga and increase the yield, largely by reducing competition for soil moisture.

Whipstick Mulga

In whipstick mulga the leaves are too high for sheep and most of them are out of reach of cattle, so grazing is not possible. In order to make feed available, the leafy tops must be brought down within the reach of the animals. Low yield and dense stands often make cutting with an axe uneconomical. It is common to employ machinery to bring down the tops. The usual method of doing this

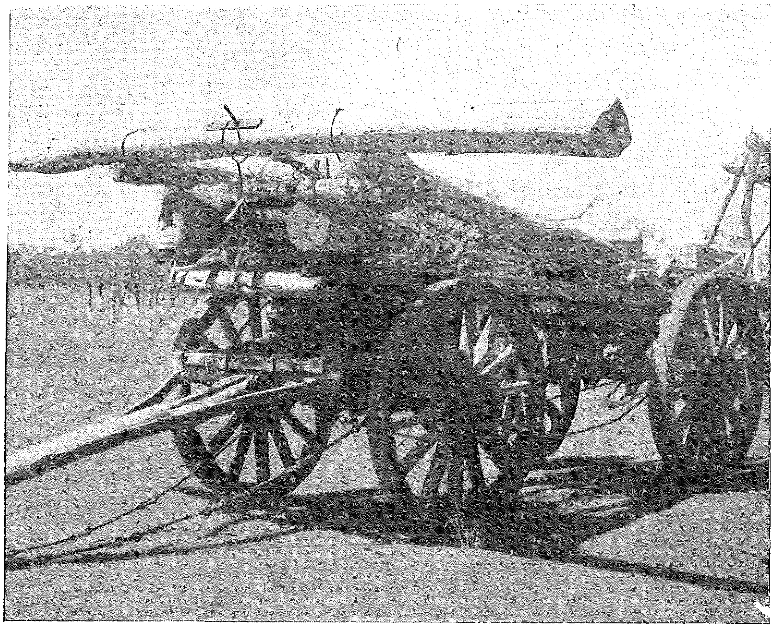


Figure 18.
Waggon fitted with log for breaking down mulga. Whynot Station, south of Quilpie. October, 1948.

is to push over the trees, using a tractor or Bren-gun carrier. The pushing machine is usually equipped with a frame in front, consisting of one or more bars, the highest of which is about 4 feet above ground level. The tractor rides over the fallen trees.

Another method is to use two tractors running on parallel courses. Attached to each drawbar is a steel cable about 60 feet long, supported in the middle by a heavy jinker and pulled along in the form of a loop. The jinker keeps the centre of the cable at a height of about 4-5 feet and the cable pulls down the trees between the two tractors. Occasionally it bends a tree and slips over it, leaving the tree still standing and practically undamaged. This method piles the fallen material into lines with a clear lane on either side. While this has the advantage of allowing sheep ready access to the leafy tops, in dense stands it has the disadvantage that some of the leafy material is buried beneath other twigs and branches and cannot be reached by the animals. To some extent this can be overcome by running the tractors closer together and pulling down fewer trees on each run.

A modification of this method is to attach one end of a steel cable to a stout tree and draw the other end round in a circle by means of a tractor, pulling down the trees within the circle. This has the disadvantage that time is wasted in moving the rope from tree to tree and making fast.

Still another method of pulling down mulga is to build a heavy frame across a big waggon. Two types have been seen. In one, there is a short log across the front of the waggon and a longer log across the back. The operator aims at breaking down the trees with the rear log. The other type (Figure 18) has a heavy log about 18 feet long set transversely across the front of the waggon and about 18-24 inches above the level of the top. The log is braced the full length of the waggon so that the shock of impact is transmitted to the rear axle.

Both types are pulled by a tractor, preferably a crawler tractor of about 22 h.p., coupled to the waggon by a long pole and a draw-bar or chain. In operation, as far as possible the tractor is driven between the trees, allowing the heavy waggon to knock them down.

An outstanding advantage of pulling is that it gives efficient use of power One of the most troublesome features of "mulga pushing" is the constant backing-off from trees which are too solid to push down at the first attempt. The fact that the tractor must climb over the fallen material can also cause difficulty and delay. Pulling practically eliminates these, since the tractor runs on undisturbed ground and the trees fall behind it.

Umbrella Mulga

This is the form most commonly used for drought feeding. Two main methods are employed for preparation, cutting and pushing over.

Cutting may be done in several ways. Most commonly, the trees are felled by cutting through the main trunk with an axe. Sometimes a power saw is used instead. Less frequently, the tree is lopped in such a way that one or more of the lower branches is left intact. Naturally, lopping is more expensive than cutting down, because it demands more care from the axeman and it takes more men to feed a given number of sheep.

Sometimes the tree is "leaned" by cutting partly through and allowing the trunk to lean over until the top touches the ground. The object of this is to bring down the leaves without killing the tree. Figure 19 shows a tree in which one branch was "leaned" after the main trunk was cut off.

Methods employed in pushing over umbrella mulga are exactly the same as those used for handling whipstick mulga. Various methods of pulling over the trees have also been used with success. Some umbrella mulga trees are too deep-rooted and too solid to be pushed over and are usually left standing. An operator soon learns to recognize trees which cannot be pushed over. They are usually sturdy individuals with a short, thick trunk, branched low down and with numerous branches and a leafy crown.

Tall Mulga

Because of their long trunks, tall mulga trees cannot economically be lopped. They are cut down, sawn down, pushed over or burnt down. In burning, three main methods are employed. One is to gather leaves and brushwood round the base of the tree and set fire to them. Another is to apply a lighted blow-lamp to

Figure 19.
Umbrella mulga in which the main trunk has been cut off and one large branch "leaned" by cutting partly through. Note regrowth from both the stump and the "leaned" limb. Tatala Station, April, 1948.

a dry part of the tree. A third method is to splash a little oil from a can on to a dry spot on the trunk and set fire to it with a fire-stick. Whatever method is employed to ignite it, once the tree is alight the trunk will burn through, making the leafy top available for stock.

REGROWTH AFTER DIFFERENT METHODS OF TREATMENT

Following different methods of treatment, mulga trees behave in different ways. Naturally, climatic conditions after treatment have an effect on the recovery of the trees, but so far no detailed work has been done on this aspect.

Grazing

Low mulga appears to be extremely resistant to grazing. Once it has attained a height where some leaves are above the reach of sheep, it will survive major droughts even when severely grazed by both sheep and cattle. Smaller low mulga bushes, about 2-3 feet high, are more readily killed by drought, particularly when subjected to grazing by sheep. Response to soaking summer rain is rapid and spectacular. For example, during the drought in 1946 areas of low mulga in the Charleville-Wyandra district were carrying only a few yellowish-green hard leaves. Good rain fell in February and March, 1947 ; in a few weeks the bushes were covered with green leaves and some of them produced shoots nearly 4 feet in length in about six weeks.

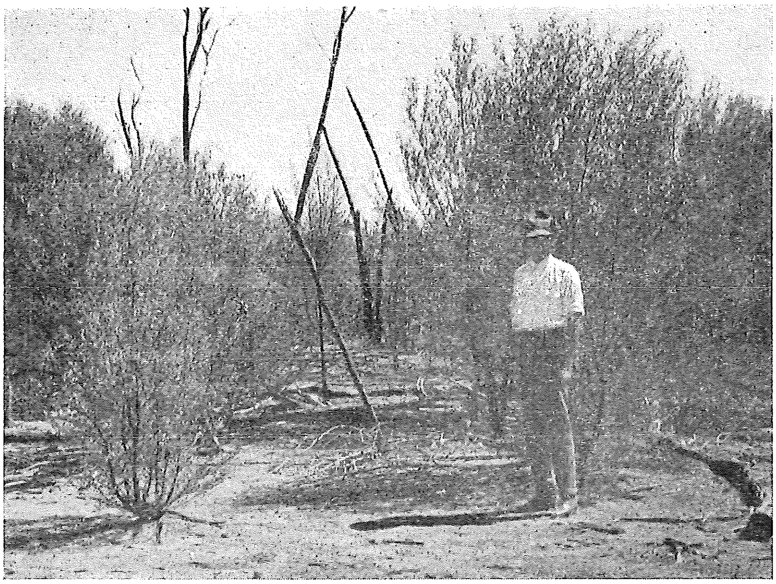


Figure 20.
Regrowth from mulga which was cut off near ground level in 1935. Paddock stocked only with horses. Oakwood Station, October, 1940.

Felling

In only one instance has any large regrowth been seen from trees cut below the lowest branch. That was at Oakwood Station, north of Charleville, in October, 1940. There vigorous young umbrella mulga in a horse paddock was cut just above ground level in 1935. Sheep were let into the paddock to eat the cut material, then removed. Subsequently, the paddock was grazed only by horses. Inspection in October, 1940, showed a vigorous regrowth of shoots on all the cut trees. The shoots were from 6-10 feet high (Figure 20). By October, 1948, these had attained a height of 25-30 feet.

In March, 1947, and July, 1947, some regrowth was observed on mulga cut down with a power saw in November, 1946. The trees had not been sawn right through but had broken off, leaving the butt of the trunk still attached to the stump by a narrow strip of bark and sapwood. About 5 per cent. of sawn trees showed some regrowth, mostly only a few tufts of leaves on one or two branches, the majority of the branches on every tree being dead.

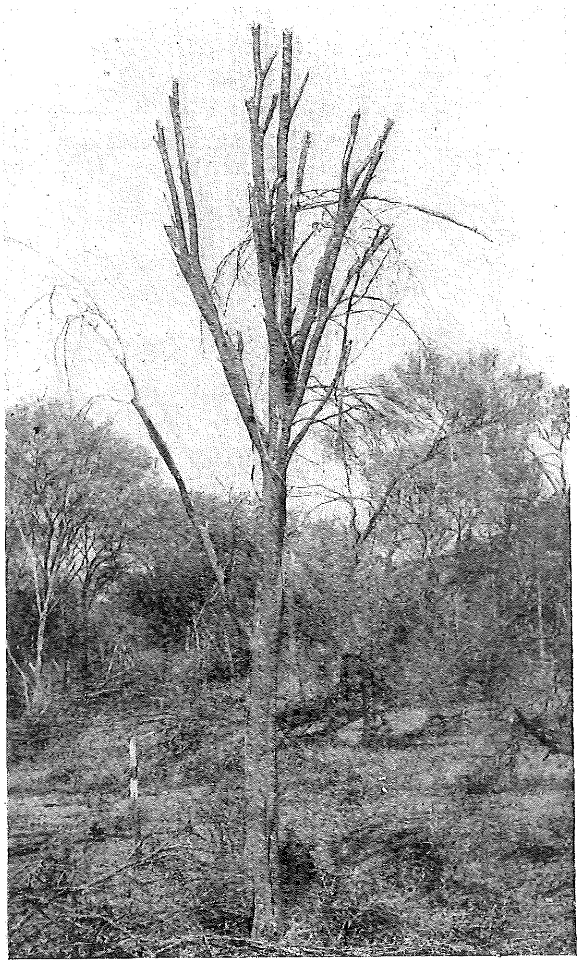


Figure 21.
Mulga (narrow-leaved variety) pruned in January, 1942, by shortening all branches by one-third of their length. Note survival of untreated trees in background. Bilbah Downs, June, 1947.

Lopping

Some experimental work has been done on lopping of mulga. At Bilbah Downs, between Emmet and Isisford, small plots of the narrow-leaved variety were lopped in different ways in January, 1942. No inspection was made until June 11, 1946, when the following counts were made :—

Treatment	Trees treated	Trees alive	Remarks
Lopped, leaving one branch	24	14	Many of the trees with one branch left seem to have had that branch blown off by wind. Of numerous trees which were cut off below the lowest branch none survived.
Lopped, leaving two or more branches	24	20	
Pruned ; every branch cut back about one third of its length (See Fig. 21)	24	nil	
Control, untreated	24	24	

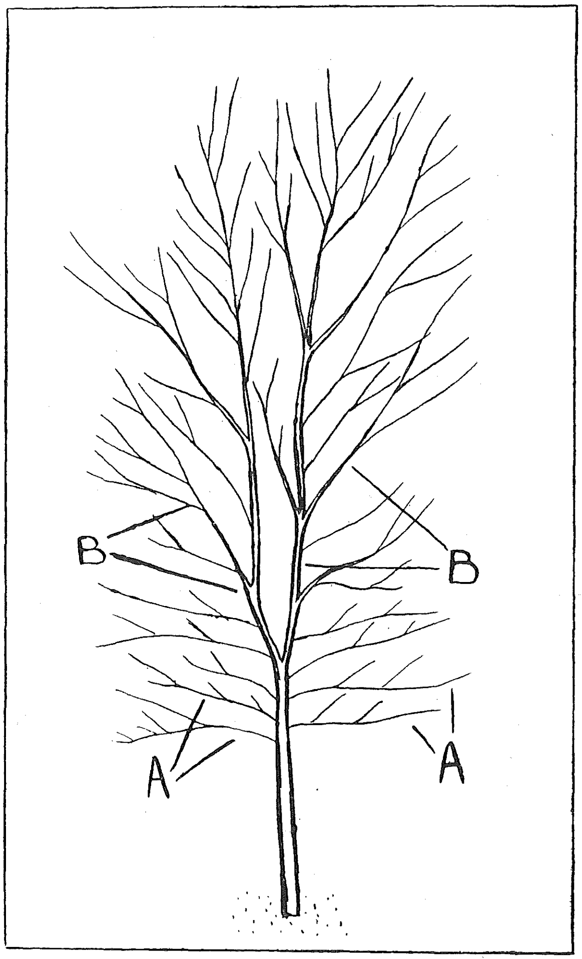


Figure 22.
Diagram of branching of mulga, showing (A) divaricate branches ; (B) obliquely ascending branches.

The plots were small and lopping was followed by four years of abnormally low rainfall. The location, too, is outside the limits of the main mulga zone. The trees which were treated resembled tall mulga rather than umbrella mulga. Further experience has indicated that such mulga is not suitable for lopping, because it branches too high and regrowth from the trees is usually not vigorous. The experiment needs to be repeated with umbrella mulga located within the main mulga zone.

According to one experienced grazier, the only trees which make any vigorous regrowth after lopping are those which possess divaricate branches and on which at least one of these branches has been left. If the trees are lopped in such a way that the divaricate branches are removed and the obliquely ascending ones allowed to remain, the tree produces very few new branches after lopping, though in many

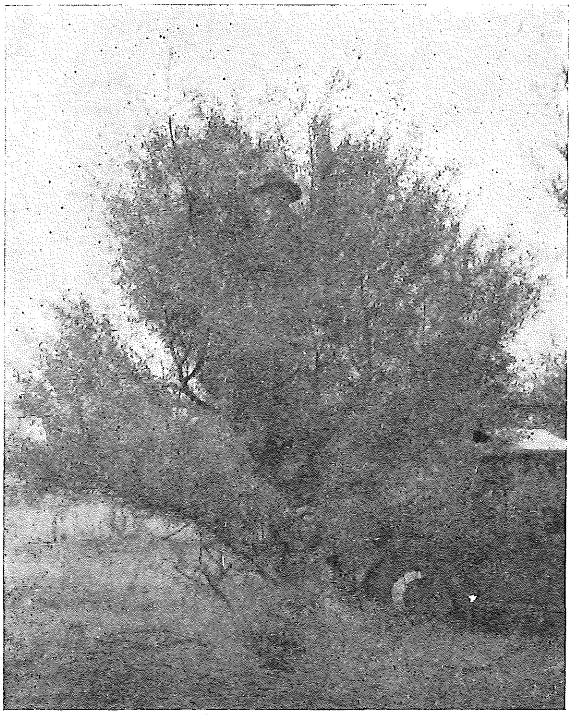


Figure 23.
Umbrella mulga lopped August, 1946. The regrowth shown has occurred since February, 1947. Dingwall Station, April, 1948.

cases the branch left intact will survive. Field observations indicate that these statements are substantially correct. This is the basis of the method of lopping whereby the centre is cut from the tree, leaving the lower spreading branches intact. Figure 22 shows diagramatically the two kinds of branches, that marked A being the divaricate and B the obliquely ascending.

The height of cutting is usually about 3 ft. 6 in. to 4 ft. 6 in. above ground level, depending on the height of the lowest branches. Most of the branches slope upwards slightly, so that the ends of branches arising at 3 ft. 6 in. would still be above the reach of sheep. Defoliation of twigs near the base of the branches does not appear to have such a deleterious effect as removal of leaves from the ends of the branches.

Trees treated in such a way usually survive and when conditions become favourable may make new growth very rapidly. Figure 23 shows regrowth from an umbrella mulga on Dingwall Station. In August, 1946, the tree was lopped in the manner described above, cuts being made about 4 feet above ground level. At that time, the lower laterals were merely thin sticks with a few leaves. No new growth took place until February, 1947. When photographed in April, 1948,

Figure 24.
Umbrella mulga lopped in 1935 leaving the lowest branches intact.
Oakwood Station, October, 1940.

the new shoots had attained a length of 8 feet. Although this regrowth is somewhat greater than normal, many trees have been observed in which new shoots had attained a length of 4 feet or more in the same period.

Figure 24 shows some mulga at Oakwood lopped in 1935 above the reach of sheep. These trees made excellent regrowth.

From discussions with graziers and from observations in the field, the following general statements seem justified. Although there are exceptions, in the majority of cases these appear to be the facts :—

(*a*) If mulga trees are cut off below the lowest branch they nearly always die.

(*b*) If one or more leafy branches are allowed to remain, trees usually survive, provided some of the terminal leaves are above the reach of sheep.

(*c*) Most regrowth takes place from slender divaricate branches in the lower part of the tree; regrowth from obliquely ascending branches is meagre.

(*d*) In a limited experiment where all branches were shortened back by one-third, leaving no branch intact, all trees so treated died during the next five years.

Figure 25.
Whipstick mulga pushed over with tractor about August, 1946. South of Charleville, March, 1947.

Pushing Over

When trees are pushed over by a tractor, some are torn out by the roots, some are snapped off completely and some are bent over and the trunks partly broken (Figures 25 and 26). In March, 1947, and July, 1947, a very meagre regrowth was observed on a small percentage of trees in the Charleville-Wyandra district (Figure 27). In appearance, the regrowth was very similar to that on the sawn-down trees mentioned above. The general opinion amongst experienced graziers was that they would die, though some were still surviving in April, 1948.

In an area where mulga was pushed over in 1936, no survivors were found among the fallen trees. The only trees alive were those which had been left standing when the rest of the trees were pushed over. These trees had improved considerably.

Pulling Over

Much the same observations were made on regrowth of pulled-over mulga. However, more trees were left intact by this method than by pushing over, leaving more trees standing for future regeneration.

In one instance observed on Dingwall Station, the survival rate was fairly high. The trees were vigorous umbrella mulga about 15 feet high, growing on rather soft soil. In August, 1946, they were pulled over, using a cable drawn by two tractors. A few hours after treatment, 75 points of rain fell. No more useful

Figure 26.
Whipstick mulga pushed over with tractor about August, 1946. South of Charleville, March, 1947.

rain fell until February, 1947. Of these trees, 90 per cent. were still alive in April, 1948, most of them with vigorous new shoots ascending vertically from the branches on the upper part of the fallen tree (Figure 28). Some of these new shoots were up to 6 feet long. They were in marked contrast to regrowth from other pulled over trees on which the new shoots were short and not vigorous. It appears probable that these particular trees will survive.

This observation suggests that during the wet season it may be practicable to pull trees over without killing them. In this way, umbrella mulga could be brought down within reach of sheep and would then be available for grazing, both during normal times and in drought.

Pulling with a waggon such as that shown in Figure 18 sometimes causes the trees to snap off near the ground, sometimes pulls them over without breaking, and sometimes breaks them at a height varying from 3 feet to 5 feet. Young trees less than 8 feet high are left intact. Many of the trees which break off at a fairly high level survive and in some instances produce new shoots comparable with those on trees properly lopped with an axe (Figure 29).

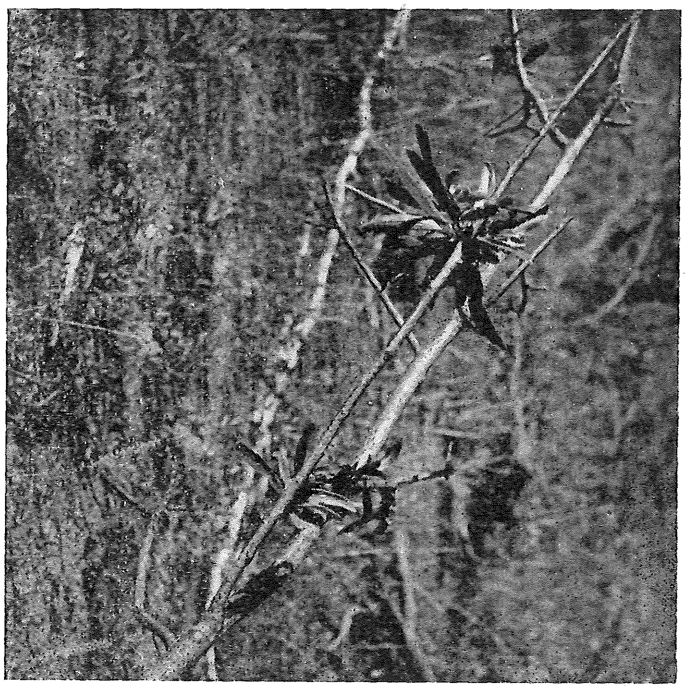


Figure 27.

Showing meagre regrowth from tree pushed over. The shoots represent regrowth since February 10, 1947. South of Charleville (same place as Figure 25), March, 1947.

Burning

No regrowth has been observed from trees burnt down. In many places regeneration of seedlings was better around burnt trees than in other parts of the same paddocks.

THINNING OF MULGA FORESTS

The density of mulga forests and scrubs varies considerably. Low mulga often grows very thickly, sometimes at the rate of more than 5,000 shrubs per

Figure 28.

Small umbrella mulga pulled over with cable in August, 1946. Pulled over in afternoon ; 75 points of rain fell at night. The vertical shoots represent regrowth since February 10, 1947. Dingwall Station, April 19, 1948.

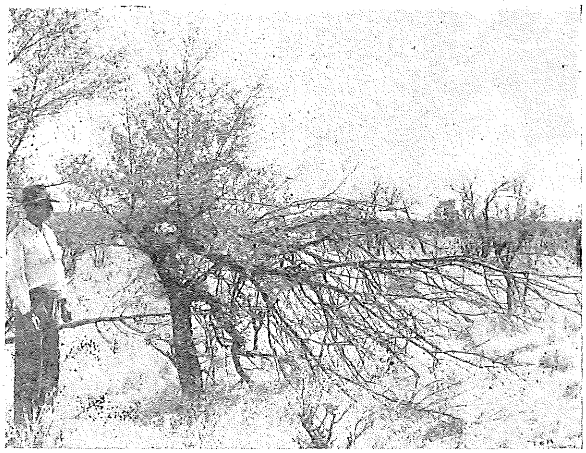


Figure 29.

Regrowth from tree broken off at a high level with a waggon. South-west of Quilpie, October, 1948.

acre. Whipstick mulga, too, often forms dense stands, 2,000 to 2,500 trees per acre being common. Umbrella mulga and tall mulga are usually more widely spaced, densities ranging from as few as 20 to as many as 500 per acre. Where density is high, competition for water is severe and often the trees are restricted in their growth. Ground vegetation, too, is usually sparse and stunted.

In 1940, observations were made at Oakwood Station on a good stand of umbrella mulga which had been cut in 1935. The original stand was about 300 trees per acre. In one area this was reduced to 60-80 trees per acre and in another to 100-120 trees per acre. At the time of inspection, the more widely spaced trees were much larger and more leafy than those in the 100-120 group, and those in turn were better than the original forest. In the well spaced area, ground vegetation was very much larger, denser and more varied. The number and size of grasses and forbs decreased proportionately as the density of the forest increased. Under the conditions prevailing in that particular area, it appeared that the optimum density for mulga was about 70 trees per acre. This allowed full development of the ground vegetation and still left a good reserve of mulga for use in time of drought. In other districts and on other soils, the optimum density might be different.

Severe drought sometimes thins out mulga forests naturally. Following the 1943-46 drought large numbers of dead trees were observed in many parts of south-western Queensland. At Oakwood, counts were made on October 15, 1948, in the same class of country as that described above. In an area of whipstick mulga originally carrying 800 trees per acre, 65 per cent. were dead, leaving survivors averaging 280 trees per acre. In an adjoining paddock with an original density of 350 per acre, less than 30 per cent. were dead, leaving survivors averaging 220 trees per acre. In some small patches about 2 chains square all trees were dead, and in other patches of about the same extent none of the trees had died. It seems significant that the final density after the drought was approximately 250 trees per acre, irrespective of the density of the original stand.

A small experiment at Bilbah Downs gave no conclusive results. Plots each 2 chains by 2 chains (0.4 acre) were thinned to densities of 20, 70, and 120 trees per acre, respectively. The thinning was done in January, 1942. Inspection in June, 1947, failed to show any obvious differences between the various areas, either in the growth of the trees themselves or in the development of ground vegetation. It is thought that the plots were too small and marginal influences too great to reveal obvious differences.

SOIL EROSION

It was feared that some methods of handling mulga might cause accelerated soil erosion. The chief cause for concern was that pushing over might cause wholesale disturbance of the surface soil and in consequence make it more vulnerable to damage by wind and water. No final statement can yet be made on this. Several areas have been examined where mulga was pushed over during the drought which ended in 1947. None of them showed evidence of accelerated erosion of the surface soil. There is ample evidence that widespread sheet erosion took place during the drought years from 1942 to 1946 to depths varying from 0.5 cm. to 2 cm., but in the areas examined it appears no deeper on areas where mulga has been pushed over than on those where the forests have been left intact. In an area where mulga was pushed over in 1936, no evidence of accelerated erosion was seen.

It is considered that, as a precaution, mulga should be pushed over across the slope as far as practicable. On flat country, it would be an advantage to lay the trees as nearly as possible in the direction north-west to south-east so as to have the fallen material at right angles to the strong, gusty, dust-bearing winds which blow from the south-west.

If water is concentrated in channels on the red-brown fine sandy loams which carry mulga, gully erosion can be severe.

CONCLUSIONS

It appears from present knowledge that at least in the region east of the Warrego River the following statements are justified :—

(*a*) Mulga is eaten readily by sheep, cattle and goats, and to a smaller extent by horses.

(*b*) Sheep and cattle may be maintained for long periods by giving them access to mulga leaves, even if no other feed is available. Falling off in condition may occur after more than six months on an unvaried diet of mulga, and factors responsible for this need further study.

(*c*) If mulga trees are felled, burnt down, pushed over, or pulled over, they usually die. Exceptions may occur, but from a regional point of view they are not important.

(*d*) Umbrella mulga which has been lopped at about 4 feet above ground level, leaving at least one branch with its terminal leaves above the reach of sheep, usually survives. Regrowth from such trees may be very rapid following suitable rainfall. Sometimes trees so treated die.

(*e*) Mulga seeds germinate freely if adequate rainfall is received during summer. Survival depends on subsequent climatic conditions and on grazing, as well as on the degree of competition of other trees.

(*f*) Sheep eat seedling mulga plants very readily, and continuous or severe grazing by sheep will prevent the establishment of mulga from seed.

(*g*) So far, no evidence has been seen of accelerated soil erosion following pushing over of mulga for sheep. Observations have been confined to a few small areas.

(*h*) If running water is allowed to concentrate in channels on mulga soils, severe gully erosion takes place.

Even this preliminary study has shown that mulga can be used for feeding sheep without fear of destroying the forests completely. Under some conditions mulga may be eliminated, but with proper management it can be maintained and improved. With further research it should be possible to

APPENDIX

LIST OF PLANTS COLLECTED IN CHARLEVILLE-WYANDRA-BOLLON DISTRICTS, 1946-47.—Continued

Botanical Name	Habitat M	Habitat B	Habitat S	Habitat C	Common Name	Remarks
Eragrostis sp.	—	—		—	——	Often locally dominant (S.L.E. 2867, 3109)
Eriachne aristidea F. Muell.			—		——	——
Eriachne benthamii Hartley				—	——	Clay flat
Eriachne helmsii Domin	—				——	——
Eriachne mucronata R.Br.			—		——	——
Eriachne pulchella Domin	—				——	Summer annual
Eriochloa pseudoacrotricha C. E. Hubbard	—	—			——	——
Eulalia fulva O.Ktze.	—	—			Brown top grass	Depressions
Neurachne mitchelliana Nees	—				Mulga Mitchell grass	——
Neurachne xerophila Domin	—				Mulga Mitchell grass	——
Panicum decompositum R.Br.		—			Barley grass	Not common
Panicum decompositum R.Br. var.		—			——	(S.L.E. 2843)
Panicum effusum R.Br.	—	—			——	Shade
Panicum effusum R.Br. var.			—		——	(S.L.E. 2829)
Panicum subxerophilum Domin	—				——	——
Paspalidium rarum Hughes	—	—			——	Summer annual
Paspalidium sp.	—	—			——	(S.L.E. 2781, 2808) shade
Perotis rara R.Br.	—	—			Comet grass	Sandy and silty soils
Setaria brownii Herrm.	—				——	Depressions
Sporobolus caroliz Mez.				—	Fairy grass	——
Themeda australis (R.Br.) Stapf.	—	—			Kangaroo grass	Depressions
Themeda avenacea Durand & Jackson ...		—			Tall oat grass	Depressions : not common
Tragus australianus S. T. Blake	—	—			Small burr grass	——
Triodia mitchellii Benth.			—		Spinifex grass	Locally dominant
Tripogon loliiformis C. E. Hubbard ...	—	—			Five-minute grass	Bare flats
Triraphis mollis R.Br.	—				Purple plume grass	Sandy soils
CYPERACEAE						
Bulbostylis barbata (Rottb.) C. B. Clarke ...	—				——	Summer annual
Cyperus aristatus Rottb.	—			—	——	Summer annual
Cyperus difformis Linn.	—			—	——	Gilgais : bore drains
Cyperus iria Linn.	—	—			——	——
Cyperus vetzii Nees				—	Nut grass	Gilgais
Cyperus rigidellus (Benth.) J. M. Black ...				—	——	Cane-grass Swamp
Cyperus victoriensis C. B. Clarke		—			Nut grass	Depressions
Eleocharis equisetina Presl.	—				——	Bore drains : pest
Eleocharis pallens S. T. Blake				—	——	Gilgai
Eleocharis plana S. T. Blake				—	——	Gilgai
Fimbristylis dichotoma Vahl.	—	—			——	——
Scirpus dissachanthus S. T. Blake				—	——	——
COMMELINACEAE						
Aneilema gramineum R.Br.		—			——	Depressions
PONTEDERIACEAE						
Monochoria cyanea F. Muell.				—	——	Gilgais

APPENDIX

LIST OF PLANTS COLLECTED IN CHARLEVILLE-WYANDRA-BOLLON DISTRICTS, 1946-1947.—Continued

Botanical Name	Habitat				Common Name	Remarks
	M	B	S	C		
LILIACEAE						
Lomandra leucocephala (R.Br.) Ewart ...			—		—	—
Thysanotus tuberosus R.Br.	—				Fringe lily	—
CASUARINACEAE						
Casuarina inophloia F. Muell. and Bail. ...			—		Thready-bark oak	—
Casuarina lepidophloia F. Muell.				—	Belah	Clay flats
PROTEACEAE						
Grevillea juncifolia Hook.			—		Honeysuckle	Locally dominant
Hakea ivoryi F. M. Bailey	—	—			Needlewood oak: corkwood	—
POLYGONACEAE						
Muhlenbeckia cunninghamii F. Muell. ...				—	Lignum	Gilgais : swamps
CHENOPODIACEAE						
Atriplex elachophylla F. Muell. (?)				—	—	—
Atriplex semibaccata R.Br.				—	Creeping salt-bush	Banks of earth tank
Bassia birchii F. Muell.		—			Galvanised burr	—
Bassia convexula R. H. Anderson	—	—			—	—
Bassia divaricata (R.Br.) F. Muell.	—		—		—	—
Bassia uniflora F. Muell.	—				—	—
Chenopodium anidiophyllum Aellen ...	—	—			—	—
Chenopodium blackianum Aellen	—	—			Red crumbweed	—
Chenopodium cristatum F. Muell.	—				Crested crumb-weed	—
Chenopodium rhadinostachyum F. Muell. ...	—				Green crumb-weed	Bare ridges
Enchylaena tomentosa R.Br.	—				Berry cotton-bush	Garden enclosure
Kochia crassiloba R. H. Anderson		—			—	—
Kochia tomentosa (Moq.) F. Muell.	—				Cottonbush	—
Rhagodia linifolia R.Br.		—			Berry saltbush	—
Rhagodia nutans R.Br.		—			Berry saltbush	—
Salsola kali Linn.				—	Soft roly-poly	—
AMARANTHACEAE						
Alternanthera denticulata R.Br.		—			—	—
Amaranthus macrocarpus Benth.				—	—	—
Amaranthus viridis Linn.	—				Green amaranth	Garden weed
Trichinium alopecuroideum Lindl. ...	—	—			Fox-brush : Prince-of-Wales feathers	—
Trichinium corymbosum Gaud.	—	—			—	—
Trichinium leucocoma Moq.	—				—	—
NYCTAGINACEAE						
Boerhaavia diffusa Linn.	—	—			Tar vine	—
PHYTOLACCACEAE						
Codonocarpus cotinifolius F. Muell. ...	—				Bell-fruit	Not common
AIZOACEAE						
Trianthema crystallina Vahl.	—	—			—	—

APPENDIX

LIST OF PLANTS COLLECTED IN CHARLEVILLE-WYANDRA-BOLLON DISTRICTS, 1946-1947.—Continued

Botanical Name	Habitat				Common Name	Remarks
	M	B	S	C		
PORTULACACEAE						
Calandrinia balonnensis Lindl.	—		—		Parakeelya	Sandy soils
Calandrinia pumila F. Muell.	—	—			——	Shade
Calandrinia ptychosperma F. Muell.		—			——	——
Portulaca filifolia F. Muell.		—			——	——
Portulaca oleracea Linn.	—	—			Pigweed	——
CARYOPHYLLACEAE						
Spergularia rubra (L.) J. & C. Presl.		—			——	Flat flooded by bore water
CRUCIFERAE						
Blennodia lasiocarpa F. Muell.	—				——	Sandy soil
Cuphonotus humistratus (F. Muell.) O. Schulz				—	——	Gilgais
Lepidium muelleri-ferdinandii Thellung	—	—			Mustard weeds or pepper-cress	——
Lepidium oxytrichum Sprague	—	—				
Stenopetalum nutans F. Muell.	—				——	——
LEGUMINOSAE						
Acacia aneura F. Muell.	—	—			Mulga	——
Acacia argentea Maid.			—		Wattle	——
Acacia excelsa Benth.		—			Ironwood	——
Acacia gnidium Benth.			—		Wattle	——
Acacia oswaldii F. Muell.		—			Nelia	——
Acacia patens F. Muell.			—		Wattle	——
Acacia sp.	—				——	Hard ridges (S.L.E. 3110)
Aeschynomene indica Linn.				—	Budda pea	Gilgais
Cassia artemesioides Gaud.	—				——	——
Cassia eremophila A. Cunn.	—				——	——
Glycine sericea Benth.	—				——	——
Jacksonia turneriana Domin			—		——	——
Petalostylis labicheoides R.Br.	—				——	——
Ptychosema trifoliatum F. Muell.			—		——	——
Swainsona procumbens F. Muell.				—	A Darling pea	——
GERANIACEAE						
Erodium cygnorum Nees	—	—			Crowfoot	——
OXALIDACEAE						
Oxalis corniculata Linn.	—	—			Wood sorrel	Shade
ZYGOPHYLLACEAE						
Tribulus terrestris Linn.	—				Bullhead, caltrops	——
POLYGALACEAE						
Polygala arvensis Willd.	—				——	——
EUPHORBIACEAE						
Euphorbia drummondii Boiss.	—	—			Caustic creeper	——
Phyllanthus fuernrohrii F. Muell.	—	—			——	——
Phyllanthus maderaspatensis Linn.		—			——	——
Phyllanthus sp. aff. *P. lacunarius* F. Muell.				—	——	Gilgais (S.L.E. 2945)
Ricinocarpus bowmanii F. Muell.			—		" Boronia "	——

APPENDIX

LIST OF PLANTS COLLECTED IN CHARLEVILLE-WYANDRA-BOLLON DISTRICTS, 1946-1947.—Continued

Botanical Name	Habitat				Common Name	Remarks
	M	B	S	C		
STACKHOUSIACEAE						
Macgregoria racemigera F. Muell.			—		——	——
Stackhousia muricata Lindl.			—		——	——
SAPINDACEAE						
Dodonaea adenophora Miq.	—				Hop bush	Ridges
Dodonaea boroniifolia G. Don.			—		——	Sandy ironbark flat
Dodonaea sp.			—		——	——
TILIACEAE						
Corchorus trilocularis Linn.				—	——	Gilgai
MALVACEAE						
Abutilon fraseri Hook.	—				——	——
Abutilon malvifolium J. M. Black				—	——	Gilgai
Abutilon otocarpum F. Muell.		—			Flannel weed	——
Abutilon oxycarpum F. Muell. var. *subsaggitatum* Domin				—	——	Gilgai
Abutilon sp. aff. *A. otocarpum* F. Muell.	—				——	(S.L.E. 2755)
Abutilon sp.	—				——	(S.L.E. 2795)
Hibiscus sturtii Hook.	—	—			——	——
Hibiscus trionum Linn.				—	——	Gilgai
Malvastrum spicatum A. Gray	—				Malvastrum	Sheep yard
Sida brachypoda F. Muell.		—			——	——
Sida corrugata F. Muell.		—			——	——
Sida cunninghamii C. T. White	—	—			——	——
Sida fibulifera Lindl.		—			Grey Sida	——
Sida filiformis A. Cunn.	—	—			——	——
Sida trichopoda F. Muell.				—	——	Gilgai
Sida sp. (green)		—			——	(S.L.E. 2776)
Sida sp. (flannelly)		—			——	(S.L.E. 2838)
STERCULIACEAE						
Brachychiton populneus R.Br.	—	—	—		Kurrajong	——
Hannafordia sp.			—		——	Rare
Keraudrenia collina Domin			—		——	——
GUTTIFERAE						
Hypericum japonicum Thunb.		—			——	Deep shade
ELATINACEAE						
Bergia ammanioides Roth.		—			——	Flooded flat
Bergia sp.				—	——	Gilgai
VIOLACEAE						
Hybanthus filiformis (DC.) F. Muell.			—		——	——
THYMELEACEAE						
Pimelea colorans A. Cunn.			—		——	——
Pimelea trichostachya F. Muell.			—	—	——	——
LYTHRACEAE						
Ammannia multiflora Roxb.				—	——	Gilgai
MYRTACEAE						
Calythrix longiflora F. Muell.			—		Heather	——
Eucalyptus exserta F. Muell.			—		Mallee	——

APPENDIX

LIST OF PLANTS COLLECTED IN CHARLEVILLE-WYANDRA-BOLLON DISTRICTS, 1946-1947.—Continued

Botanical Name	Habitat				Common Name	Remarks
	M	B	S	C		
Eucalyptus melanophloia F. Muell. ...	—		—		Silver-leaf ironbark	—
Eucalyptus populifolia Hook.	—	—			Poplar box	—
Eucalyptus sp.	—	—			Forest gum	(S.L.E. 2899)
Eucalyptus sp. (Possibly hybrid *melanophloia* X forest gum)	—				—	Only one tree seen
Melaleuca linariifolia Sm. var. *trichostachya* (Lindl.) Benth.	—				Paper-bark Tea tree	Only one tree seen
Melaleuca sp.			—		—	(S.L.E. 2637)
Thryptomene parviflora Domin			—		—	—
HALORRHAGACEAE						
Halorrhagis odontocarpa F. Muell.	—	—			Mulga nettle	—
UMBELLIFERAE						
Actinotus paddisonii R. T. Baker			—		—	—
Trachymeneglaucifolia (F. Muell.) Benth. ...	—	—			Wild parsnip	—
EPACRIDACEAE						
Leucopogon mitchellii Benth.			—		—	—
PRIMULACEAE						
Anagallis arvensis Linn.		—			Pimpernel	Deep shade
GENTIANACEAE						
Limnanthemum crenatum F. Muell. ...				—	—	In water
CONVOLVULACEAE						
Breweria media R.Br.			—		—	—
Convolvulus erubescens Sims	—	—			—	—
Evolvulus alsinoides Linn.	—	—			—	—
BORAGINACEAE						
Heliotropium tenuifolium R.Br.	—	—			—	—
VERBENACEAE						
Spartothamnella juncea (R.Br.) Briq. ...		—			—	—
Spartothamnella puberula (F. Muell.) Maid. & Betche			—		—	—
LABIATAE						
Prostanthera suborbicularis White & Francis	—				Mint bush	—
Teucrium racemosum R.Br.				—	—	Gilgai
SOLANACEAE						
Datura ferox Linn.	—				Thorn apple	Sheep yard
Nicotiana ingulba J. M. Black	—	—			Wild tobacco	—
Nicotiana megalosiphon Huerck & Muell. Arg.		—			Wild tobacco	—
Solanum ellipticum R.Br.	—	—			Potato weed	—
Solanum esuriale Lindl.		—			" "	—
Solanum ferocissimum Lindl.	—	—			—	—
Solanum nigrum Linn.	—				Black-berried nightshade	Around tanks
Solanum quadriloculatum (F. Muell. (?)) ...	—				—	Sheep yard
SCROPHULARIACEAE						
Mimulus prostratus Benth.		—			—	Dry watercourse
Peplidium humifusum Delile				—	—	In mud

APPENDIX

LIST OF PLANTS COLLECTED IN CHARLEVILLE-WYANDRA-BOLLON DISTRICTS, 1946-1947.—Continued

Botanical Name	Habitat				Common Name	Remarks
	M	B	S	C		
ACANTHACEAE						
Ruellia australis R.Br.	—	—			—	—
MYOPORACEAE						
Eremophila bowmanii F. Muell.	—				—	—
Eremophila gilesii F. Muell.	—				"Turkey bush"	
Eremophila glabra (R.Br.) Ostenf.	—	—			Black Fuchsia	—
Eremophila longifolia (R.Br.) F. Muell. ...	—	—			Berrigan	—
Eremophila maculata F. Muell.				—	Fuchsia bush	—
Myoporum deserti A. Cunn.	—	—			Ellangowan poison bush	—
PLANTAGINACEAE						
Plantago varia R.Br.	—				Lamb's tongue; Wild sago	Sandy soil
CUCURBITACEAE						
Cucumis myriocarpus Naud.	—				Prickly cucumber	Sheep yard
CAMPANULACEAE						
Pratia puberula Benth.	—	—			—	Bare patches
Wahlenbergia bicolor Lothian		—			Bluebell	—
Wahlenbergia gracilenta Lothian	—				Bluebell	—
GOODENIACEAE						
Goodenia disperma F. Muell.			—		—	—
Goodenia glabra R.Br.	—		—		—	Sandy soil
Goodenia hederacea Sm.			—		—	—
Goodenia subintegra F. Muell.				—	—	Gilgai
Scaevola aemula R.Br.		—			—	—
Scaevola depauperata R.Br.			—		—	—
Velleia connata F. Muell.			—		—	—
Velleia paradoxa R.Br.	—	—			Peethebed	—
BRUNONIACEAE						
Brunonia australis Sm.			—		Cornflower	—
STYLIDIACEAE						
Stylidium eglandulosum F. Muell.			—		Trigger plant	—
COMPOSITAE						
Calotis cuneifolia R.Br.	—	—			Daisy burr	—
Calotis suffruticosa Domin	—	—			Daisy burr	—
Epaltes australis Lees	—				—	—
Erigeron linifolius Willd.				—	Fleabane	—
Glossogyne tenuifolia Cass.	—	—			Cobbler's pegs	—
Helichrysum bracteatum (Vent.) Andrews ...	—				Everlasting	—
Helipterum anthemoides DC.				—	Paper daisy	—
Helipterum floribundum DC.		—			Paper daisy	—
Helipterum jessenii F. Muell.	—				—	—
Ixiolaena leptolepis Benth.	—	—			—	—
Isoetopsis graminifolia Turcz.	—				—	Sandy soil
Minuria integerrima (DC.) Benth.				—	—	Gilgai
Podolepis arachnoidea (Lindl.) Druce ...			—		—	—
Pterocaulon cylindrostachyum C. B. Clarke		—			Ragweed	—
Sigesbeckia orientalis Linn.		—			Indian weed	—
Stuartina muelleri Sond.	—				Mulga lettuce	Deep shade
Vittadinia scabra DC. var.	—				—	(S.L.E. 2910)
Vittadinia sp. aff. *V. macrorrhiza* (DC.) A. Gray			—		—	(S.L.E. 2922)
Wedelia spilanthoides F. Muell.		—			—	—

APPENDIX

LIST OF PLANTS COLLECTED IN CHARLEVILLE-WYANDRA-BOLLON DISTRICTS, 1946-1947.—Continued

M = red-brown fine sandy loams with mulga (*Acacia aneura*) as the dominant tree.

B = red-brown fine sandy loams to clay loams with poplar box (*Eucalyptus populifolia*) as dominant.

S = yellow-brown to red-brown sands and fine sands with spinifex grass (*Triodia mitchellii*) as dominant.

C = clay soils, either gilgais (small depressions which hold water after rain) or more extensive clay flats with impeded subsoil drainage.