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The Plant Communities of Western Queensland and their Relationships, with Special Reference to the Grazing Industry

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THE PLANT COMMUNITIES OF WESTERN QUEENSLAND AND THEIR RELATIONSHIPS, WITH SPECIAL REFERENCE TO THE GRAZING INDUSTRY.

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[Read before the Royal Society of Queensland, 29th November, 1937.]
Plates VII.—XXVI., two maps and two text figures.

IN a State such as Queensland, where the national wealth is dependent to such an enormous extent upon the success of the grazing industry, an accurate survey of the pasture lands, and indeed of all vegetation, would seem to be a prime necessity. Such a survey has yet to be made. It is true that three previous maps, featuring the vegetation of Queensland, have been published. The first was "The Forest Conditions of Queensland," prepared for the British Empire Forestry Conference of 1928 by E. H. F. Swain.[37] As this deals purely and simply with commercial timbers and their occurrence, its application is very limited, and is quite misleading to the student of general vegetation. Two maps were published by the Council for Scientific and Industrial Research. The first of these is "The Soils of Australia in Relation to Vegetation and Climate," by J. A. Prescott, published in 1931.[31] Then in 1936 appeared "A Survey of the Pastures of Australia. . . .," by A. McTaggart.[25] Both dealt with Australia as a whole, and as a result Queensland was very inadequately treated. Serious errors occur, and while some are the natural result of the method of preparation and the practical impossibility of obtaining reliable data about many districts, others are less easy to explain, particularly the inconsistency in nomenclature. Some of the most serious of these will be pointed out when discussing the communities. A most useful purpose was served by these maps in that they stressed the necessity for detailed work in this direction. The best general accounts of Queensland vegetation have been given by Domin[14] and White,[39] while its general relationships have been discussed by Herbert.[21]

In the present paper an attempt has been made to describe all the important plant communities that occur in the area usually referred to as Western Queensland. The paper is based entirely on field work carried out in connection with general botanical investigations on pasture problems. A large part of the area was hitherto practically unexplored botanically, and the floristics of a large part of the remainder imperfectly known. As the result of intensive field work, carried out over the period of three years as a Walter and Eliza Hall Fellow, material has now been accumulated for a fairly thorough knowledge of the area. Considerable time will be required before all the botanical material can be worked up, but in view of the increased interest and activity which is being manifested in pastoral problems, it has seemed advisable to present the general results of this work, leaving the details to be filled in later. As the work progresses material will be available for a more comprehensive account of the vegetation of Queensland than has yet been possible.

The limits of the occurrence of some communities have been in part plotted from surveys and other data made available to me through the courtesy of officers of the Department of Public Lands. However, I take full responsibility for the discrimination of the communities as such, and for their arrangement.

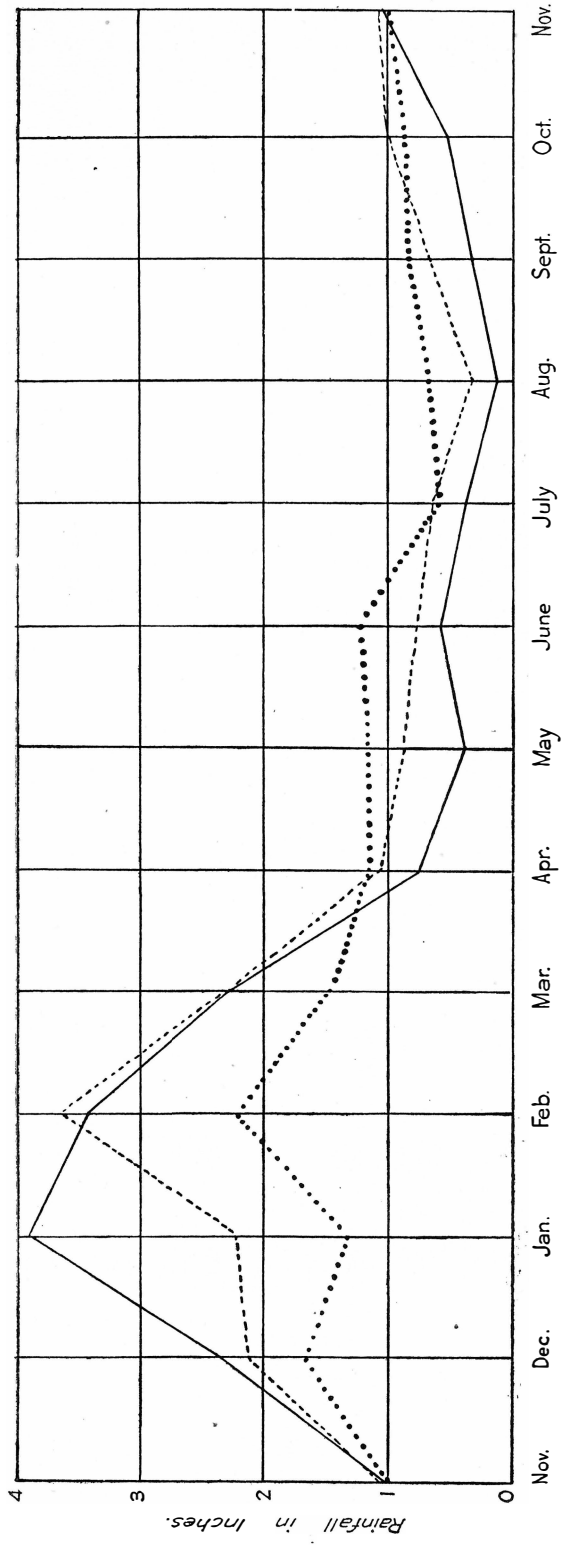
It is with deep pleasure that I offer my sincere thanks to the many persons who have assisted me in diverse ways. First and foremost I wish to express my deep gratitude to the members of the Walter and Eliza Hall Trust. This Trust made the work possible, and has continued to finance it, and it is through the courtesy of the members that it has been possible to bring the work to its present extent. Throughout the prosecution of field work in all parts of the State, transport facilities have been afforded me by many people. To the officers of the Department of Agriculture and of the Department of Public Lands I am indebted in this and other ways. Through the courtesy of many graziers, I have been enabled to study the composition of pastures in relation to stocking and other aspects. The section on soils has been prepared with the assistance of members of the Department of Geology in this University. To others who have assisted in any way whatsoever, I tender thanks.

The area here discussed covers nearly 330,000 square miles, and embraces the greater part of purely pastoral Queensland with the exception of the very large area surrounding the Gulf of Carpentaria, which constitutes a definite botanical province to be defined later. The southern boundary of this province is approximately the northern limit of the area described in the present paper. The climate, topography, soils, river systems, and available water are discussed. The plant communities, of which about forty-five are recognised, are arranged in fourteen groups, and described as to habitat, dominant species, floristic detail, reaction to stocking, their relationships, and their history. To account for certain features, including the instability of some of the large communities, the idea of a fluctuating climax is introduced. Maps showing the distribution of the chief soil-types and plant associations are included.

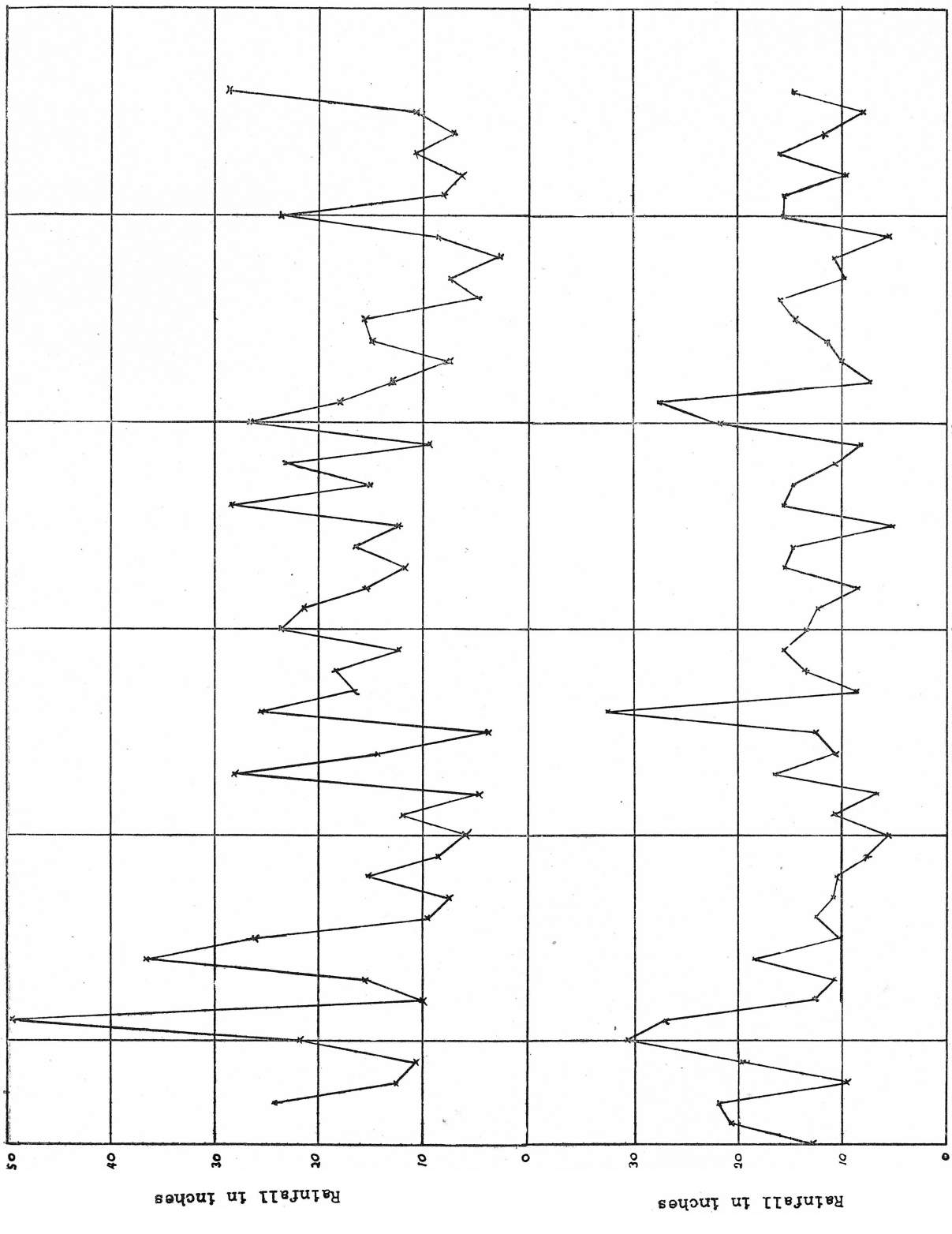
Climate.

The whole of the area lies within the 30-inch isohyet and the greater part within the 20-inch isohyet, while in the far south-west the average annual rainfall falls below 6 inches. Extremes of temperature are usual. By far the greater part lies within Davidson's Desert Zone and the greater part of the remainder is within his arid zone[13] (see, however, discussion under Simpson Desert on p. 199). The rainfall is rather erratic throughout and in the south-west is sporadic. There are occasional years of heavy rainfall and frequent periods of prolonged drought.

To the north rain falls almost exclusively in summer, while to the south-east winter rains become increasingly important. No reliable data are available as to the minimum effective fall, but on the "downs" it is commonly considered that isolated falls of less than half an inch are of no value. On light soils smaller falls produce a definite response in the vegetation. It has been proved that in the very low rainfall areas of South Australia[29 42] and elsewhere that dew is of considerable importance to plant growth, and this is probably true for parts of Queensland.



Text Fig. 1.—Graph showing average monthly rainfall throughout the year for three stations each with an average annual rainfall of about 15 inches. The full line is the graph for Mackinlay, the broken line is that of Longreach, and the dotted line that of Cunnamulla. Note the increasing importance of winter rains towards the south and the very pronounced summer rainy season towards the north.



Text Fig. 2.—Graphs showing variation yearly in rainfall for Mackinlay (above) and Cunnamulla (below)

In Western Queensland the term "season" is almost invariably used in relation to rainfall. A "good season" is a period in which rain has been sufficient in quantity and distribution to produce a good permanent growth of grass, &c., and a relative sufficiency of surface water; while a "bad season" is one in which these effects have not been attained.

Some idea of the nature of the rainfall is shown by the graphs in text figs. 1 and 2. These and also the isohyets on map 1 have been prepared from official records from earliest times to 1936.

Topography and Geology.

The greater part of the area does not exceed 1,000 feet above sea-level, and near the border of South Australia descends almost to sea-level. Much of the country consists of plains and undulating country. Many of the plain areas are alluvial in origin. The Barkly Tableland in the north-west, on which Camooweal is situated, is an extensive, nearly flat, area with a gentle southern slope. Its greatest height is about 800 feet. It is composed largely of the sometimes siliceous Georgina limestones of Cambrian age. On the eastern margin are the rocks of the Templeton Series, also of Cambrian age, consisting of sandstones, siltstones, cherts, and siliceous shales (Whitehouse[41]). Apart from a few basalt tablelands, of which the most striking is one which extends for about 100 miles in a general east-west direction from the Great Dividing Range to the north-east of Hughenden, the remainder of the non-hilly country consists of rolling downs gradually flattening out to plains in some places. These downs and plains are within the Great Artesian Basin, and rest upon calcareous shales of Cretaceous age belonging to the Winton, Tambo, and Roma Series.

There are three groups of mountainous or hilly areas. In the Cloncurry-Mount Isa district is an extensive development of rugged, frequently knife-edged ranges and hills exceeding 1,500 feet above sea-level in places, composed of a wide variety of gneisses, schists, and other rocks of Pre-Cambrian age. In the east is the Great Dividing Range running in a general north-south direction, with its offshoots—the Drummond, Warrego, and Chesterton Ranges. The rocks are of varied nature and age, but sandstones are common and gneisses occur. The eastern scarp of the Great Dividing Range is well marked, but on the westward side the country flattens out with no definite scarp. Much of the Warrego Range, with its extensions and branches, the Gowan, Cheviot, and Grey Ranges, are merely elevated regions of the rolling downs, though Tertiary sandstone hills are often associated.

Over a large part of the rolling downs and to the south-east is a great development of flat-topped ironstone capped sandstone hills and tablelands of chiefly Tertiary age in all grades of weathering (figs. 29, 11, 13.) Towards the South Australian border, the tablelands which are here scarcely 50 feet above the valleys, form with the downs a characteristic topography intermediate between the two. The whole system is frequently called the "Desert Sandstone."

Everywhere associated with the sandstone area, and particularly in the far south-west, are the gibbers (cf. figs. 5, 6, 11). These gibbers are boulders or pebbles varying in size from that of a man's head downwards. They are the fragmentary remains of the ironstone capping

(duricrust) of the hills broken down by weathering, and by a continuation of the same process reduced to polished, irregularly-rounded fragments stained brown, reddish-brown, or purplish-brown by iron oxides. On the gibber plains of Sturt's Stony Desert the gibbers attain their greatest size and often form a thick layer, but elsewhere they are more usually represented by a surface layer or thin scattering of small pebbles rarely exceeding an inch in diameter and often quite small. In this state the pebbles are frequently referred to as "gidgea gravel." On the sides of the hills every stage in the weathering of the duricrust can be seen. The uppermost edge frequently assumes fantastic forms.

Superimposed on the gibber plains and elsewhere in the south-west is a big development of sand-dunes. They are in some way related to the sandstones and the gibbers, and it seems likely that they were derived from them. They have been discussed previously by Madigan[24] and Ratcliffe.[34 35] Their greatest development is in the Simpson Desert, where they form a series of long parallel ridges, usually pale-yellowish in colour, mostly 30-50 feet high, rarely if ever exceeding 60 feet, and spaced from one-sixth to one-quarter of a mile apart. The direction of their length varies from N 20° W at Birdsville to N 40° W where they cross the Central Australian border in about latitude 23° S. Between the dunes are nearly perfectly flat claypans. Crystals of gypsum, commonly known as "copi" (also spelt "copai," "kopi," and "kopai"), are frequently associated.

The direction of the dunes is governed by the direction of the prevailing wind. On their naked crests are superimposed small crescentic dunes caused by secondary winds. The latter are accordingly frequently undergoing change, and sand being shifted and blown about by the wind (fig. 21). This sand is not always blown off the the dune. In the few instances where personal observation was possible the sand was first blown off the crest and was then caught in an eddy on the leeward side and carried *up* the dune and deposited a few yards behind the point of departure. The net result is merely an alteration of the conformation of the crest.

On one occasion efforts at throwing light objects from the top of a sandhill were consistently defeated, such objects being regularly caught by these eddies and returned to the crest of the dune.

But under certain conditions sand is removed from the mass. On the edge of the desert, and sometimes at a considerable distance from any dune, small pockets of fine sand occur among the gibbers. They *may* be formed *in situ,* but it seems more likely that they are the result of sandstorms, the sand being transported in the manner described by Bagnold[1] for the Libyan Desert.

There is, however, as pointed out by Madigan,[24] a definite movement of the dunes in the direction of their length. This is well shown where the northern end of a dune is close to a watercourse where there is a tendency for trees to be buried. It is likely that this movement, comparatively slow as it is, is stopped by large streams. It is also stopped in places by low, stony ridges.

Near large streams and swampy areas the dunes tend to lose their regular arrangement.

To the north and east of the Simpson Desert proper is an area where sandhills occur different in many respects from the true desert dunes, but, nevertheless, closely related thereto. This is the "marginal

country'' of Ratcliffe. They are usually of a bright brick-red colour, though neighbouring hills may differ in this respect. They are scattered over the gravelly downs and alluvial flats and occasionally occur between river channels (fig. 38). Sometimes they form small clusters, very frequently small isolated dunes occur, and only rarely are they of any length. There appears to be no well-marked prevailing wind, but meteorological data on this point are lacking.

Very many of the dunes have hollows on the crest, and occasionally in such hollows masses of dune rock are exposed. From the large number of stone chips and occasional nardoo-stones and other implements found in these hollows, it is evident that the dunes were often occupied by aborigines. It is very likely that this occupation was the cause of the hollows being produced by wind eddies.

There is generally a limited area surrounding the dune or dune complex covered by sand. Beyond this area no sand is to be found (fig. 25). Within the dune mass small claypans may occur, and they may retain water for a considerable time (fig. 26).

Still further away from the desert the sandhills gradually lose their individuality, finally being represented merely by small sandy patches. These will be discussed below in dealing with the vegetation.

Drainage and Surface Water.

Several long rivers belonging to the four great drainage systems of the State traverse this part of the country. Though of noble proportions in times of flood, yet for a large part of the year they are little better than a string of waterholes. Those rivers with sandy beds are frequently quite dry for long distances, though water can be obtained without much trouble by digging. Such streams are the Flinders and the Maranoa.

The comparative paucity of surface water has exerted a powerful effect on the history of pastoral settlement, and accordingly the effect of the latter on the vegetation. But important changes followed on the discovery and wide utilisation of artesian water. Both artesian (flowing) and sub-artesian (non-flowing) bores are numerous. With flowing bores it is the general practice to lead narrow drains (bore-drains) from the bore-head over the country, sometimes for many miles, making use of the undulations of the ground to traverse as large an area as possible before they are finally led into a stream bed. The presence and lay-out of the drains are, of course, of inestimable value to the grazier, as they assure him of a permanent water supply for his stock. At the same time they indirectly control the nature of the pasturage by controlling the movements of grazing animals, and even produce a few distinctive communities of their own.

The construction of earthen tanks in many places has likewise been a factor in vegetation control by controlling the movements of stock, and perhaps also by the divergence of rain water.

The average fall of the rivers is about 12 inches per mile, and in the lower courses may be considerably less. The stream is not restricted to a single channel as a rule, but is divided among several. In times of flood these channels overflow and their united waters may spread for many miles, thoroughly saturating the soil and depositing silt. The rate of flow of such water is very slow. Fig. 39 shows a portion of the Diamantina River after the flood waters had receded a considerable distance.

The country between the channels is referred to as "channel country," and that affected by flood waters as "flooded country." Some of the large lakes of the south-west, such as Lake Yamma Yamma and Lake Machattie, are large areas of flooded country.

A few centres of inland drainage occur, giving rise to lakes of a different nature. Nearly all are more or less brackish, Lake Buchanan particularly so, producing a heavy thickness of salt in drying up. The other important lakes of this type are Galilee, to the north-east of Aramac and south of the previous, and the Dynevor Lakes, between Eulo and Thargomindah.

Soils.

So far there has been little detailed work done on the soils of the area. Profiles have been studied in very few places indeed. Most of the present discussion is based on my samples of surface soils now in the Department of Geology of the University of Queensland, supplemented by field notes. This is indeed the only source for a great part of the area. For the area between St. George and Cunnamulla I have had the assistance of Dr. F. W. Whitehouse, who has kindly placed his unpublished field notes at my disposal. For some localities I have relied entirely upon his work. Dr. W. H. Bryan has assisted me in classifying the soil samples.

There is a fairly sharp distinction between sandy and non-sandy (heavy) soils, and these are closely correlated with rock type. The line of demarcation between the two is often remarkably sharp, as is shown in fig. 1. This line of division between the so-called "desert" and the "downs" is one of the most remarkable and most important features in the State.

Prescott[31] recognises ten major soil types as occurring in Australia, and in a later publication[32] figures profiles. Five of these types are indicated as occurring in our area. These are the desert soils, the soils of the semi-desert and desert steppe, the black earths, grey and brown soils, and podsolised soils. To these must now be added his lateritic sand plain. True alluviums are also widespread.

The first type embraces the desert sands which have been discussed above. The soils of the semi-desert appear to be represented by a development of deep, excessively fine-grained, bright-reddish sandy loam extending from east of Cunnamulla to Thargomindah. Whitehouse considers this to be a fossil alluvium. It is readily affected by the wind when the plant cover has been removed. For reasons detailed below I do not consider the gibber and gravel plains to belong to this type, but to the brown soils.

The black earths and the grey and brown soils are collectively known in Queensland as "black soils," a term also used to designate such alluvial soils as are very sticky when wet. True black earths occur widely in the Clermont-Springsure belt, extending east, south, and somewhat to the west. In some places they occur patchily. They are derived both from basalt and from shales. In the extreme north, similar soils occur on the basalt tableland to the north and north-west of Hughenden, and near Prairie. (Slightly to the north-east of Hughenden and to the north of Springsure soils of a much lighter texture are derived from vesicular basalt. In the latter case a thin sandy soil is produced. Both must be regarded as very exceptional cases.)

Grey and brown soils are of wide occurrence. They are the typical soils of the rolling downs and the Barkly Tableland, and extend to the Stony Desert. They are chiefly clay loams, clay silts, and silt loams, rarely becoming somewhat sandy, and then chiefly on the crests of undulations. There are two well-defined types within the group. What appears to be the typical grey soil is friable, contracts greatly on drying, and distinctly grey in colour. The other, which is invariably associated with gidgea gravel, is much less friable and distinctly yellowish-brown in colour. This type characterises the "gravelly downs" and underlies the gibbers of the gibber plains. In an area to the west of Betoota the soil is remarkably fine and incohesive, and is known locally as "bull-dust."

Large tracts of sand, apparently comparable in nature with the lateritic sand plains of Western Australia, occur between the Balonne and the Warrego Rivers, and to the north-east, south-east, and west of Windorah.

Part of the large sandy area associated with the Great Dividing Range also appears to be comparable, while modifications occur in the neighbourhood of Quilpie and Adavale.

Podsolised soils occur in the north and central-east, in the former case alternating with lateritic soils.

Over a considerable part of our area occur the formations known as claypans. These are flat expanses with a hard, more or less polished surface, and usually devoid of permanent vegetation. They are of regular occurrence between the sandhills of the Simpson Desert and are frequently found beside stream channels. Another development is found in the Cunnamulla district on old alluvium. Claypans may also be found under other conditions.

Both impregnation by salts and scouring by wind and water seem to be important factors in the production of claypans. Before wind can play a part a bare surface has to be produced by drought or other means. Some are merely the dry beds of large shallow lakes.

The soil of claypans varies, but is usually silty in nature and nearly impervious to water. Frequently there appears to be little, if any, difference between the soil of a claypan and the soil of an adjacent well-vegetated patch, but no detailed work has been done in this direction. In many claypans there occur small patches of a slightly different nature, frequently sandy, and these often support vegetation. The appearance is produced of small islands scattered about the claypan, an effect which is enhanced when water is lying on the claypan (fig. 14).

While soil-erosion has no doubt played a part in the formation of some of these claypans, erosion on a large scale appears possible only on two types of soil. In each case it is dependent on the destruction of the plant cover. Soil drift is very noticeable on the reddish sandy loam west of Cunnamulla under such conditions, and can occur on the sandy tracts near Windorah. It is likely to occur also in the timbered sandy country in the south-east if wholesale clearing is allowed to continue.

Erosion due to water is important in places on the rolling downs, chiefly as gully erosion. Water erosion in these places is a natural and inevitable phenomenon, and through long periods of time has produced the marvellously rich "channel country." In some places, however, such erosion has become serious, due to the combined effects of trampling by stock and drought. These cases are discussed below when dealing with the effects of stock on vegetation.

There is no evidence whatsoever for the contention that an encroachment of the desert is in active progress as alleged by Hirschfeld.[22]

Vegetation.

The major factors influencing the vegetation appear to be soil type, incidence of rainfall, and drainage. As periodic droughts are experienced, it is perhaps natural to find that many species, apparently the more highly drought-tolerant or drought-escaping, enjoy a wide geographical range. Towards the south, as the winter rains increase in importance, a marked change in the floristic detail takes place. Other important factors influencing distinctive community formation are the remarkably sharp western boundary of the sandy soil associated with the Great Dividing Range, the distribution of the desert sandstone, the increasing aridity towards the south-west, the trend of the rivers in this direction, and the effect of settlement. The effects of the white man and his introduced grazing animals are not capable of exact estimation, but in many cases they are very pronounced and distinctive communities have resulted. It is convenient to classify these as induced communities as does Cockayne.[11]

The terminology here employed calls for some explanation. It has been usual for non-Queenslanders to describe the *Eucalyptus*-dominant communities of Queensland as "savannah" (savanna), or more frequently "savannah woodland," as for example Prescott,[31] and Domin[15] ("savannenwälder").

In Queensland they are commonly referred to as eucalyptus forest, or, particularly if other tree species are important, as "open forest," or simply "forest." The first has been employed by Warming.[38] The grasslands have been variously described as "savannah," "grass steppe," "open grassland," "downs," and "plains."

Owing to the loose application of the term "savannah," both in Australia and elsewhere, it has seemed advisable to employ the terms "eucalyptus forest" to those communities dominated by species of that genus and in which the trees are fairly close together, and "eucalyptus parkland" to those in which the trees are more scattered. Although in such eucalyptus forests grasses are always prominent, they rarely bear any relationship to neighbouring grassland species.

The use of the term savannah is here restricted to a type of grass-dominant community with scattered shrubby trees usually of a stunted appearance. There appears sufficient precedent for such usage, though it includes part of Prescott's "sclerophyll scrub."

Scrub is here used in its generally accepted sense of a closed association of small trees or tall shrubs, and frequently consists of pure stands of individual species. In many cases, however, some of these scrubs should be described rather as forests if tree height be any criterion. However, for the present at any rate, the local usage will be followed in this respect.

The descriptive names of the individual communities have been selected, so far as freedom from ambiguity permitted, from terms in common use. Where practicable also, vernacular names of plants have been introduced, but it must be stressed that many of these are used very loosely, and variations in spelling may be found. Apparently many of the incongruities present in McTaggart[25] are the result of an attempt to identify plants by means of local names alone.

The chief community types recognised as occurring in our area can be arbitrarily arranged as follows:—

A. Primitive Communities.
- I. Grasslands.
- II. *Triodia* communities ("Spinifex country").
- III. Regional Forests.
- IV. Scrubs.
- V. Fringing Forests and Scrubs.
- VI. Channel Country.
- VII. Communities dominated by Chenopodiaceae (Saltbush, &c.).
- VIII. Communities of the Sandhills.
- IX. Miscellaneous communities of the more arid regions.
- X. Miscellaneous communities of the Great Dividing Range.

B. Induced Communities.
- XI. Artificial grassland.
- XII. Communities of the Bore-drains.
- XIII. Communities of the Stock Routes and Reserves.
- XIV. Introduced species.

A. PRIMITIVE COMMUNITIES.

Strictly speaking, primitive communities are communities which have not been affected by and are not the result of man's action. All, or nearly all, primitive communities have been modified in some way or other, and owing to the practical impossibility of determining exactly how much modification has taken place, it has been found convenient to group together here those communities which have not been profoundly affected by man's activity.

The importance of railway enclosures and cemetery reserves in arriving at a concept of truly primitive vegetation is discussed below.

I. Grasslands.

In grasslands tall woody plants are nearly or quite absent. Trees, when present, are mostly stunted, usually very scattered, but sometimes numerous enough to produce parkland.

According to the dominant genus the grasslands fall into three well-marked groups:—

1. Blue grass country with *Dichanthium sericeum* (blue grass) dominant.
2. Mitchell grass country with *Astrebla* spp. (Mitchell grasses) dominant.
3. *Triodia* grasslands, which are more conveniently described below.

The Blue-grass Grasslands (fig. 2).

These are characteristic of the better rainfall areas and the soil is usually a black earth. The grasses are tufted species, the tufts being very leafy, fairly close together, and not very large. The more prominent species are less fibrous and shorter lived than the dominant species of the other grasslands. They are numerous and frequently two or more are co-dominant. The most characteristic are the blue grass (*Dichanthium sericeum* and certain closely allied forms), *Bothriochloa erianthoides* (satin top, silver top), *Paspalidium globoideum* (shot

grass, sago grass, tapioca grass), *Panicum decompositum, P. queenslandicum, Digitaria divaricatissima* (all known as star grass, a term also applied to *Chloris* spp.), and *Thellungia advena* (water grass). Other characteristic plants are *Ixiolaena brevicompta,* generally known as "chamomile" and highly esteemed as a fodder plant, *Caspedia uniflora,. Sida pleiantha* and other species, various legumes such as species of *Indigofera* and *Neptunia,* and others.

Two climatic subtypes occur. The southern zone lies chiefly in the Darling Downs district and lies beyond the scope of the present paper. With a pronounced winter rainfall, the genera *Danthonia* and *Stipa* with *Aristida leptopoda* are important. *Themeda avenacea* is also important in places. This species, though widespread, elsewhere rarely occurs in grassland.

In the northern zone *Stipa* and *Danthonia* are absent, and *Astrebla* and *Iseilema* occur, usually sparsely and frequently as the result of invasion. *Aristida leptopoda* is common in places and is alleged to have been introduced by stock from further south, whence its usual vernacular name of "Darling Downs spear grass."

On small bare places are to be found such species as *Brachyachne convergens* and *B. tenella, Enneapogon nigricans* ("fluffy top" is one name in common use), *Tragus biflorus,* and a few other grasses, together with *Portulaca intraterranea* (pigweed), *Trianthema crystallina, Tribulus terrestris, Atriplex semibaccata, Euphorbia Drummondii* (caustic or caustic weed), and *Boerhaavia diffusa* (tahvine). *Chenopodium album** (fat hen) is seasonally prominent, sometimes attaining considerable height.

Degradation of the pasture gradually results in the progressive dominance of the comparatively worthless *Panicum decompositum,* often with *Aristida leptopoda* common.

For the most part blue grass country is treeless (except along watercourses), but its continuity is broken by patches of forest on differing soils, and occasional trees stray into the grassland. These are principally *Eucalyptus populifolia* (box), *E. melanophloia* (ironbark), and *E. terminalis.* The weeping myall (*Acacia pendula*) sometimes occurs chiefly on the forest edge, usually as copses (scrubs). Isolated brigalow (*Acacia harpophylla*) scrubs are not uncommon.

The Mitchell grass Grasslands (figs. 3, 4, 6-9).

Mitchell grass dominates very large areas of plains and rolling downs on soils belonging to the group of grey and brown soils. Considerable areas also occupy old alluviums, which are usually strongly silty. Over a very large part of these plains and downs trees are completely absent except along the deeper watercourses. *Acacia farnesiana* (mimosa or prickly acacia) occurs as scattered compact shrubs of 6-8 feet or so along shallow gullies in the north and north-east.

Over much of the country, however, trees are more or less prominent. They are confined almost entirely to the following species: —*Atalaya hemiglauca* (whitewood), *Ventilago viminalis* (vine tree or supple jack), *Flindersia maculosa* (leopard-wood), *Owenia acidula* (emu-apple or gruie), *Apophyllum anomalum* (mustard bush), *Acacia Cambagei* (gidgea, gidgee, gidyea, gidya, giddia, or gidiya), *A. homalophylla* (boree), and *A. pendula* (myall or weeping myall).

Of these whitewood, vine-tree, gidgea, and boree are widely spread, while emu-apple, leopard-wood, and mustard bush occur chiefly in such

* Introduced.

places as the crests of those undulations as have a shallow slightly sandy soil. Myall occurs only towards the south-east, and usually on the edge of grassland as described above. All with the exception of gidgea are useful fodder plants, and even this is eaten.

Whitewood is usually a small tree with grey scarcely fissured bark, and an open somewhat irregular crown of pinnate glaucous leaves. In its very young stages the leaves are very coarse and frequently simple. Under certain conditions, particularly when in flower or young fruit, it may be poisonous, but nowhere in our area is walkabout produced as in the far north-west of the State or in the Kimberley district of West Australia. (Murnane and Ewart.[27])

Vine-tree commences life as a cluster of two or more slender stems which later on intertwine to produce the characteristic trunk-system. The crown is usually dense and weeping, of a dark dull green, but small stunted shrubs are common. It is one of the best forage trees.

Boree is mostly a straight tree with a rather light grey somewhat fissured bark, and a rather sparse somewhat obovate crown composed of numerous crownlets of glaucous narrow pendulous phyllodia.

Gidgea is usually a dull glaucous bushy-headed tree with dark grey fissured bark, but occasionally approaches boree in appearance. The flowers always, and the phyllodia when moist, have a powerful somewhat foetid odour.

Leopard-wood commences life as a divaricate prickly shrub, from the centre of which arises the characteristic slender trunk with its smooth mottled grey and cream-coloured bark and rather dense oblong crown of small simple scented leaves.

Mustard-bush, when mature, has a comparatively short, sometimes irregular, trunk with dark grey hard furrowed bark, and a dense rounded leafless crown of long, rather rigid, but more or less pendulous, somewhat flexuose dull green branchlets. The spiny stipules prominent in the younger plants are usually small or rudimentary.

The emu-apple is a small shapely tree with a very dense rich-green crown of pinnate leaves and a strong tendency to sucker.

The characteristic grasses are the four species of *Astrebla* (Mitchell grasses), *Eulalia fulva* (brown top, sugar grass), and *Eragrostis setifolia* (never-fail). *Dichanthium sericeum* (blue grass) occurs over the areas of better rainfall, and is fairly common at times.

These species of *Astrebla, Eulalia*, and *Eragrostis* are all long-lived species with short thick branching rhizomes closely covered by shining horny scales. They form dense tussocks, withstand heavy grazing, have the ability to sprout from the lower nodes, and respond very rapidly to rain. The *Eragrostis* is the least palatable.

In normal grassland these tussocks are spaced from 1½ to 3 feet apart, rarely closer.

In *Astrebla*, the older leaves are flat and more or less recurved when dry, and of a characteristic whitish colour. When in full vigour they are usually of a rich green, though a tendency to glaucousness is shown in *A. pectinata* and *A. elymoides*. They flower freely, but seed sometimes fails to mature, partly due to insect attack, and perhaps due partly to local climatic variations. A smut, *Tilletia* sp. aff. *T. fulva*.

has been found near Dirranbandi. The awned spikelets are readily transported by stock. Contrary to general opinion the grain germinates freely and under a variety of conditions. The young seedlings are, however, readily torn up by stock. As a rule the old plants are not grazed until the other plants of the pasture are eaten.

The species vary somewhat in habit. *A. squarrosa* (bull mitchell) and *A. pectinata* (barley mitchell) produce erect-growing tufts with comparatively short, dense, bristly inflorescences, the former attaining 4-6 feet, and green, the latter mostly about 2 feet, and somewhat glaucous. Distinct races are included in the other species, but both are more spreading in habit. The leaves of *A. elymoides* (weeping mitchell or hoop mitchell) are frequently slightly glaucous and dry off before those of any other species. The flowering culms are long, very slender, and weakly spreading or strongly flexuose. *A. lappacea* (common mitchell or curly mitchell, sometimes also downs mitchell) is rather intermediate in habit with a stouter inflorescence.* The leaves show a more pronounced tendency to curl when dry than in the other species.

Eulalia fulva forms erect, leafy tufts of varying height with a tawny or bright-brown inflorescence of two or more erect or slightly oblique closely appressed densely but shortly hairy racemes. The old leaves are flat and reddish-brown in colour.

Eragrostis setifolia forms rather compact tufts rarely attaining 2 feet, with rigid inrolled sometimes slightly pungent leaves.

Ungrazed vigorous areas of the more spreading species may show an almost complete though undulating cover when viewed from a short distance, but otherwise the tufts are very distinct. Under suitable conditions the spaces between the tufts are closely occupied by a rich variety of short-lived perennials or facultative perennials and ephemerals belonging to a variety of families, chiefly grasses, *Chenopodiaceae, Malvaceae, Leguminoseae,* and *Compositae.*

The chief grasses are *Iseilema* spp. (Flinders grasses),† *Panicum Whitei* (pepper grass or pigeon grass), *P. decompositum* (variously but inconstantly known as star grass, windmill grass, and sometimes as neverfail), *Eriochloa* spp. (sometimes known as summer grass), *Chloris divaricata, C. truncata* (both known as star grass), *Aristida latifolia* (feather top), with *A. leptopoda* and other spp. in the south, *Enneapogon avenaceus, E. Lindleyanus, E. nigricans* (white top, fluffy top), *Dactyloctenium radulans* (button grass), *Sporobolus australasicus, S. Caroli* (both known as fairy grass), and *S. actinocladus.*

Of the chenopods the most important are *Salsola australis* (roly poly), *Atriplex* spp. (salt bushes and salt weeds), *Bassia* spp. (goat-head, prickly bush or roly poly, red and other burrs, &c.), *Kochia coronata, Threlkeldia proceriflora,* and the shrubby *Chenopodium auricomum* (blue bush), and *Rhagodia parabolica.*

Among the legumes the following are important:—*Sesbania Benthamiana* (sesbania or sesbania pea), *Rhynchosia minima, Crotolaria dissitiflora, Glycine falcata, Psoralea graveolens, P. cinerea, Indigofera* spp., *Aeschynomene indica, Neptunia* spp., and *Cassia* spp. (including some shrubby spp.).

* One race approaches *C. elymoides* rather closely.

† These have been discussed in a previous paper (5).

The *Malvaceae* are numerous in individuals belonging to the genera *Abutilon* (chiefly *A. malvifolium*), *Sida* (*S. virgata, S. corrugata,* and others*), *Hibiscus* (*H. trionum, H. brachysiphonius, H. ficulneus,* this last being known as wild rosella), and *Malvastrum spicatum.*

Some of the composites are *Calotis hispidula* (martagai, bogan flea, or bindey-i), *C. scapigera, C. lappulacea,* and other spp. (bindey-i, daisy burr), *Brachycome* spp., *Helipterum* spp., *Rutidosis helichrysoides, Gnaphalium indicum,* &c.

Among other families the following spp. are important:—*Trianthema crystallina* (bastard pigweed), *T. decandra, Portulaca* spp. (pigweed), *Amaranthus Mitchellii* (bogabri, smooth roly poly), *Corchorus trilocularis* and spp., *Euphorbia Drummondii* (caustic or caustic creeper) and spp., *Daucus brachiatus* (carrot), *Plantago varia* (lamb's tongue), *Solanum esuriale* (wild tomato), *Ipomoea Brassii* (cow-vine) and spp., *Boerhaavia diffusa* (tahvine), and *Eremophila maculata* (native fuschia—a low shrub).

The annual and sub-perennial vegetation is of the greatest importance, for upon its nature depends the value of the pasture. The great value of Mitchell grass lies not so much upon any high nutritional qualities it possesses, but upon the fact that the plants do not break up when dry, and while in that state are still acceptable to stock, and retain sufficient nutriment to carry stock long after the other plants have been eaten off or in times when drought has hindered the development of other plants. Such a pasture is in reality a paddock of standing hay. In mixed pasture it is usual for Mitchell grass not to be grazed until the other members of the pasture have been eaten, and indeed, there is sufficient evidence to show that in some localities, at least, pure Mitchell grass has little value for fattening.

The plants other than grasses are popularly referred to under the collective term ''herbage,'' and the broad distinction is useful.

The shorter-lived vegetation varies tremendously in composition, and several minor communities are distinguishable. The nature of these is a reflection, not only of minor variations of surface and drainage, but very largely of ''season'' and of stocking in previous years. These communities can thus be designated ''indicator communities.'' Incidence of rainfall also plays a very big part in determining the communities, summer and early autumn rains tending to produce grass growth, while winter rains usually produce a preponderance of herbage. But there is no absolute rule, and in the more arid parts the actual amount of rain that falls seems to be the most important factor. Light rain in winter frequently results in the so-called ''blackening'' of grass, rendering it brittle and unpalatable. (Blake[5 6]).

The *Astrebla* grasslands are by no means homogeneous, even when certain local variations are neglected. There are several well-marked types which may be arranged in three groups characterised by differences in soil type, dominant species of *Astrebla,* nature of the chenopods if present, reaction to stocking, and other features. Probably when the floristic detail has been adequately studied, it will be found that these types can be defined in other terms as well, and perhaps further subdivided.

* Some are undescribed.

1. The Ashy Downs Group.—On the typical "ashy downs" which occupy the north and east portions of the Mitchell grass communities (fig. 3), the soil is grey to dark-grey in colour, very fine-grained, friable, and nearly free of gravel. When dry it opens out in large deep cracks, and swells considerably when wet. Trees are usually absent; when present they are restricted to sparsely scattered, more or less stunted whitewood or vine tree, or occasional shrubs of *Acacia sentis* (gunda-bluie). *Astrebla pectinata* is rare or absent, chenopods are restricted to *Salsola,* though *Atriplex Muelleri* occurs as a product of degradation, and *Iseilema* is well represented, both in species and individuals. In most years herbage is comparatively scanty.

On badly-drained areas *A. squarrosa* is the dominant species. This is the "bull mitchell country" so characteristic of large areas in the neighbourhood of Nelia, Nonda, and Julia Creek. *A. elymoides* (weeping mitchell), *Eulalia fulva* (brown top), *Chenopodium auricomum* (blue bush), and other plants of damp places such as *Iseilema convexum, I. calvum* (Flinders grasses), *Eragrostis leptocarpa, Cyperus Gilesii, Sesbania Benthamiana* (sesbania), *Neptunia* spp., and *Minuria integerrima* are associated.

On better drained country the characteristic species are *Astrebla lappacea* (common mitchell) and *A. elymoides* (weeping mitchell) often as alternes. On the rolling downs this is the characteristic community, frequently with small bull mitchell communities in the depressions.

Related to the true ashy downs are areas to the north and north-west of our area, but represented in part by the country near Camooweal. Bull mitchell is the characteristic grass, but the other species may all be present in some proportion. A large glaucous species of *Eriachne* occupies the smaller channels. To the north, towards the Gulf of Carpentaria, other communities dominated by bull mitchell grass occur, but they lie without the scope of the present paper. All these communities have one character in common; the dry grass does not support stock in the same way as it does further south.

2. A south-eastern development, which may be regarded as the extension of the ashy downs to the regions of higher or more evenly distributed rainfall. In places a gradation to blue grass is shown, a feature which will be dealt with in more detail when discussing the relationships of the grasslands.

The soil is frequently a black earth, and the characteristic species are *Astrebla lappacea, A. elymoides, Aristida leptopoda,* an undescribed species allied to *A. muricata, Thellungia advena, Panicum queenslandicum, Paspalidium globoideum,* and other grasses, while *Calotis scapigera, Brachycome* spp., and *Sida pleiantha* are among the herbage plants. *Iseilema* is represented chiefly by *I. membranaceum,* though *I. vaginiflorum* occurs in places. In depressions *Panicum prolutum, Eragrostis parviflora, E. leptocarpa, Cyperus bifax,* and an undescribed species allied to *C. Gilesii* and *C. fulvus* are prominent.

Myall, either as scattered trees or "scrubs," occurs in places, but in many instances has been destroyed.

On the basalt tableland to the north and north-west of Hughenden a community of a very similar grass composition occurs, though *Iseilema* is represented also by the northern *I. Windersii.*

There is a type of community botanically related to both ashy downs and gravelly downs which is to be found on areas of old alluvium near Cunnamulla and elsewhere (fig. 4). The soils are sometimes somewhat yellowish in colour, claypans are frequent, but though chenopods are frequent at times the plant composition is rather of the ashy downs. It has been described by Francis.[19]

3. The Gravelly Downs group (figs. 6-9).—The gravelly downs (also called stony downs and pebbly downs) takes its name from the fact that the soil, a yellowish brown to light chestnut clay silt or clay loam (rarely somewhat sandy), is invariably associated with gidgea gravel, and is more compact than that of typical ashy downs. Towards the South Australian border, the gravelly downs grade imperceptibly into Sturt's Stony Desert.

A characteristic feature, particularly of the more arid parts, is the occurrence of small, shallow depressions, comparatively free from gravel, which are known as "crab-holes" or "gilgais."

The dominant grass is *Astrebla pectinata* (barley mitchell). In the less arid parts the other species are usually associated to some extent, and *A. lappacea* is often locally dominant, while it is to be found occasionally in the drier parts. Annual species of *Bassia* and *Atriplex* are very characteristic of the gravelly downs, sometimes mixing freely with the grasses and other herbage, sometimes forming definite communities as described below and then alternating with portions of the grass community (fig. 7). Within the gravelly downs as thus defined, three broad trends may be recognised. In two of these there is a fairly close and regular ground cover, and the bull mitchell community above described occurs in some form or other in depressions (fig. 8). In one trend *Acacia Cambagei* (gidgea) is prominent, either as the scattered scrubs described below, or as more scattered trees (gidgea downs). In the other trend boree (*Acacia homalophylla*) appears as scattered trees tending to form a parkland (boree downs). Very frequently there is an intermediate state (gidgea-boree downs) (fig. 9). Except for an isolated area near Hughenden, where chenopods (except *Salsola*) are rare, the characteristic species of *Bassia* are *B. lanicuspis* on the gidgea downs, and *B. anisacanthoides* and *B. echinopsila* on the boree downs.

The third trend is found in the area within the 10-inch isohyet. The vegetation tends to restrict itself to the margins of the crab-holes and along gullies, while large areas are at times quite devoid of plant life. The characteristic *Bassia* is a form closely allied to *B. divaricata* and *Atriplex Muelleri,* so common elsewhere, is rare or absent. A typical crab-hole near Haddon's Corner (fig. 6) carries at its margin *Astrebla pectinata, Sporobolus actinocladus, Panicum decompositum, Bassia* sp. aff. *B. divaricata, Atriplex spongiosa,* and *A. conduplicata.* Except for a comparatively small area to the north of Birdsville (fig. 12), where occur scattered plants of the very peculiar almost pine-like "waddy" *Acacia Peuce,* with its exceptionally hard and heavy wood, trees are absent or represented by occasional shrubs of *Acacia tetragonophylla* (dead finish) or *Cassia* spp. At the head of gullies in the low ridges an occasional shrub of the handsome *Eremophila Latrobei* occurs, to be replaced lower down by *Acacia cyperophylla* (minaritchie) and still lower down by gidgea. *Acacia cyperophylla* appears to be restricted to the east and south of the Diamantina River, so that between Birdsville and Boulia much of the upper part of the gully is bare of shrubs.

On the little pockets of drift sand among the gibbers in areas adjacent to the Simpson Desert, a varied and interesting plant population frequently occurs. Mitchell grass (the usual *A. pectinata*) may itself occur here, though more frequently the plants are shorter-lived species, such as *Iseilema eremaeum* (restricted apparently to this area), *I. vaginiflorum, Stenopetalum lineare, Goodenia* sp., *Bassia* spp.

II. Triodia Communities (figs. 28-33).

Triodia is a genus of grasses restricted to Australia, and widely known as "spinifex"* or "porcupine grass." From many points of view it is a very interesting group, closely allied to both *Astrebla* and *Danthonia,* but differing widely in habit from nearly all other grasses. The culms are freely branched below, and the plants form dense tussocks, or large somewhat hemispherical hummocks, spiny by reason of spreading, hard, rigid, often rather long, more or less strongly pungent leaves, which are for the most part convolute and apparently terete. The hummocks may attain six feet or more in diameter and four feet in height, though usually they are smaller than this. The flowering culms, borne one to three feet higher, are usually exceedingly numerous, but the flowering period is brief, and appears to be dependent on rainfall. The seedlings commence to branch when very young; old plants frequently die in the centre, the hummocks then assuming an annular or crescentic or even an S-shaped form. The production of stolons is common, but this feature appears to depend to some extent on habitat, and is not constantly specific in nature.

Some species are very viscid, with a strong resinous odour. These produce mostly compact green tufts with less pungent, less rigid, but often longer leaves than is usual in other species, and are rarely stoloniferous. This type is sometimes referred to as "turpentine grass" or "turpentine spinifex."

All species are readily inflammable when green. The less pungent species have a distinct fodder value dependent largely on their extreme resistance to drought and the readiness with which they put forth fresh growth after rain or burning. The grain is an excellent stock food, particularly for cattle and horses. The resin was used by the aborigines in preparing cements. The upturned plants have been used as bed-mattresses. The sand-dwelling species are most important agents in preventing soil-drift.

The genus is widely spread in Queensland, and is to be found occupying a great variety of habitats. The species enter into the formation of several distinct communities, usually referred to collectively as "spinifex country." These communities are usually exceedingly xerophytic in appearance, but curious anomalies occur, chiefly outside our present limits. True trees are nearly always absent, but crooked or gnarled, single- or several-stemmed shrubs or tree-shrubs are not uncommon, particularly species of *Acacia, Hakea,* and *Eucalyptus,* the latter thus partaking of the mallee-form. As pointed out below, gradations to true *Eucalyptus* forest occur, in which *Triodia* is present merely as a member of the ordinary grass-flora of the latter. Occasionally a type of grassland or steppe is produced, in which the species of *Trioda* are the tallest members of the community.

* Not to be confused with the genus *Spinifex.*

In the typical *Triodia* communities, the hummocks of *Triodia* completely dominate the landscape. A complete cover is never attained, though occasionally the edges of the plants are sufficiently close to prevent a person from walking between them with any degree of comfort. Usually, however, the plant masses are much further apart. Between the masses various perennial and numerous annual plants, often small, find a footing. An undescribed creeping species of *Neurachne* is widespread, and is noteworthy from the fact that it is one of the two distinctly creeping grasses indigenous in Western Queensland.

The species of *Triodia* do not as a rule mix, but alternating stands are common. It seems probable that some species are very sensitive to variations in the substratum, but owing to the present chaotic state of the genus it is not possible to discuss these in detail.

The habitats are frequently highly siliceous in nature, either sand or sandstone or acid volcanic rocks, but siliceous limestone and silt beds are also supporters of such communities.

Several well-marked major communities are known, and there occur numerous small or scattered ones in special habitats. The more important are as follows:—

1. The grassland community of the north-west. This is found on undulating siliceous Cambrian limestone east of Camooweal and north-east of Duchess. The surface is stony, and there is scarcely any soil, though in the hollows small patches accumulate which support Mitchell grass, chiefly, if not entirely, bull mitchell. The community is very poorly known. In the Duchess development, *T. pungens* appears to be an important species. The species of the other area are unknown, but at least two are important. Annual plants, such as species of *Enneapogon, Eriachne, Polycarpaea,* &c., are common after rain. *Trichinium* is well represented. The mallee-like *Eucalyptus leucophylla* occurs in places, sometimes as a prominent member of the association. There appears to be a definite gradation to the following.

2. The *Eucalyptus pallidifolia - E. leucophylla - Triodia* community (mountain gum—spinifex country) (fig. 32). This is well developed on the rugged mountainous country of the Cloncurry—Mount Isa district. Except in the valleys where there is a varying depth of fine sandy or loamy soils, reddish in colour, soil is practically absent. The characteristic "trees" are *Eucalyptus pallidifolia* (mountain gum or snapping gum) and *E. leucophylla* (generally, though incorrectly, known as coolibah). The mountain gum usually produces a cluster of two or more rather crooked or spreading rather slender trunks with a pure white smooth bark, and a sparse crown of rather small glaucous leaves. It is specially characteristic of the hills, and is invariably associated with *Triodia*. Its timber is very brittle. *E. leucophylla* is of somewhat similar growth-form, but the bark is a brown or grey shortly fibrous "box" bark, the leaves are longer and the young growth is very glaucous. The species occurs on the low ridges, but is particularly characteristic of the valleys and flats.

Another eucalypt, *E. pruinosa* (silver box, silver-leaved box, silver leaf), occurs near the north and north-eastern edge, but is more characteristic of a very different community to be described in a later paper. It is usually stouter than the preceding species, with a dark grey, rugged, somewhat coarsely-flaky bark, and large rounded

opposite sessile silvery leaves. In the present case it occurs chiefly on lower ground often where *Triodia* tends to be partly replaced by *Aristida.*

Frequently on the more rugged peaks and scarps are to be found isolated trees of *Sterculia australis* (bottle-tree), where it makes a striking spectacle with its very stout, swollen trunk and dense green crown of deciduous leaves.

Other characteristic shrubs and small trees of the community are *Terminalia aridicola, Ficus opposita, Eucalyptus pyrophora* (bloodwood), *Eremophila* sp. nov. (?), *Cassia* spp., and several species of *Acacia,* including the ubiquitous gidgea. *A. costinervis* is the most striking of these. It is a handsome fastigiate shrub with curly, flaky, reddish and grey bark, rich green viscid phyllodia, and when in flower, with a profusion of brilliant yellow spikes.

Several species of *Triodia* occur. Of these *T. pungens* is very abundant over large areas, but on the more precipitous slopes is at least partly replaced by two much more pungent non-stoloniferous species. *Eriachne* is a characteristic genus, and particularly the series of forms described under the names *E. mucronata* and *E. scleranthoides.* In its extreme form the latter is a peculiar grass, forming small dense patches among rocks in the more rugged places. The culms are only a few inches long, but are closely covered by several short slightly recurved rigid pungent, convolute leaves, and a very short inflorescence of one or very few spikelets.

Several plants are viscid, some strongly so. Among the most striking are the abovementioned *Triodia pungens* (some forms only) and *Acacia costinervis,* two smaller species of the same genus, the annual *Polanisia viscosa,* and the following grasses and sedges:— *Eragrostis desertorum, Enneapogon asperatus, Cyperus ixiocarpus, C. Cunninghamii,* and *C. xerophilus.* The latter is associated with *Eriachne scleranthoides.*

Other important species are the glaucous, leafless, bushy or climbing *Sarcostemma australe* (caustic bush or caustic climber), with its cylindrical, somewhat fleshy stems, various species of *Abutilon,* with their handsome lemon-yellow or deeper yellow flowers, which open only at dusk or when well shaded, and close in bright sunlight, an occasional variously coloured *Hibiscus,* numerous species of *Trichinium,* with their dense spikes of hairy flowers of green, pink, crimson, or mauve, the woolly *Scaevola densivestita,* spiny, thick-leaved, and more or less velvety species of *Solanum, Indigofera* spp., *Tephrosia* spp., small species of *Polycarpaea, Euphorbia,* and *Heliotropium,* the widespread annual *Bulbostylis barbata,* and many grasses. The chief of these are (perennials): the lemon-scented *Cymbopogon bombycinus,* a characteristic form of *Themeda australis, Sehima nervosum, Aristida* spp., particularly *A. arenaria, A. longicollis, A. inaequiglumis,* and *A. pruinosa,* the creeping *Neurachne* mentioned above, and the annuals: *Iseilema dolichotrichum, Rottboellia formosa, Schizachyrium* sp., *Paspalidium rarum, Digitaria ctenantha, Enneapogon* spp., *Chloris scariosa, Sporobolus australasicus, Eriachne ciliata, E. pulchella,* and *E. tuberculata.*

3. Extensive *Triodia*—dominant communities are to be found on the hills of Desert Sandstone except in the south and south-east. They occur on the tops of the larger hills, but more particularly over considerable areas on the broken tablelands (figs. 29-31). Small trees are

usually associated, but they may be very scattered. These are usually an *Acacia,* of which gidgea (*A. Cambagei*), lancewood (*Acacia* sp.), and mulga (*A. aneura*) are the most important, though other species also occur. On the lower ground the mallee, *Eucalyptus normantonensis,* is found in some places (fig. 31). Several species of *Triodia* occur, but most, if not all, are undescribed. Usually they form rather large and comparatively widely spaced masses. Between these *Bassia eriacantha, B. lanicuspis, B. tricuspis, B. longicuspis,* and *Kochia Georgei* occur chiefly on the hills. Otherwise there is little difference between the details of the flora of the hills and the shallow valleys between. *Sida* spp., *Abutilon* spp. the woody crucifer *Lepidium strongylophyllum, Trichinium* spp., *Polycarpaea* spp., *Frankenia serpyllifolia,* and a few grasses, including two undescribed species of *Neurachne,* an undescribed *Sporobolus, Aristida arenaria, Brachyachne ciliaris, Brachiaria Gilesii, Paspalidium rarum* and an undescribed species, *Eriachne scleranthoides, E. pulchella,* and *E. tuberculata.*

On Mount Walker, near Hughenden, and probably also on the neighbouring hills, a rather different community occurs more nearly related to parts of the forest country to the east. The *Triodia* is *T. pungens,* and scattered trees of *Eucalyptus Whitei* and *E. pyrophora* occur, together with lancewood, dead finish (*Albizzia basaltica*), and other shrubby plants.

4. The Spinifex Sand-plain of the south-west (fig. 28). On the lateritic sand-plain between Windorah and the South Australian border and to the east of Jundah, a *Triodia*-community covers large areas of country. Over considerable areas shrubs of any kind are absent, but elsewhere more or less scattered small shrubby trees or shrubs are found. Chief among these are a very stunted form of *Eucalyptus papuana,* with its pure white smooth bark and sparse crown of narrow drooping leaves, and *Hakea Ivoryi,* a narrow irregular shrub up to 15 ft., with terete pungent lobes to the pinnate leaves. A bloodwood, *Eucalyptus pyrophora,* and mulga (*Acacia aneura*) are also important, while to the north-east, where the eucalypts assume tree dimensions, the peculiar "desert oak" (*Acacia juncifolia*), with its long terete phyllodia, and an occasional beefwood (*Grevillea striata*) are noticeable. Occasionally, also, almost a parkland effect is produced.

The dominant species of *Triodia* is *T. Basedowii,* and over the greater part at least is the only species. It is a large stoloniferous species, and occurs also on the sandhills of the Simpson Desert. Indeed, the present community may be considered to occur in a modified and disconnected way along the bases of many of these sandhills. So far as is at present known, the associated plants are chiefly grasses of which *Eragrostis eriopoda, Aristida Muelleri, A. arenaria, Neurachne* sp. are most important. Other plants known to occur are *Calandrinia* spp. (parakeelya), *Bassia Cornishiana, Brunonia australis,* and a few composites. The parakeelya is a famous fodder plant with thick fleshy leaves, and stock can live on it for a considerable time without water.

5. There is an ill-defined community developed to the east of Barcaldine, in which *Triodia pungens* and *Eucalyptus papuana* are associated on sand. In many respects it is intermediate between the north-eastern development of the previous community and Eucalyptus forest. Desert oak is generally present. It might be considered as a

very extreme case of the south-western community in which *Triodia pungens* replaces *T. Basedowii*, but it is desirable to draw attention to it by reason of its connection with Eucalyptus forest.

6. Communities of silt-beds. These communities are found in a few places on a fine silt, which is nearly impervious to water. So far as known the area of greatest development, which lies some miles to the east of Barcaldine, appears to be a centre of inland drainage, and water may lie on the surface for a considerable time. The species is allied to *T. irritans*, and forms large masses with stout, excessively rigid and pungent leaves. It is locally known as "porcupine grass," and the community as "porcupine plain." Apart from a few scattered irregular shrubs of *Hakea acacioides* (needlewood), with its pungent terete leaves, and the peculiar diminutive composite *Eriochlamys Behrii*, very little else grows, and the country is almost worthless.

7. The communities of *Triodia Mitchellii* and allied species. Under this heading are arranged those communities in which very viscid species predominate. They appear to be developed no further west than long. 145° 15′ E., roughly a line passing through Burra on the crest of the Dividing Range west of Pentland, and Cunnamulla. *T. Mitchellii* is the most important species.

There are two major trends in the communities. In one of these the characteristic habitat is the rocky crests of the hills in the neighbourhood of Springsure, and of those associated with the Great Dividing Range. In the nature of the numerous eucalypts and ericoid shrubs which are usually present, as well as in a few other features, these communities should be regarded rather as slightly modified forms of the range communities described below.

In the other case a true *Triodia* savannah is formed. Scattered individuals or groups of dwarfed eucalypts are always present, but discontinuously. The habitat is a slightly elevated tract of loose, usually reddish sand. The eucalypts are the irregular white to grey-barked *E. dealbata* to the west of St. George, and stunted *E. melanophloia* to the south of Charleville, in both places accompanied by the characteristic *Angophora melanoxylon*, while in communities lying between Jericho and Barcaldine (fig. 33) these are replaced by the bushy-crowned *E. setosa* (nut-wood), a mallee-form of *E. exserta*, and the widely tolerant *E. erythrophloia*. Several shrubs occur throughout, including the root-parasite *Leptomeria* sp., *Grevillea juncifolia*, *Acacia* spp. (*A. argentea* is a handsome plant of the more northern area), *Olearia* spp., &c. Many of the smaller herbaceous plants occur throughout, and indeed many of these are characteristic of loose sandy places in many parts of the State. The chief species or genera are *Calandrinia* spp., *Stackhousia viminea*, *Goodenia* spp., *Brunonia australis*, several composites belonging to the genera *Calotis*, *Rutidosis*, and *Craspedia*, and numerous grasses, such as *Panicum effusum*, or a closely allied species, *Digitaria Brownei*, *D. ammophila*, *Cymbopogon* spp., *Schizachyrium* sp. nov., *Themeda australis*, numerous spp. of *Aristida*, *Eragrostis eriopoda*, *Eriachne mucronata*, *E. aristidea*, *Neurachne* sp., and a few sedges such as *Fimbristylis Neilsonii* and *Bulbostylis barbata*.

To the west of Pentland, near the upper part of the Great Dividing Range, on shallow sand overlying sandstone, is a community mentioned and figured by Prescott as a "desert scrub." It is in many respects intermediate between a *Triodia* savannah and a range community.

Triodia sp. aff. *T. Mitchellii* is everywhere prominent, usually forming large masses. *Eucalyptus setosa, E. erythrophloia,* shrubby *E. exserta,* stunted *E. melanophloia,* and the peculiar *Melaleuca tamariscina* with its whitish somewhat papery bark and long slender pendulous branchlets with minute almost scale-like, closely set leaves are in more or less prominence, but the characteristic feature is the frequency of numerous species of brilliant-flowered ericoid myrtaceous and leguminous shrubs belonging to such genera as *Calythrix, Thryptomene, Baeckia, Burtonia,* and *Jacksonia.*

III. Regional Forests.

Under this heading are included those forests and related communities which occupy fairly extensive and continuous areas. There are three well-marked types: (1) Eucalyptus forests and parklands; (2) Cypress pine (*Callitris glauca*) forest; and (3) Ooline (*Cadellia pentastylis*) forest.

1. Eucalyptus Forest. The communities dominated by species of *Eucalyptus* have been variously described as pointed out above. Owing to the frequently rather sparsely foliaged crown with its vertical leaves, the forest floor receives a considerable amount of light, and a rich ground vegetation is usually present. In parkland, as here understood, the trees are more widely spaced, without as a rule any other alteration in the community. The genus is represented in Queensland by about 120 species. Of these, about 45 are actually known from our area, though only about 30 are of any real importance, and some of these are restricted to special habitats and have a small range. The discrimination of the species is a difficult task. Species, which may be very similar as herbarium specimens, are often very distinct in the field, while others are almost indistinguishable in the field in the absence of fruit. Besides, some species vary considerably in habit under different conditions. Shrubby states of *E. papuana* and *E. exserta* have already been mentioned. Both may occur as large trees, the former particularly being often very shapely.

Popular classification is based largely on the nature of the bark, and as this is an obvious character which is often correlated with others, it is most useful. Sometimes it affords the readiest means of distinguishing species otherwise closely related.

The chief groups based on this character are:—

(*a*) The Gums, possessing a smooth bark which is shed yearly in thin scales or strips, leaving a very clean, smooth trunk and branches. Usually there is some grey, persistent flaky or scaly bark at the butt. *E. papuana* and *E. pallidifolia* are previously mentioned species belonging to this group.

(*b*) The Boxes, with grey or mealy, fibrous, much interlocked, persistent bark. In this, as in all groups, the small branchlets are almost invariably smooth, the characteristic bark not developing until a later date. *E. populifolia* is the widest spread species of this group.

(*c*) The Ironbarks, with a hard, rough, deeply furrowed, dark grey or black bark more or less impregnated with a dark red kino ("gum"). *E. melanophloia* is a previously mentioned species of this group.

(*d*) The Stringy-barks, possessing a very fibrous, persistent bark. True stringy-barks are scarcely represented in this area.

(*e*) The Bloodwoods. Typical bloodwoods possess a persistent bark, which is somewhat spongy, friable, and more or less distinctly tessellated. They are not common in the interior, where the term is used for closely related species with a distinctly scaly but friable bark on the trunk, but with a gum bark on the branches. An allied type is the "Yellow Jack," with a yellowish, very spongy but more or less friable and tesselated bark.

Sometimes the bark of the upper part of the tree may be different from that on the greater part of the trunk. Such a tree is said to be "half-barked," and is described in such terms as "gum-topped box," and "gum-topped ironbark." The line of demarcation may be very sharp. Sometimes the shed bark of the upper part may remain as long strips hanging from the line of junction.

A few cases of intermediate type are met with, as in the case of *E. pruinosa* and *E. exserta,* where the bark is intermediate in nature between the ironbark and the box.

The seedling leaves of many species are very different in shape, venation, and disposition from the mature leaves. Sometimes there is a pronounced intermediate stage, usually with very large leaves. When damaged by fire or ring-barking, trees sucker freely, and the leaves of such suckers are very similar to those of seedlings. The intermediate stages are, however, passed through more rapidly.

Eucalyptus forest in some form or other occupies extensive areas in Queensland, and definite *Eucalyptus*-prominent communities are to be found almost throughout the State on a variety of soil types. Many of the communities grade into one another, and sharp distinctions are not possible. The extreme forms are, however, so well marked that it is equally impossible to regard the whole development as a single community. It is not feasible in the present paper to deal with the forest areas in detail, and trends only will be indicated. As an initial generalisation it may be stated that ironbarks tend to occupy hilly or stony ground with shallow soil. On the crests of ranges and similar places yellow jacks replace the ironbarks. Boxes are characteristic of flattish or low-lying ground, while gums are commonly to be found on river banks, though a few are restricted to barren rocky hills.

In describing the communities it is convenient to select a central type as it were, point out its prominent features, and then indicate how the other communities differ. This is the box-ironbark (*E. populifolia—E. melanophloia*) community so common in the so-called "desert country" to the east of Barcaldine and elsewhere (fig. 34). The soil is chiefly sandy, mostly lateritic in nature, but podsolised soils occur in places.

E. populifolia (poplar box, or box), usually a straight tree attaining 40 ft. or more, is a typical box with a grey or mealy bark, a rather dense crown obovate in shape, and shining green broadly ovate to broadly lanceolate leaves on long very slender petioles. Near the border of New South Wales some of the smaller branches are gum barked.

E. melanophloia (silver-leaved ironbark, or called simply ironbark, where no other tree of this group is present) has the characteristic bark of the group. In this community it is usually a straight or slightly crooked tree with a rather broadly oblong somewhat dense crown; the leaves are opposite, sessile, rigid, glaucous, and more or less orbicular-ovate, and not very different from the juvenile leaves. The young growth is strongly pruinose.

The two species grow either mixed or in separate alternes, and both enter into other communities. When alternes occur, the ironbark occupies areas of shallower soil. Another species of extensive range frequently enters the community. This is *E. papuana,* variously known as cabbage gum, sugar gum, and pudding gum. When associated with box and ironbark, it forms straight, shapely trees with a fairly compact crown with more or less pendulous branchlets and narrow undulate varnished sap-green or rarely glaucous-green leaves. The species has a typical pure white gum bark, sometimes with a little persistent grey scaly bark at the base, but this is of very irregular development. The leaves are relished by cattle. Other smaller trees and shrubs frequently enter the community, but a definite undergrowth is not formed. Among the important species are *Eremophila Mitchellii* (buddah or sandal-wood), *Petalostigma quadriloculare* (quinine) with its short, dark grey, rough-barked trunk and a broad very dense crown; *Bursaria incana* (prickly pine), usually a narrow small tree more or less spiny; *Albizzia basaltica* (dead finish), usually shrubby, though sometimes assuming tree size; *Capparis Mitchellii* (bumbil), a small tree with a rather large bushy crown; *Pittosporum phillyraeoides* (cattle bush), a slender pale-green tree or tall shrub with a smooth light grey bark and an excellent stock food; *Sterculia diversifolia* (kurrajong), a shapely deciduous tree and another excellent fodder plant; and several species of *Acacia. Carissa lanceolata* (currant bush) forms large prickly bushes; *Parsonsia lanceolata, Pandorea pandorana,* and the prickly *Capparis lasiantha* are characteristic lianas. *Loranthus* spp. parasitises some of the trees, and in places the leafless and rootless parasitic *Cassytha filiformis* covers some of the larger plants with a maze of yellowish filiform stems. The orchid *Cymbidium canaliculatum* is an epiphyte in parts.

The forest floor is dominated by grasses. Chief among these are: *Chrysopogon pallidus, Bothriochloa Ewartiana* (desert mitchell, forest mitchell, desert blue grass), *B. decipiens* (chiefly the luxuriant var. *cloncurrensis*), *Themeda australis* (kangaroo grass), *Sorghum plumosum, Cymbopogon* spp., *Panicum* spp., *Digitaria* spp., *Aristida* spp. (very common), *Enneapogon* spp., *Eragrostis* spp., and *Triodia pungens.* Other plants which are widely spread are: *Erodium cygnorum* (crow foot), *Waltheria americana, Abutilon otocarpum, Ipomoea* spp., *Evolvulus alsinoides, Trichinium alopecuroideum, Bassia convexula* (a slender form), *B. Birchii* (galvanised burr), *Trichodesma zeylanicum, Goodenia* spp., various legumes such as species of *Zornia, Glycine, Crotolaria, Tephrosia, Swainsona,* and *Indigofera,* such composites as *Calotis* spp., *Brachycome* spp., *Helichrysum* spp., *Ixiolaena tomentosa, Craspedia uniflora,* and *Senecio* sp., and a few sedges, of which *Cyperus fulvus, C. conicus, Fimbristylis Neilsonii, F. dichotoma* and allied forms on the drier ground, and *Cyperus concinnus* and *C. iria* on the damper ground are most important.

To the south the ironbark tends to drop out of the community, tending to form separate communities on stony ground with *Eriachne* prominent. Two small trees, not common in the centre, become important. *Geijera parviflora* (wilga) usually forms a handsome plant with a dense broad somewhat weeping crown of narrow pendulous pale somewhat olive-green leaves. There are two races, one of which is freely eaten by stock, and the other ignored. They are apparently inseparable morphologically. *Eremophila Mitchellii* (buddah, sandalwood, false sandalwood) is a smaller single-stemmed shrub with a rounded dense dark dull green crown. It also is eaten by stock, at least in some places. *Heterodendron oleifolium* (boonery or rosewood), myall (*Acacia pendula*), and whitewood (*Atalaya hemiglauca*) occur in places where the soil becomes somewhat clayey. *Triodia* is absent, or is represented in places by *T. Mitchellii. Angophora melanoxylon* (apple) is common in places. The genera *Stipa* and *Danthonia* become prominent, and *Neurachne Mitchelliana* (mulga mitchell) and *Amphibromus* sp. nov. are often important, particularly where mulga (*Acacia aneura*) enters the community. *Paspalidium* spp. are also important, and the distinctive *Sida pedunculata** may be prominent.

To the north *E. populifolia* is replaced by the closely similar *E. Brownii,* which differs chiefly in the narrower adult leaves and differently shaped juvenile leaves. *E. melanophloia* frequently tends to be restricted to the rather stony hillsides, its place in the community being taken by a narrow-leaved species, of which *E. racemosa* is most widely spread. In the neighbourhood of Prairie the smaller, more glaucous *E. Whitei* is important. These ironbarks often occur pure, and *E. racemosa* frequently attains considerable size. Usually it is a well-formed tree with a fairly large crown of narrow pendulous leaves. Other plants are the trees *Grevillea glauca* (nut-wood), *G. parallela* (silky oak), *Melaleuca* spp., an occasional *Terminalia,* the shrub *Astrotricha pterocarpa,* the peculiar fern *Gleichenia microphylla,* the sedge *Fimbristylis cymosa,* and such grasses (chiefly annuals) as *Rottboellia formosa, Schizachyrium* spp., *Elyonurus citreus, Thaumastochloa pubescens, Ectrosia leporina, Brachiaria holosericea,* and *Arundinella setosa. Bothriochloa pertusa* is known from the far north-east corner, and *Aristida hygrometrica* occurs along the northern edge. Both these species are very characteristic of the communities further north.

Two other eucalypts are prominent in the central and northern areas. These are the bloodwood *E. erythrophloia* and the yellow jack *E. similis.* They tend to form separate communities on areas of loose reddish sand. The bloodwood tends to form an open parkland, and its association with *Triodia Mitchellii* has already been described. Sometimes, however, the ground vegetation is that characteristic of the yellow-jack community. The yellow jack usually forms fairly large spreading trees, fairly close together, and between them is a dense growth of typical loose-sand grasses—*Aristida* spp. *Perotis rara, Triraphis mollis, Enneapogon* sp., and others. Particularly in the central parts *Aristida sciuroides* is very prominent. Sometimes exceeding 6 feet and rarely shorter than 5 feet, the species forms close tufts of slightly branched, erect slender culms with long, narrow, gracefully inclined or weeping inflorescences.

* *Sida pedunculata.* A. Cunn., not of Domin.

Associated with the steeply undulating country of the Drummond Range, and also further north and south, is a parkland of a narrow-leaved ironbark (*Eucalyptus racemosa,* at least in part) with *E. erythrophloia* and *E. melanophloia* in varying proportions. The grasses appear to be chiefly kangaroo grass (*Themeda australis*) and black spear (*Heteropogon contortus*).

In the hilly country near Springsure and the Carnarvon Range the handsome but poisonous *Macrozamia Moorei* (zamia) is frequent.

2. Cypress Pine Forest.—The chief species is *Callitris glauca,* which ideally is a handsome, conical, more or less glaucous tree, sometimes of considerable size, sometimes small. Frequently it is more or less broken. The community varies from forest to parkland, and almost invariably is developed on loose, pale-coloured sand. Transitions to Eucalyptus forest (box-ironbark) are common. *Triraphis mollis, Perotis rara, Nicotiana* spp. (wild tobacco), *Abutilon* spp., *Sida* spp., are common plants, but sometimes the vegetation is much richer with *Aristida* spp., *Digitaria* spp., *Panicum effusum,* or an allied sp., *Sorghum plumosum, Fimbristylis Neilsonii, Bulbostylis barbata, Clematis microphylla,* and others.

3. Ooline Forest.—Ooline (*Cadellia pentastylis*) sometimes at least forms a close forest of fairly tall trees, which in appearance is not unlike rainforest. Lianas and epiphytes, except algae, lichens, and mosses, are, however, absent. The dominant and sometimes the only tall tree is the ooline itself, with a dense crown of deep-green leaves. A tall acacia (*A. aneura*) is sometimes present as isolated trees, sometimes forming alternes; *Eucalyptus pillagaensis,* a slender gum-topped box, is occasional, as also are other species. There is a distinct second story, in which *Acalypha nemorum* is most prominent as a dense shrub of 4-5 feet, with small leaves, dark green above paler below. With it is associated a large, massively shrubby, strongly glaucous species of *Rhagodia,* the shrubby *Notelaea punctata,* the shrubby grasses *Stipa ramossissima* (up to 5 feet), *Eragrostis megalosperma,* and *"Panicum" uncinulatum** (2-3 feet). Other plants include species of *Olearia, Sida, Abutilon, Nyssanthes,* and *Dodonaea,* the fern *Cheilanthes, Paspalidium, Stipa, Eragrostis leptostachya,* and other spp., the peculiar diffuse *Calyptochloa gracillima* with cleistogamous spikelets hidden in the base of the leaf-sheaths, *Chloris unispicea, Cyperus gracilis,* and *Carex inversa* (a form or very closely allied species).

This is a most interesting community with a curious assemblage of species. In many ways, both in aspect and composition, it recalls certain coastal communities. The community is known to me only from the development on a low ridge (altitude, 1,600 feet approximately) about 20 miles west of Mitchell on a greyish, gravelly silt loam. On removal of the forest large tussocks of *Aristida ramosa* var. and small ones of *A. caput-medusae,* together with a rather small, densely tufted *Paspalidium* and other plants, take possession.

Other communities are said to occur in similar circumstances to the south of Morven.

* This is not a true *Panicum,* but its true genus is still uncertain.

According to Jensen[23] ooline occurs associated with other species in brigalow scrub to the east of our area.

IV. Scrubs.

Scrubs are widespread in Western Queensland, and while in many parts they possess a varied composition, over most of our area they consist of nearly pure stands of some species of *Acacia,* with or without a definite ground vegetation. The scrubs may be of large extent or they may occur scattered through forest and grassland, sometimes along watercourses. In such cases their boundaries are often sharply marked. Frequently a nearly complete canopy is produced; at other times the individuals are more scattered. To the eastward some of the scrubs attain forest size.

The genus *Acacia* is represented in Queensland by well over 120 species, the great majority of which possess no true leaves except in the seedling stage. The functions of the leaves are carried out by phyllodes —the enlarged, usually flattened, often broad petiole—which vary considerably in size, shape, and nervature in different species, but is by no means constant on the same plant. The flowers are small, usually yellow or cream, and borne in variously arranged heads or spikes.

As in the case of *Eucalyptus,* classification is most difficult, but presents greater problems than in that genus. The chief characters relied upon are the presence or absence of leaves, the capitate or spicate nature of the inflorescence, the shape and nervature of the phyllodes, and the characters of pod, seed, and funicle. Owing to the very erratic nature of the flowering period of most species, flowers and particularly pods of many forms are rarely met with, and even yet the taxonomic status of some widely spread forms is quite uncertain.

The differences in habit are enormous, some species being low undershrubs, others being tall trees, while many types of branching occur. Some species are viscid. The bark varies considerably, but in a few species only is it sufficiently characteristic to be of practical importance.

Several forms have received popular names frequently of aboriginal origin, and while some are of local importance only, in many cases these names are most useful in community-description.

The most important scrub-forming species are Gidgea, Lancewood, Mulga and Bendee, Minaritchie, and Brigalow.

Gidgea (*A. Cambagei*) has been described previously. Indeed, it is difficult to treat of most communities without mentioning it, for of all trees and shrubs in Western Queensland the gidgea enjoys the widest range of habitats. Though generally distinctive enough in the field, it occasionally approaches boree (*A. homalophylla*) in appearance, while in the herbarium the two species are scarcely separable, and for a very long time were treated as one in scientific literature.

In the basin of the Georgina River, in its middle part, gidgea is the name of the somewhat similar but usually more gnarled *A. Georginae.*

Lancewood is the name applied to a group of species of similar growth form and habitat requirements, and of which *A. Shirleyi* appears to be the most common. Others have not yet been identified. The dull-coloured crown of numerous rather pendulous long narrow phyllodes is borne on a fairly straight trunk, sometimes tall, with a grey fissured but somewhat flaky bark and numerous inclined rather straight branches.

Mulga and Bendee at present appear to represent different states of the very variable species, *A. aneura.* Typical mulga possesses a trunk, sometimes very short, with a compact slightly fissured or nearly smooth bark. The main branches are fairly numerous, are oblique, and the secondary and other branches tend to be horizontal, so that the glaucous phyllodes appear to be arranged in tiers. The phyllodes are very variable in size and shape. Several types are recognised depending on size of plant ("dwarf mulga" and "tree mulga"), shape of phyllode ("narrow-leaved mulga," "broad-leaved mulga," &c.), and palatability to stock. Some forms are readily and even greedily eaten, others are avoided when possible. "Red mulga" is *A. cyperophylla* below.

Bendee is used in two senses. It is mostly used to designate a tall form usually with an irregularly furrowed trunk, and less strongly glaucous crown. This form is frequent in the south-east in the Eucalyptus forest on stony ground, either as scrubs or perhaps more frequently as scattered trees. In many places the names mulga and bendee appear to be used indiscriminately.

In the more arid districts, however, "bendee" appears to designate a stunted trunkless form, also growing on barren ridges, often with no other vegetation whatsoever. This, however, appears to be a distinct though undetermined species.

A. brachystachya is also called mulga.

Minaritchie is the name applied to at least two species with a characteristic curly-flaky bark, grey on the outside, pinkish within. One of these is *A. cyperophylla* with characteristic long sub-terete phyllodes arranged in a graceful bushy crown. More particularly in South Australia it is also known as "red mulga," and is considered an excellent stock feed. The other is an undetermined and possibly undescribed species with entirely different botanical characters.

Brigalow (*A. harpophylla*) is a small or large tree with a hard dark-grey or black furrowed bark, and a very dense rounded glaucous crown of rather large strongly falcate phyllodes. It suckers freely from the roots, and almost invariably occurs in scrubs. Like other species of *Acacia* it is parasitised by *Loranthus Quandang,* often very freely.

Gidgea Scrubs (figs. 10, 11, 17).—These occasionally occur in Eucalyptus forest, and on claypans, and are frequently scattered over the less arid parts of the gravelly downs. In the more arid regions they are to be found in places as fringing scrubs along the channels (fig. 11). Big developments of scrub, sometimes rather open, occur on and between the Desert Sandstone hills and tablelands. Gradations between scrub and grassland are common. The characteristic associated plants of typical scrub are *Chenopodiaceae* (*Bassia longicuspis, B. tricuspis, B. divaricata, B. echinopsila, B. lanicuspis,* the peculiar foetid *Chenopodium rhadinostachyum,* and other species of that genus, the shrubby *Kochia Georgei* and occasionally other spp., *Atriplex* spp.), *Tetragonia expansa* (wild spinach), large-flowered spp. of *Abutilon* such as *A.*

Mitchellii and *A. calliphyllum, Trichinium nobile* with its large mauve-grey inflorescence, and a few other spp., and other plants. Near the Wilson River the *Bassia* population is very varied, and though *B. longicuspis* and *B. tricuspis* are absent, *B. intricata, B. patenticuspis,* and *B. decurrens* are common. In some places *Sarcostomma australe,* occurring as a climber is prominent.

On destroying gidgea a rich herbaceous vegetation usually results, with an abundance of grasses, but according to some reports this is not permanent. In Mitchell grass country, however, the mitchell grass may take possession.

The details of the communities of *Acacia Georginae* are scarcely known. The soil in the area studied is a light brown silt loam. *Eremophila maculata* (fuchsia), *Cassia* spp., *Atriplex* spp., *Ehretia salicina,* and certain widespread annuals are known, but at the time of my only visit the country was badly drought-stricken and very little ground vegetation was recognisable. Possibly several of the plants recorded by Bailey[2] for the Georgina River find their home with the gidgea. For a very long time this community has had a bad reputation of being very deadly to cud-chewing animals at certain times of the year. A hypothetical explanation of this long-known mysterious poison was put forward by Finnemore[17] in which it is claimed that the pods contain a substance which in association with fuchsia liberates prussic acid from the latter. As a matter of fact, a saponin or closely related substance is present in the young leaves and pods of the gidgea but is absent from the old leaves, and this may be the actual cause of the deaths. Field observations seem to support this view, but the subject cannot be discussed here.

The Lancewood Scrubs.—These are found chiefly on the more rugged slopes or tablelands of sandstone connected with the Great Divide and in similar situations elsewhere, such as Mount Walker near Hughenden, to the south-west of Winton, west of Eromanga, and to the east of Eulo. The forest-floor is often littered with fallen branches, and there is very little ground vegetation. In the more western areas the lancewood seems to be a local replacement of gidgea, and what vegetation there is consists of scattered individuals of species characteristic of gidgea scrub. *Eremophila* sp. aff. *E. Latrobei* is frequently present as a handsome shrub of 4-5 feet. In the eastern development scattered plants of the suffrutescent grass *Cleistochloa subjuncea* may occur as plants of 1-1½ feet.

Mulga Scrubs (figs. 18-20).—Mulga scrub in some form or other is found over extensive areas in Western Queensland. It forms a most valuable reserve fodder in times of drought. If the plant is not cut down entirely, but pruned so that a leading branch is left, it readily recovers, and an almost constant supply is assured. Complete lopping, however, destroys the plant, and in areas where this has been done a large part of the vegetation has been destroyed, and soil drift has become locally serious. Figs. 19 and 20 illustrate the differences. Generally speaking the plants decrease in size westward. In the east mulga scrub grades almost imperceptibly into Eucalyptus forest. In the south-west open or partly open patches often occur. Whether these are natural or have been induced is difficult to say. It seems likely that some at least are induced. Clapyans also occur.

Apart from the communities of the spinifex sand-plains and the sand-hills in which mulga is important and which are discussed elsewhere, there are three distinct habitats for mulga scrubs. The first is

the reddish fine sandy soil mentioned above, with extensions further east. The second is reddish "iron-shot loam" (silty clay with fine gravel) of apparently lateritic origin, as for example between Quilpie and Windorah. The third is the desert sandstone hills and the more or less broken country between which often is intermediate in character between the hills and the second type. With the exception of the actual hills these three types are frequently referred to as "red country."

In the neighbourhood of Charleville, for instance, box (*Eucalyptus populifolia*), ironbark (*E. melanophloia*), and ironwood (*Acacia excelsa*) occur in the community as scattered plants, but further west they are replaced by various *Myoporaceae* belonging to the genera *Myoporum* (*M. deserti,* the ellangowan, a powerful poison) and *Eremophila,* of which *E. Latrobei, E. Dalyana, E. Freelingii,* and *E. Gilesii* are the chief. The bloodwood (*E. pyrophora*), beefwood (*Grevillea striata*), and kurrajong (*Sterculia diversifolia*) are scattered through the communities. Alternes with gidgea are common in places, while on some of the low stony ridges the mulga is replaced by the low bendee. *Eucalyptus Thozetiana* (mountain yapunyah) occurs on many of the ridges. Other rather similar low ridges carry only a few shrubs of the rigid *Acacia tetragonophylla* (dead finish).

The ground vegetation is varied and sometimes, chiefly in the more open places, rather dense. Characteristic species are the various so-called "mulga grasses" (*Aristida arenaria, A. anthoxanthoides, A. latifolia*), mulga mitchell (*Neurachne Mitchellii*), *Amphipogon* sp. nov., *Chloris pectinata, Eragrostis eriopoda, E. Kennedyae, Tripogon loliiformis, Fimbristylis* sp. aff. *F. dichotoma* (the two latter known as "eight-day grass" or "five-minute grass" on account of their rapid response to rain), *Sida platycalyx* ("noodle" or "lifesaver," another excellent fodder which responds very rapidly to rain), *S. pedunculata, Atriplex* spp., numerous spp. of *Bassia,* of which *B. paradoxa, B. uniflora, B. Cornishiana, B. parallelicuspis,* and *B. convexula* are specially characteristic, occasional plants of *Kochia Georgei, K. triptera,* and *Calotis* sp., *Evolvulus alsinoides,* and *Velleia connata.*

In the more open parts of the community, crab-holes sometimes occur lined by *Aristida anthoxanthoides, Eragrostis xerophila, Enneapogon* spp., and a *Bassia* or so.

[Note.—According to McTaggart[25] *Centotheca lappacea* is a prominent member of the Queensland mulga scrubs. It is, however, restricted to the rain forests of the north-east coast.]

Minaritchie Scrubs.—These occur almost entirely fringing the gullies in the more arid parts. *A. cyperophylla* appears to be almost restricted to the area between Cooper's Creek and the Diamantina River. It occurs in the upper part of the gullies, and on the flatter ground tends to be replaced by gidgea. Ground vegetation, if any, is scanty.

Another minaritchie occurs either as scrubs or associated with gidgea and mulga on sandstone hills in the arid parts.

Brigalow Scrubs.—Brigalow scrubs cover or used to cover very large areas in Queensland. Their greatest development lies outside our present limits, so that a full treatment must be reserved until later. For the present they will be discussed rather in their relation to the other communities than as to their detailed composition.

A well-developed scrub is very dense and occupies a very heavy, very dark grey or black soil. They may occur scattered in grassland or in Eucalyptus forest, or may be very extensive. According to Jensen[23] the soil occupied contains a high percentage of sodium carbonate. *Casuarina lepidophloia* (belar or belah), *Geijera parviflora* (wilga), *Eremophila Mitchellii* (budda), and other shrubs and small trees are frequent in places. Until comparatively recently these scrubs were heavily infested with prickly-pear (*Opuntia inermis*).

V. Fringing Forests.

Along all the larger watercourses in the grasslands are to be seen communities dominated by trees with which are associated a few smaller plants which are rarely, if ever, found elsewhere. These fringing forests may be very narrow, or may extend some little distance into the grassland, and more or less gradually merging into it. In forest, the rivers are lined with a few species which do not enter into the general make-up of the community, thus forming a type of fringing forest. And, thirdly, there is another kind which is developed along some of the larger northern rivers with a wide sandy fossil flood plain. In the far south-west fringing forest is intimately associated with and forms part of the channel country.

In forest, the characteristic trees lining the rivers are *Eucalyptus camaldulensis* (more generally known as *E. rostrata,* and in Queensland popularly called "river gum," though other names are used) and *Melaleuca saligna* (tea-tree or paper-bark). The latter occurs chiefly in the north, and is a tall tree with a thick whitish many-layered papery bark, and a dense, rather glaucous crown with long slender branchlets and narrow, pendulous leaves hanging in graceful festoons. The gum is a large tree of varied habit, sometimes straight, sometimes irregular, with a whitish or pale grey bark and rather green lanceolate leaves. The forests of the fossil alluvial plains usually have, in addition to the above, several other trees. In the neighbourhood of Hughenden, for example, there occur also *E. coolabah, E. pyrophora, E. papuana* (as a very handsome tree), *Bauhinia Carronii* (bauhinia), *Acacia salicina, A. Sentis, Owenia acidula, Atalaya hemiglauca, Eremophila Mitchellii, Eremophila bignoniiflora,* the two rounded spiny spreading shrubs *Carissa lanceolata* and *Capparis nummularia* (Flinders rose, elsewhere called split-heart), the climbing cucurbitaceous *Melothria argentea,* the handsome parasitic *Loranthus Miquelii, L. Exocarpi,* a few "herbage" plants such as *Portulaca* spp. (pigweed), *Abutilon* spp., *Sida* spp., *Malvastrum spicatum, Bassia anisacanthoides, Psoralea patens, Calotis* spp., and numerous grasses, including *Chrysopogon pallidus, Bothriochloa Ewartiana, B. decipiens* var. *cloncurrensis, Dichanthium annulatum, Themeda avenacea, Brachiaria Gilesii, B. Windersii, Digitaria ctenantha, Chloris pectinata, C. acicularis* var. *queenslandiae,* and more or less frequent spp. of *Aristida* and *Enneapogon.*

Minor variations occur elsewhere, but they rarely alter the general character of the type.

The typical fringing forest of the "downs" is of very different character (figs. 14, 37, 39). The characteristic tree is *Eucalyptus coolabah* (coolibah, coolibar, coolabah), a "gum-topped box" of irregular habit with the lower bark dark grey and somewhat rugged, and the light grey upper bark varying in the extent of its development. Small trees which are frequently associated are the green bushy-crowned

Eremophila bignoniiflora (river angee or emu-bush) and the somewhat glaucous willowy *Acacia salacina* (the "bellalie" of the Cooper country), and *Bauhinia* occurs in places.

A fairly definite herbaceous vegetation is associated. At the edge of pools a zone of *Cyperus dactylotes,* the rather shrubby cane-grass *Leptochloa digitata,* and sometimes also *C. exaltatus* is usual. On the bank a dense growth of *Cyperus victoriensis* and *Paspalidium jubiflorum* is most characteristic, and *C. bifax* and *Panicum Whitei* are often associated. In damp places generally, but chiefly where the *Cyperus* is absent, or less dense, *Eragrostis japonica, Dichanthium annulatum, Eleocharis pallens, Alternanthera nodiflora, Morgania glabra, Mentha australis,* and *Minuria integerrima* occur.

Towards the southern border in the fringing forests of the Warrego, Paroo, Bulloo, and Wilson Rivers a characteristic tree accompanies the coolibah. This is the yapunyah (*Eucalyptus ochrophloia*), a much narrower and greener tree than the coolibah and usually more regular. The upper bark is somewhat reddish in colour.

The yapunyah extends further away from the channels than does the coolibah, so that there is often a broad intermediate zone in which Mitchell grass and chenopods may be frequent.

Near Dirranbandi there is a modification of the fringing forest in that a broad belt of coolibah parkland is formed in which Mitchell grass is prominent and is sometimes dominant. In other places a salt-bush community is associated.

VI. Communities of the Channel Country.

Channel country is most strongly developed along the lower courses of the Bulloo, Wilson, Cooper, Diamantina, and Mulligan (including Eyre's Creek). A fringing forest is present along the deeper channels, but it is in the more or less open country between that the characteristic communities are developed. These communities are almost entirely herbaceous, and often entirely annual. Their existence depends, not to any marked degree on local rainfall, but on the extent of the periodical floods. After big floods the vegetation is most luxuriant, and forms a fine fattening pasture. The floristic detail is imperfectly known. The tall, handsome-flowered *Lavatera plebeia* (hollyhock) is frequent near the coolibahs in some places. Two grasses are characteristic and are highly esteemed. These are the so-called "soghum," *Echinochloa Turneriana,* an erect, succulent annual of several feet and a heavy producer of grain, and the "pepper grass," *Panicum Whitei.* This is not so tall. The herbage is particularly rich, the more outstanding plants being *Trigonella suavissima* (clover), *Blennodia canescens* (heliotrope), *B. nasturtioides* and other spp., *Lepidium rotundum* and spp., *Craspedia chrysantha* (yellow top), *Helipterum* spp., *Senecio Gregorii, Calocephalus* sp., *Gnephosis eriocarpa, Goodenia* spp., various *Scrophulariaceae, Marsilea Drummondii* (nardoo), and occasional plants of *Bassia* spp. and *Atriplex* spp. (fig. 38).

In many places communities of *Cyperus victoriensis* occur, and in the wetter places lignum swamps (fig. 39) and cane-grass swamps are developed. (*See* below under "Miscellaneous Communities"). Claypans are well developed in places, and rarely chenopod communities occur.

VII. Communities Dominated by *Chenopodiaceae*.

The family *Chenopodiaceae* is strongly represented in Queensland in species and individuals. A few species are widely spread, including some on the sea-coast, but the majority are characteristic of the drier parts of the interior. Some species have already been mentioned when describing other communities. Here it is proposed to deal with the several communities in which chenopods are not only dominant, but in which other plants are relatively rare or even absent.

Several species are long-lived, compact shrubs, many are annual or short-lived plants, usually bushy in habit. Several of the latter enter into the formation of communities which are the degradation products of heavily over-grazed country. As such they are actually induced communities, but for the sake of continuity and clarity it is better to describe them here and then refer back to them later. Others are definitely of a seral or quasi-climax nature, and they also will be discussed in this connection elsewhere.

Communities of Shrubby Species (Shrub Steppe).—Within this group come the salt-bush steppe and blue-bush steppe of South Australia. These communities appear to be of minor importance in Queensland. Two areas of *Kochia* steppe occur some distance to the north of Birdsville on a heavy grey soil derived from a Tertiary limestone. The sole perennial vegetation consists of the dense dull greyish shrub *Kochia planifolia*. When examined the only other vegetation consisted of a fairly close covering of *Enneapogon* sp. on small patches of fine drift sand.

Small communities of a somewhat similar nature (*K. Georgei* and other spp.) have been observed on stony ground comparable with gravelly downs near Thargomindah, and another on red soil near Eromanga, so that it is possible that small patches of like nature may be scattered about in the drier regions.

Two types of *Atriplex* communities (saltbush) are to be found. Old Man Saltbush (*A. nummularia*) dominates communities chiefly of limited extent which occur along the Georgina River and Eyre's Creek, some of the tributaries of the lower Diamantina and of Cooper's Creek, and also the lower Bulloo (Bailey [2]). There is an apparently isolated development associated partly with coolibah (*Eucalyptus coolabah*) and partly with box (*E. populifolia*) to the south-east of Dirranbandi. Probably, however, similar communities occur elsewhere near the New South Wales border. Old man saltbush forms large, dense, silvery-glaucous shrubs which can attain 8 feet or more in height, but they are usually kept very much smaller by grazing, as the leaves and young shoots are very palatable to stock.

In all cases so far observed this type of community is developed either near or on flooded ground. Herbaceous plants are usually those of such areas, in the far west often those of claypans.

The communities of *Atriplex vesicaria* of South Australia have been described in great detail by Osborne, Wood, and Paltridge ([28, 29 42, 43]). Such communities are rare in Queensland. The best development so far seen is on Narine Station, to the south-east of Dirranbandi, where the complete dominance of the saltbush is due at least in part to the removal (by horses) of Mitchell grass which had at one time been associated. Saltbush, at least in this locality, appears not to be relished by horses. The soil is a grey clay silt common in the district. A few

trees of box (*Eucalyptus populifolia*), leopardwood (*Flindersia maculosa*), and sandalwood (*Eremophila Mitchellii*) occur, while herbaceous plants are those common in degraded Mitchell grass pasture, of which *Sida virgata, Malvastrum spicatum,* and annual species of *Atriplex* and *Bassia* are prominent.

On Narine and Noondoo both species of *Atriplex* mix in places, and *Rhagodia spinescens* is frequently associated. This mixed community is developed in association with either box or coolibah. In the far south-west of the State *A. vesicaria* occurs within the limits of the gravelly downs. A fairly well-marked development occurs on the eastern slope of the Grey Range west of Thargomindah on reddish brown to yellowish brown gravelly fine sandy loam (fig. 35). Various species of *Bassia,* with occasional trees or patches of gidgea and *Eremophila Dalyana,* are associated.

In several places traces of similar communities occur, as for instance to the west of Eromanga. Scattered plants sometimes form a kind of fringing community beside some of the gullies in the Stony Desert, usually in association with a few shrubs of *Eremophila* or *Cassia.*

Chenopodium auricomum (blue bush) and *C. nitrariaceum* are rather tall shrubs which sometimes form definite communities under somewhat swampy conditions. The former species is usually associated with bull mitchell grass, but not always. It is widespread. The latter species has so far only been observed in the very arid regions.

Communities of Annual Species (Herb Steppe).—Although the individuals of these short-lived communities have no permanence in themselves, yet the actual communities are, on the whole, well defined, and may persist for many years. Many are, however, quite unstable. The numerous species which go to form these communities belong particularly to the genera *Salsola, Atriplex, Bassia, Kochia,* and *Threlkeldia.* Many species regularly form the ground communities of gidgea scrub, and several enter the composition of grasslands. These have been mentioned above. The communities here described are, with one exception, developed on treeless country.

Salsola Communities.—*Salsola Kali* is a very widespread polymorphic species, of which the Australian forms have sometimes been considered as distinct under the name of *S. australis.* In Queensland the species extends from the east coast to the Simpson Desert. Two varieties have been noted from the interior, of which var. *strobilifera* is most characteristic. The species is fairly generally known as roly-poly, and the var. *strobilifera* is frequently called buck-bush. The latter is a characteristic coloniser of the sand-hills, and will be considered later in this respect, though it also occurs in other places.

The species in all its forms is a more or less rounded bush, more or less prickly except when young, which at maturity breaks off at the ground-level and is bowled over the ground by the wind, scattering seeds as it does so, until it is finally brought to rest by a fence or bore drain. In this stage it is a great pest, but when young it is readily eaten by stock.

Roly-poly is present in grassland almost everywhere, and at times assumes physiognomic dominance. Sometimes it forms pure or nearly pure communities on stock-routes, and possibly because of this the dominance or apparent dominance on grassland has been interpreted as due to over-grazing. While this may be true in some cases, it is quite certain

that in many, possibly the majority, of instances this dominance is an example of "seasonal dominance." Gregory[20] notes that on the Peak Downs (near Capella) *Salsola* was very abundant long before the country was stocked.

Species of *Atriplex* and *Bassia* may form pure stands or they may mix with one another and with *Threlkeldia proceriflora* to form certain distinctive communities. The species of *Atriplex* concerned form low rounded or spreading bushes of whitish aspect with flat, more or less mealy leaves. *Bassia* is by far the largest genus, and is represented by about thirty species in our area. A few are true perennials and distinctly shrubby. The majority are facultative perennials. Usually annuals, they can perennate under favourable conditions, though they probably are only relatively short-lived. They are nearly all dense, low bushes, branching freely close to the ground. In many the branches are rather short or intricate; in others they are often longer and divaricate. In the former case more or less rounded bushes are usually produced; in the latter the plants are usually less compact. The leaves are fleshy and in most species very narrow or terete, green to sub-glaucous, but very frequently the whole plant is more or less covered with a hoary or white tomentum. The fruits are sessile and axillary, and usually solitary, furnished with two or more usually rigid spines, which may be quite short or, in *B. longicuspis,* may attain $1\frac{1}{2}$ inches. In some the fruits fall at maturity; in others they remain firmly attached, and distribution depends on the breaking up of the plant. In most cases the species furnish good forage at least when young. Some become somewhat woody when old, and long-spined forms are avoided as much as possible.

Threlkeldia proceriflora resembles in general habit some of the smaller species of *Bassia.*

The Communities.—A widespread community consists of a mixture of *Atriplex Muelleri* (annual salt-bush), *Bassia anisacanthoides, B. echinopsila* (red burr), and *Threlkeldia proceriflora.* The community is invariably developed on a heavy soil, and appears in some places to be a climax community. In such cases it is usually associated to some extent with gidgea. In other cases it is certainly an induced community, resulting from the degradation of Mitchell grass grass-land by overgrazing. These cases have been discussed by Francis,[19] and will be further considered below.

The proportion of the species in the community varies considerably, and one or more may be missing. Owing to the relative unpalatability of the saltbush there is a tendency for it to dominate the situation, and in places it occurs as a pure stand. Towards Dirranbandi there is a marked tendency for it to be replaced by *A. leptocarpa.*

To the far south-west this community is represented by others (fig. 11), of which the characteristic species are *Bassia* sp. aff. *B. divaricata, Atriplex spongiosa,* and *A. conduplicata.* This type of community is widely distributed over the gravelly downs with many variations. Several species of *Bassia* are usually present, including those of the former community. Near the Cooper *B. brachyptera* is prominent, and in the north of the gravelly downs area *B. lanicuspis* frequently dominates.

Bassia Birchii, commonly known as galvanised burr, though also as camel burr and Woolerina burr, has a strong tendency to form communities on sandy soil. In most cases these are the result of heavy

overgrazing. The burr acts as a coloniser soil-binder and seed bed, and its character has been briefly discussed in a previous paper.[5]

Other species assume physiognomic dominance at times. *Bassia quinquecuspis* (roly-poly or prickly bush), *B. bicornis* (goat-head), and others form communities in grassland, usually induced.

Samphire and Cottonbush Communities (fig. 36).—On the saline sandy shores of the Dynevor Lakes, and on the extensive silt beds of the middle and lower course of the Wilson, near Haddon's Corner, and still further to the north-west, is developed a type of community not closely connected with the foregoing. Annual and perennial chenopods are prominent, but other plants are very important. Those most widely spread are *Pachycornia* spp. and *Arthrocnemum* spp. (samphire), *Kochia aphylla* (cotton-bush), *Bassia tricuspis, Gunniopsis quadrifida,* and *Glyceria ramigera* (cane grass). Near the Wilson the peculiar *Kochia*-like shrub *Hemichroa* is common. *Cyperus victoriensis* is common in places in depressions, but on the edge of the Dynevor Lakes it appears to be replaced by *C. gymnocaulos.* Several annual plants occur, notably *Bassia* spp., *Babbagia dipterocarpa, Malacocera tricornis, Eragrostis Dielsii, E. leptocarpa,* a distinctive undescribed species of the same genus, and others.

VIII. The Communities of the Sandhills (figs. 22-27).

The communities of the sandhills are numerous and varied, their composition being influenced by their position on the dune and the nature of the latter. Weather conditions are, of course, very important. The present discussion will be confined to the dunes of the Simpson Desert and those of the "marginal country" surrounding it. Perennial plants—at least long-lived ones—are relatively few. For a large part of the time a great part of the dune and, perhaps, the crest always is at the mercy of the wind, and is frequently undergoing minor changes. Thus a very special kind of habitat is produced. On the lower part, which may be relatively stable, a more or less permanent vegetation may exist, closely related to the *Triodia* community of the lateritic sand-plain as pointed out above.

A few small trees and large shrubs are occasionally to be found on sandhills. The commonest are *Acacia aneura* (mulga), *A. ligulata, A. dictyophlebia,* and *Hakea leucoptera* (needlewood), while in the marginal country *Clerodendron floribundum, Owenia acidula* (emu-apple), *Atalaya hemiglauca* (whitewood), and *Eremophila* spp. are occasionally to be seen. The common shrubs to be found throughout, or nearly throughout, the sandhill area are the large bushy dull-greyish *Crotolaria Cunninghamii* (parrot bush or bird flower), with its peculiar large green-veined greenish yellow flowers and the smaller very glaucous *C. eremaea* with its bright yellow flowers while two grasses are widely spread. *Triodia Basedowii* (spinifex or porcupine grass) has already been described. On the sandhills it tends to form irregular masses, particularly if on the upper slopes. *Spinifex paradoxus* (sandhill cane grass or simply "cane grass") (fig. 22) is a dioecious rhizomatous dense intricately-branched green shrub up to 5 feet high, with rather few short rigid leaves. Both these species are excellent sand-binders. Other more or less distinctly perennial plants of wide distribution are *Scaevola depauperata, Leschenaultia divaricata, Ptilotus latifolia, Newcastlia cephalantha, Psoralea eriantha, Echinospermum concavum, Solanum ellipticum,* and the slender more or less herbaceous *Sida argentea* and *Andrachne Decaisnei.*

A host of short-lived plants appears after rain. Of these some are commonly and, perhaps, restrictedly colonisers. Among these are the grasses *Plagiosetum refractum* and *Paractaenum novae-hollandiae.* The former is common on the marginal hills (fig. 24), but in the true desert it seems to be replaced by the latter. Both species form large masses on the sides of the dunes, tending to stabilise the sand. The other coloniser is the ubiquitous buckbush (*Salsola australis* var. *strobilifera*). Another plant which colonises the hills, in some localities at least, is the brilliant yellow-flowered *Tribulus hystrix* with its large grotesque spiny fruits. It is often to be seen partially buried, the long trailing and flattish pinnate leaves holding the sand. *Calandrinia* spp. (parakeelya) are common at times. In the Simpson Desert, and at least in parts of the marginal country, occur the brilliantly yellow-flowered *Goodenia cycloptera ?*, the lilac or white-flowered, sweet scented *Blennodia pterosperma,* the yellow and white flowered *Myriocephalus Stuartii* (poached eggs), the brilliant yellow *Senecio Gregorii,* and others.

Apparently under some conditions *Crotolaria* can act as a coloniser, though probably only in the marginal country.

On the spread of the sandhills in the marginal country there is very frequently a fairly dense community of varied composition. Sometimes a patch of mulga scrub is present, while fig. 25 shows a community on Mount Howitt in which a close growth of *Eriachne ovata* with *Eragrostis eriopoda, Aristida Muelleri, Neurachne* sp., *Eriachne aristidea, Amphipogon* sp. nov., and *Sida argentea.* In another case occurred an interesting and unusual community of Mitchell grass (*Astrebla pectinata*), the sand having apparently acted as a mulch. At the edge of the spread an occasional tree is often to be found, such as *Bauhinia* or the bloodwood *Eucalyptus pyrophora.*

Moving north and east from the centre of the desert shrubs and trees become prominent. Firstly, mulga and needlewood come into greater prominence. In the east these tend to be replaced, firstly, by hop-bush (*Dodonaea* sp.), and still further east by cypress pine (*Callitris glauca*), Towards the north the mulga and needlewood are gradually replaced by two eucalypts, *E. papuana* and *E. pyrophora.* The extreme case of this is shown in fig. 27, illustrating a community some miles to the south of Boulia. The sandhill is reduced to a broad slightly elevated patch of sand supporting *Eucalyptus papuana, Eragrostis eriopoda, Aristida Muelleri,* and *Atriplex elachophylla.*

The further away from the desert the greater the tendency for the occurrence of sandhills to be restricted to the neighbourhood of watercourses.

IX. Miscellaneous Communities of the More Arid Regions.

There still remain several communities of local importance to be considered. These are often small in extent, and occur scattered through the area, frequently restricted to special habitats. Some of these are dominated by or consist entirely of a single species. One group is treated separately below, the others may be grouped as follows. Some of these have already received incidental mention:—

1. Communities dominated by a single species, which is more or less shrubby—
   - (*a*) Lignum swamps.
   - (*b*) Cane-grass swamps.
   - (*c*) *Cassia phyllodinea* communities.
   - (*d*) *Eremophila* communities (except *E. Mitchellii*).

2. Communities of ephemeral species—
   (*e*) Communities of claypans.
   (*f*) Communities of sandy river beds, &c.
   (*g*) Communities of muddy or silty river beds, &c.

Lignum (*Muehlenbeckia Cunninghamii*) forms large more or less hemispherical masses of nearly leafless cylindrical stems (fig. 39). Individual plants may be several feet in diameter. They form distinctive communities either lining channels or occupying depressions chiefly in grassland or channel country. The plants may be contiguous or some distance apart. The intervening space may be bare or populated by various plants, the species being those of damp places. Lignum communities are always subject to flooding in such a way that water lies on the ground for a considerable time.

Cane grass is the name given to two stout rigid, branched, shrubby grasses up to 8 feet high, with comparatively short, rigid, more or less inrolled leaves. They are characteristic of areas where water lies for a considerable time. One of these grasses is *Leptochloa digitata* of fairly wide range, except in the driest areas, where it is replaced by the other. It frequently forms a zone around waterholes. Associated plants, if any, are those typical of damp places. The other species is *Glyceria ramigera,* which is nearly restricted to the more arid regions except for an apparently isolated development to the east of Cunnamulla. Large communities sometimes occur on claypans, and other plants seem to be rare or absent. It is eaten by stock. It is almost certain that the cane grass referred to by Bailey[3] belongs to this species, and not to the previous.

Cassia phyllodinea is a compact glaucous leafless shrub mostly 2-3 feet high, with flat narrowly obovate vertical phyllodia and yellow violet-scented flowers. Communities, sometimes dense, sometimes open, are formed on flats of a claypanny nature or in open places in mulga scrub. In the former case other plants are often absent. In the latter, where the community is often more open, plants of the crab-hole development previously described are often present.

Eremophila spp. occasionally form small communities chiefly in mulga scrub or occasionally on the tops of the desert sandstone hills.

Communities of the Claypans (figs. 14, 40).—It has already been pointed out that several communities may be associated with claypans. In the extreme development of claypans, however, vegetation is restricted to scattered plants of ephemeral species, particularly grasses. The characteristic species are *Aristida anthoxanthoides, Tragus biflorus, Enneapogon* spp., sometimes *Uranthoecium truncatum, Brachyachne ciliaris, Eragrostis Dielsii;* besides *Trianthema decandra, Portulaca* sp., and an occasional *Bassia.* All these are pioneer species, and many are characteristic of bare places generally. *Cyperus bulbosus* (mungeroo), a species perennating by tunicated bulbils, is present in many places.

The Communities of River Beds.—After a stream has dried up quite a variety of plants spring up to form a very open but short-lived community. Many of these are found in damp situations generally; others appear to be more or less restricted to the rivers. Species of wide occurrence are *Cyperus pygmaeus, C. iria, Brachiaria Windersii, Echinochloa colona, Diplachne Muelleri, Eragrostis japonica, E. parviflora, E. leptocarpa, Glinus lotoides, Ammannia* spp., *Alternanthera nodiflora, Centipeda* spp., &c. On the sandy beds, particularly in the north,

Fimbristylis miliacea, F. microcarya, Bulbostylis barbata, Brachiaria piligera, B. miliiformis, Setaria surgens, Chloris virgata, Polanisia viscosa occur in addition, while on muddy beds *Pterigeron adscendens, P. odorus, Pterocaulon glandulosum, Minuria integerrima, Morgania glabra, Neptunia* spp. *Marsilea Drummondii* (nardoo) and *Sporobolus Benthamii,* a rather wiry stoloniferous grass, are characteristic. The three species last named are perennial, but can be included here.

X. Miscellaneous Communities of the Dividing Range.

On the uppermost rocky slopes of the Great Dividing Range and some of the adjacent ranges and hills is developed a peculiar and most interesting type of community. Eucalypts and *Acacia* spp. are present, sometimes stunted, either mixed or certain species of *Acacia* tending to form scrubs. The characteristic feature is the development of an often dense undergrowth of shrubs of ericoid habit belonging to the families *Epacridaceae* (*Acrotriche, Leucopogon, Melichrus*), *Myrtaceae* (*Calythrix, Thryptomene, Baeckia*), *Rutaceae* (*Boronia, Phebalium*). *Leguminosae* (*Burtonia, Jacksonia, Daviesia, Aotus, Bossiaea,* also *Hovea*), and prickly, thick-leaved spp. of *Solanum.* A characteristic grass is the wiry suffruticose *Cleistochloa subjuncea,* with its cleistogamous spikelets in the leaf-axils. The dioecious, rigid *Scleria sphacelata* occurs in places. Its presence is interesting, as it also occurs in the coastal rain-forests.

In the steep gorges of the Carnarvon Range the tropical fern *Angiopteris evecta* has been found, while on the cliff faces *Platycerium Veitchii* occurs. The eucalypts of this district are varied, and include the ironbark *E. nubilis,* the gum-topped ironbark *E. decorticans, E. maculata* (spotted gum), *E. citriodora* (scented gum), *E. trachyphloia* (yellow bloodwood), *E. tesselaris* (Moreton Bay ash or carbeen), *Angophora intermedia,* and other trees. Further north *E. peltata,* a yellow jack, is abundant.

This type of community appears to occur throughout the length of the Great Divide, and a full account cannot be given in the present paper. A most interesting feature is the similarity of the shrubs to the shrubs of the Wallum of the east coast.

B. INDUCED COMMUNITIES.

XI. Artificial Grassland.

In many timbered localities attempts have been made to improve the natural pasture by killing, usually by ringbarking, and frequently by the ultimate removal of the trees. This has been freely practised to the south-east, chiefly beyond our present limits. The result is usually the production of an artificial grassland, in which the original herbaceous members of the forest community dominate, at least at first. A close ground cover is produced, usually with one or more species dominant. On the more usual sandy soils there is always a tendency for certain species of *Aristida* to dominate, of which *A. echinata* is most prominent in the south-east. With continued stocking *Bassia Birchii* tends to replace the grass. Careful stock management is necessary to maintain a satisfactory pasture.

On the heavier soils in the south-east there is not such a pronounced tendency for the dominance of *Aristida. Chloris divaricata* (star grass) is usually prominent, though *Sporobolus Caroli* dominates at times.

There seems to be no definite rule. Further change takes place in one of two ways. Sometimes, particularly when coolibah was present in the original vegetation, Mitchell grass, particularly weeping Mitchell (*Astrebla elymoides*), gradually assumes dominance with *Eriochloa* sp. prominent. On the other hand, many chenopods may enter the pasture, the most characteristic species being *Atriplex neurivalvis, Bassia stelligera,* and *B. quinquecuspis* and its var. *villosa.* Heavy over-grazing results in the dominance of the *Atriplex leptocarpa-Bassia-Threlkeldia* community described above.

Eremocitrus glauca (lime-bush) frequently enters the pasture, and tends to form scrubs of erect, glaucous shrubs or small trees.

Gidgea scrub has been rung or felled in places, but full details of the induced communities are not available. In some places the final result is grassland (Mitchell grass) with a percentage of chenopods, and possibly some of the chenopod communities are also of similar origin. In one locality studied to the west of Quilpie *Eragrostis* spp. dominated. The commonest species were *E. Kennedyae* and an undescribed species with small spikelets widely spread in Western Queensland. It has been reported that in freshly rung gidgea scrub a wealth of herbage appears, but does not persist for any length of time.

XII. Communities of the Bore-drains.

Along all bore-drains, and particularly at the end where they spread out, sometimes to form swampy areas, species are to be found which rarely, if ever, occur elsewhere in our area. Along the banks of most drains is to be found a close mat of couch (*Cynodon dactylon*), and sometimes on the lower ground *Sporobolus Benthamii.* With these may be associated a tall, stout species of *Eriochloa.* Near the bore-head a few chenopods, notably *Atriplex Muelleri* and *Bassia* spp., are often to be found.

Lower down the drain, where the stream is slower, or in the channel into which drains are usually led, there sometimes occurs a dense stand of the bullrush *Typha angustifolia* var. *Brownii.*

In a swampy area near Barcaldine at the end of a bore-drain in Eucalyptus forest several coastal sedges occur, including *Kyllinga brevifolia, Fimbristylis depauperata, F. dichotoma* var., *Fuirena ciliaris,* and *Cyperus difformis.*

XIII. Communities of Stock-routes and Reserves.

Effects of Grazing.

Artificial stocking by cattle, sheep, and horses, together with the introduction of the rabbit, must have produced a profound effect on the original vegetation. Not only have the plants been subjected to more intensive grazing than previously, but this has been of a much more destructive nature. Rabbits are practically restricted to the southern parts, but it is difficult, if not impossible, to assess the extent of change wrought by them alone. All that can be attempted, in the present paper at least, is to describe some of the results brought about by stocking, and to indicate the trends of the changes taking place.

For purposes of comparison it has been usual to study the vegetation in railway enclosures and cemetery reserves, but difficulties are numerous. In the first place, railway enclosures are of value in open

country only. Then many stray species are distributed by passing trains. Frequently in severe drought stock has been turned into the enclosures; and, finally, in many places there are no enclosures.

Cemetery reserves are often located on atypical areas, particularly on the downs, where they are regularly located on a slightly sandy rise, if such is available in the district. And it is always likely that the vegetation may have been interfered with in some way.

Although, from the grazier's point of view, the effects of continued heavy stocking are very deleterious, yet there is no doubt that over large areas, particularly on the ashy downs, the pasture has been considerably improved by stocking. A striking example of this came under observation to the north of Barcaldine on typical ashy downs, and is illustrated in fig. 15. The paddock on the right had been consistently heavily stocked with sheep for several years. On the right is a piece of land which has lain idle for many years. The photograph was taken in December, 1935, following good rains, which were preceded by a long, severe drought. The stocked paddock carries a very fine stand of mixed Mitchell grass and herbage, while the idle ground carries a very sparse vegetation, consisting chiefly of young *Salsola* and the bottle caustic, *Euphorbia Stevenii*.

This is certainly an extreme case, but comparable examples are not wanting. Frequently, when a paddock is spelled or but lightly stocked for a period, differences are noticeable between it and neighbouring paddocks, sometimes in favour of one, sometimes of the other.

These different reactions to stocking seem to be connected with the nature of the soil. The loose, "cracky" nature of the ashy downs has been alluded to above. The continual trampling tends to pack the soil, making it more compact, when it holds moisture better. A better and more permanent plant growth is induced. Heavy stocking on the gravelly downs, at least for short periods, may also result in an improvement in the pasture.

The tendency for sheep to graze up-wind also produces its effects on the pasture. Thus the dominantly leeward side of a paddock is more continuously and closely grazed than is the windward side, which, indeed may be comparatively little grazed (fig. 16). The position of water in a paddock modifies the effect of this tendency, so that where fences are judiciously arranged with respect to watering facilities a more even grazing of paddocks is secured.

There is, however, a limit to the permanent carrying capacity of any particular area, and when this is regularly exceeded a very different state of affairs results. Sooner or later the more palatable species are gradually eaten out. Young plants are not allowed to reach maturity, so that seed becomes scarcer and scarcer, and as the older plants die there are no young ones to replace them. There is thus a tendency for the palatable species to be replaced by others less palatable, and these again by species still less palatable.

The extreme case of such replacement is well shown near towns on the reserves and commons. This is due largely to the communal herds of goats, sometimes assisted by cattle and travelling stock.

The plant communities of such places are often most striking. The perennial plants are the least palatable species, and associated are various short-lived annuals. On sandy soil *Bassia Birchii* (galvanised

burr) finds its greatest development, associated with such plants as *Aristida* spp., *Tragus biflorus,* and *Perotis rara.* On the heavy soils the communities are often remarkably different in neighbouring localities. At Hughenden the very conspicuous *Pimelea haematostachya* (wild poppy or bottle brush) with its tufted, erect, nearly simple stems, very glaucous leaves and dense scarlet to crimson flowering spikes becoming white in fruit, dominates the situation in places. It is absolutely ignored by all classes of stock, including goats. In more open situations are found *Flaveria australasica, Brachyachne convergens* (spider or fern grass), *Enneapogon avenaceus, Malvastrum spicatum, Sida virgata, Atriplex Muelleri, Cassia planitiicola,* and frequently *Iseilema* spp. These are common species of these reserves. Towards the south chenopods become numerous and varied, chiefly *Bassia* spp. and *Atriplex* spp.

On stock routes—those great arterial highways along which many thousands of stock pass annually from pasture to pasture, or from pasture to market—the original vegetation has undergone many pronounced changes. Here, possibly more than anywhere else, do extremes of environmental conditions operate upon plant life. The trampling effect of the passage of many thousands of animals must in itself be a severe test on the plant. Added to this is the grazing of these same animals. And perhaps equally important is the effect of the continual manuring and urination on the plants and on the soil. On the downs the position of even comparatively old sheep camps can be recognised by the presence of a community of *Atriplex Muelleri.* And this is one of the commonest plants of stock routes on heavy soils, frequently forming large communities. In the central and southern parts the chief vegetation consists of the *Atriplex Muelleri-Bassia-Threlkeldia* community described above. (See also Francis,[19] where the history of the community on the Ward Plain is discussed.) Other plants commonly found on stock routes are *Wedelia asperrima* (sunflower weed), *Pennisetum Basedowii* (these two chiefly in the north, and the latter probably introduced by stock either from still further north or from North Australia), *Bassia bicornis* (goat head; chiefly found in the central parts), *Salsola* (ubiquitous), *Bassia quinquecuspis* (chiefly towards the south), and some annual grasses, chiefly *Enneapogon* and *Tragus. Iseilema* spp. (Flinders grasses) are common at times, chiefly in the north.

[NOTE.—In this connection it is interesting to note the results of an irrigation experiment carried out near Ilfracombe in 1935-6. An area of ashy downs was flooded with bore water. A crop of chenopods at first appeared, but after rain there was practically no plant growth.]

Bare places are not uncommon (fig. 13), and true claypans are frequent in places, particularly as the result of concentrated trampling followed by scouring near watering places. These carry the annual vegetation described above for these places.

It must not be thought that stock routes carry only this degraded vegetation. Actually every gradation from grassland to claypan occurs, and on the larger stock routes Mitchell grass may be abundant in places. Much depends on the season and the amount of stock that passes.

On sandy soil *Aristida* spp., *Triraphis mollis, Perotis rara,* and *Bassia Birchii* are the characteristic species, the lastnamed tending to assume dominance.

At the present time recuperation of stock routes is a serious problem, and drastic measures in their control will be necessary. Regeneration on the routes and on over-grazed areas generally is possible, but the time factor is important. Many instances of some degree of regeneration have come under my notice, usually as the result of spelling or partial spelling. A great deal depends, of course, on the season.

XIV. Communities of Introduced Species.

The most important species are *Parkinsonia aculeata* (parkinsonia), *Xanthium pungens* (Noogoora burr), *X. spinosum* (Bathurst burr), and *Argemone mexicana* (Mexican poppy).

Parkinsonia aculeata was introduced from the West Indies as a shade and fodder tree, and has been freely planted about homesteads and towns. It has a tendency to form copses, and occasional small patches are to be seen in some localities. In a few places a string of trees may be seen along shallow channels on the downs.

The species of *Xanthium* are among the worst pests of the grazing districts. Both are poisonous when young, and the spiny burr-like fruits are a terrible nuisance in wool and hair. Bathurst burr is of comparatively little importance in our region, and rarely persists for any length of time. It can be controlled by judicious pasture management. Noogoora burr presents a very different and much more serious problem. It is almost invariably restricted to watercourses and edge of channels, and is being continually distributed further down stream. Not infrequently it forms an impenetrable barrier to sheep, so that they are unable to reach water.

It is most unfortunate that the burr was first introduced to the upper courses of the streams.

Argemone mexicana is gradually extending its range westward, sometimes forming more or less definite communities on dry stream beds. It is avoided by stock.

Prickly pear (*Opuntia inermis* and other spp.) once formed dense communities over large areas, but it is being rapidly exterminated by *Cactoblastis cactorum*.

THE STATUS OF THE COMMUNITIES AND THEIR RELATIONSHIPS.

On examining the field-interrelationships of the communities described above the following features stand out very clearly:—

1. Brigalow scrub is slowly but surely extending its range, many changes having taken place within the memory of living men. Both grassland and Eucalyptus forest have been invaded and replaced. All stages in the invasion can be seen, and in some older scrubs box stumps are to be found. With the invasion of forest the nature of the soil gradually changes until the very heavy nearly black soil of old-established scrubs is obtained.

2. There is a tendency for gidgea to invade the grassland of the gravelly downs.

3. The reverse process is also in operation. Gregory[20] records large areas of dead *Acacia*, presumably gidgea, along the Barcoo. And in 1935-6 large areas of dead gidgea were to be seen to the south-west of Winton and elsewhere (figs. 10, 11), with grass coming in.

4. Mitchell grass has replaced blue grass over large areas. At the beginning of the present century blue grass dominated a far larger area

than it does to-day. The exceptionally severe drought of 1902 appears to have been one of the factors concerned in the change, but the lower palatability and the longevity of Mitchell grass appear to have decided the issue. For in recent years blue grass has been fairly common in railway enclosures though absent or nearly absent elsewhere. This change has occurred in the pastoral districts of Warrego and Maranoa, and appears to be still in progress in the Leichhardt district. It is not of a continually progressive nature, however, for in parts of the Maranoa and Mitchell districts at least, Mitchell grass was very common, if not dominant, many years previous to 1902,* and, indeed, prior to settlement (Mitchell[26]).

5. The relationship between the chenopod communities and the grasslands is a very unstable one. Some of the communities of the former group are plainly of a seral nature, such as those induced by overgrazing. Sometimes an apparently stable system is to be found where alternes (fig. 7) occur but in which the actual area occupied by each alterne varies from time to time. A similar system occurs on a very large scale on the fringe of the Stony Desert. The usual state of affairs is a mixed grass-chenopod vegetation confined to the crabholes (fig. 6). In some years perennials may be lacking or chenopods alone may occur (fig. 11), or even these may be absent (fig. 5, see also Sturt[36]). At other times this country is said to be continuously though lightly covered with Mitchell grass.

6. The Simpson Desert is a distinctly stable formation as a whole, and its northern and eastern boundaries are clearly limited by the direction of the prevailing wind and the river channels. The sandhills of the marginal country appear to be quite stable except for minor variations in conformation. Some occur among river channels and are obviously older than the latter (fig. 38). (It may be pointed out that the northern and eastern limits of the marginal country approximate to, but lie within, the limits calculated by Prescott[33] as the theoretical limit of the Australian Desert. However, it must be stressed that meteorological data for Western Queensland generally, and for the more arid areas particularly, are so very meagre that very little importance, if any, can be attached to theoretical considerations based upon them. Furthermore, complications are introduced by the presence of gibbers and gravel and by the little pockets of drift sand, both of which check evaporation, and by the presence of ridges and hills. It is only in times of severe drought that true desert conditions prevail.)

Beyond the marginal country there is another series of sandhills which gradually disappear to the north and east. It has already been pointed out that there is a complete gradation in character and vegetation from the dunes of the Simpson Desert to these low, scarcely discernable, far-outlying ridges. It would seem that at one time the desert occupied a greater area than it does to-day, and as it regressed the dunes gradually became more stable, were weathered lower and lower, and began to support an increasingly stable vegetation.

7. Lake Eyre and some associated lakes in South Australia used to be fed by Cooper's Creek, the Diamantina, and Mulligan Rivers. These streams very rarely reach Lake Eyre now. It has been generally considered that this, together with the occurrence of dead and dying coolibahs along the banks, was evidence of an increasing aridity of climate. But the failure of these streams to reach the lake appears to be due to a very different cause. It has been pointed out that the country

* According to records in the Department of Public Lands.

in these regions is often excessively flat, and that very extensive alluvial plains occur. These plains are being continually built up, slowly it is true, but sufficient maybe to hinder the very slow flow of the stream and each year making it more difficult for the rivers to reach the lake. It is now only in years of exceptionally heavy flood that the streams have sufficient power to scour out the silted channels to reach the lake.

8. It may be not out of place here to mention that changes in vegetation are in progress elsewhere in Queensland. In many instances rainforest is spreading at the expense of open forest. Young plants of open forest species are never found within the rainforest, though young plants from the latter invade open forest. As in the case of invasion by brigalow the character of the soil changes with the appearance of rainforest, becoming richer in humus. Many instances of pockets of Eucalyptus forest entirely surrounded by rainforest occur. The only feasable explanation seems to be that the Eucalyptus forest was formerly of far greater extent and that these pockets were isolated by advancing rainforest. The sere in parts of South Queensland has been described by Swain.[37]

Similar instability exists between the Wallum country of the east coast and Eucalyptus forest on the one hand and rainforest on the other.

The point which is desired to be stressed is that almost throughout Queensland the vegetation is of an unstable nature, so that it is frequently difficult to state what are seral and what are true climax communities. For Western Queensland it has been shown that these changes are oscillating, not progressive. It is convenient to use the term "fluctuating climax" to denote that condition which appears relatively stable, but which in reality is in a state of unstable equilibrium. A true static climax may never exist. The communities of blue grass and of Mitchell grass in the districts abovementioned are an example of an fluctuating climax. So also are the chenopod communities and the Mitchell grass communities at the edge of the stony desert, and elsewhere. The major communities concerned in the fluctuating climax may be termed "complementary communities," "complementary associations," &c., as the case may be. Each complementary community is a climax under the existing set of conditions. What these conditions are is at present doubtful. Rainfall and, since settlement, stocking appear to be two of the factors concerned, but only indirectly, and it is possible that cyclic variations in the salt content of the soil may be an important factor. It has been well proven that there is a pronounced tendency for salts to accumulate in the upper layers of soils in dry climates, while the opportunities for lessening the concentration are few. Whatever the actual cause it is scarcely necessary to stress the importance of the changes in relation to the carrying capacity of the country.

With this concept in mind it is possible to recognise the following formations and associations in Western Queensland*:—

I. The Open Forest Formation, in which the chief associations are—

1. Eucalyptus Forest. In addition to the *Eucalyptus*-dominant communities, the following communities occur often as definite sub-associations or consociations:—

* In the sense of Clements ([10]).

(*a*) Cypress pine (*Callitris glauca*) forest.

(*b*) Fringing forest in part, principally such communities as described above as occurring near Hughenden.

(*c*) *Eucalyptus papuana—Triodia pungens* community.

(*d*) *Eucalyptus—Triodia Mitchellii* communities.

2. The mixed *Eucalyptus—Acacia*—ericoid shrub association of the Great Dividing Range.

Other associations occur elsewhere in Queensland.

II. A Closed Forest Formation, represented by the two associations, ooline forest and (mature) brigalow scrub. The formation is richly developed further east, and includes true rainforest and other associations.

III. The Acacia Scrub Formation, including the following associations:—

1. Gidgea scrub (fig. 17).
2. Mulga scrub and its variations, including most of the communities of *Cassia phyllodinea* and some claypans (figs. 18-20).
3. Lancewood scrub.

IV. The *Triodia* Formation, with four well-defined associations—

1. The *Eucalyptus pallidifolia—E. leucophylla—Triodia* Association, comprising the first and second *Triodia* communities described above (fig. 32).
2. The Desert Sandstone Association, consisting of the *Triodia* communities associated with *Eucalyptus normantonensis*, gidgea, lancewood, and mulga. (The third community figs. 29-31.)
3. The Spinifex Sand Plain. (The fourth community—fig. 28.)
4. The sixth community (*T. irritans* or an allied species) is best regarded as a distinct association belonging to this formation.

V. The Grassland Formation with the following associations:—

1. The Blue Grass Association. (Fig. 2.)
2. The Ashy Downs Mitchell Grass Association. (Figs. 3-4.)
3. The Gravelly Downs Mitchell Grass Association. (Figs. 6-9.)
4. A Herb Steppe Association. (Fig. 11.)

Each of the first three associations consist almost entirely of the communities described above under these names. The various types described may be regarded as sub-associations. The fourth association consists of a small part of the annual chenopod communities, particularly those in which *Atriplex Muelleri, A. spongiosa, A. conduplicata, Bassia lanicuspis, B.* aff. *divaricata,* and *B. anisacanthoides* play an important part. The first association is complementary with both the second and third, and the third and fourth with one another. The second and third intergrade or alternate and may be in part complementary, but there is insufficient evidence on this point.

VI. The Channel Country Formation, included in which are:—

1. A Fringing Forest Association, including the *Eucalyptus coolabah* and *E. coolabah—E. ochrophloia* communities, and the minor communities described under these. (Fig. 37.)

2. The Herbaceous communities of the alluvial plains. (Figs. 37, 38.)
3. Most of the communities of *Atriplex nummularia* (old man saltbush).
4. Some of the cottonbush and samphire communities.
5. Some claypans.

The formation is a heterogeneous and discontinuous one, but the communities cannot be satisfactorily arranged elsewhere. They are all dependent more or less for their existence on the actual flooding of the country. Where water lies for any length of time, swamp conditions prevail, and as similar conditions occur beyond the limits of the true channel country, these communties have been considered to form a separate but likewise discontinuous formation.

VII. The Swamp Formation.—There is possibly but one association with, however, three well-marked consociations.

1. Lignum swamp. (Fig. 39.)
2. *Glyceria ramigera* (cane grass) swamp.
3. *Chenopodium* (including Blue bush, *C. auricomum*) swamps.

VIII. The Shrub Steppe Formation.—The best developed associations are—

1. The *Kochia planifolia* Association and other *Kochia* communities.
2. The *Atriplex vesicaria* Association, consisting of scattered communities of this species. (Fig. 35.)
3. The cotton-bush communities (in part).

The first of these associations is small in area and consists of scattered communities, the others are closely connected with, and grade into, associations of other formations.

IX. Desert.—The true desert in Queensland embraces the Simpson Desert (figs. 21-23) and Sturt's Stony Desert. The Simpson Desert consists of the true desert sandhills alternating with claypans, the latter of which sometimes carry gidgea, mulga, coolibah, or cotton-bush steppe. Near Poeppel Corner mulga occurs on the sandhills themselves.

The Stony Desert grades into the gravelly downs, and in places is complementary thereto. In its extreme form it carries a few plants of *Eremophila,* &c., and scattered plants of annual species of *Chenopodiaceae,* particularly *Bassia* spp. (fig. 5).

Ecotones.—Some of the above formations and associations are remarkably well defined, as for example, Mitchell grass grassland and Eucalyptus forest, grassland and the various *Triodia* associations, &c., but in others broad ecotones occur. This is particularly noticeable between Eucalyptus forest and mulga scrub. Sometimes gidgea scrub acts almost as an ecotone between the Mitchell grass associations and the other associations.

Explanatory Notes to the Map.—It has been found advisable to omit the swamp formation and not to distinguish the different associations of the forest, shrub steppe, and channel country formations. Broad ecotones are indicated by diamonds, alternes by narrow horizontal bands,

and scattered small areas by triangles. These diamonds, bands, and triangles refer merely to areas in which these features occur, not to definite areas occupied. Likewise areas in which fluctuating climaxes occur are indicated by vertical bands.

The height of the geological hammer to be seen in some of the plates is 13 inches.

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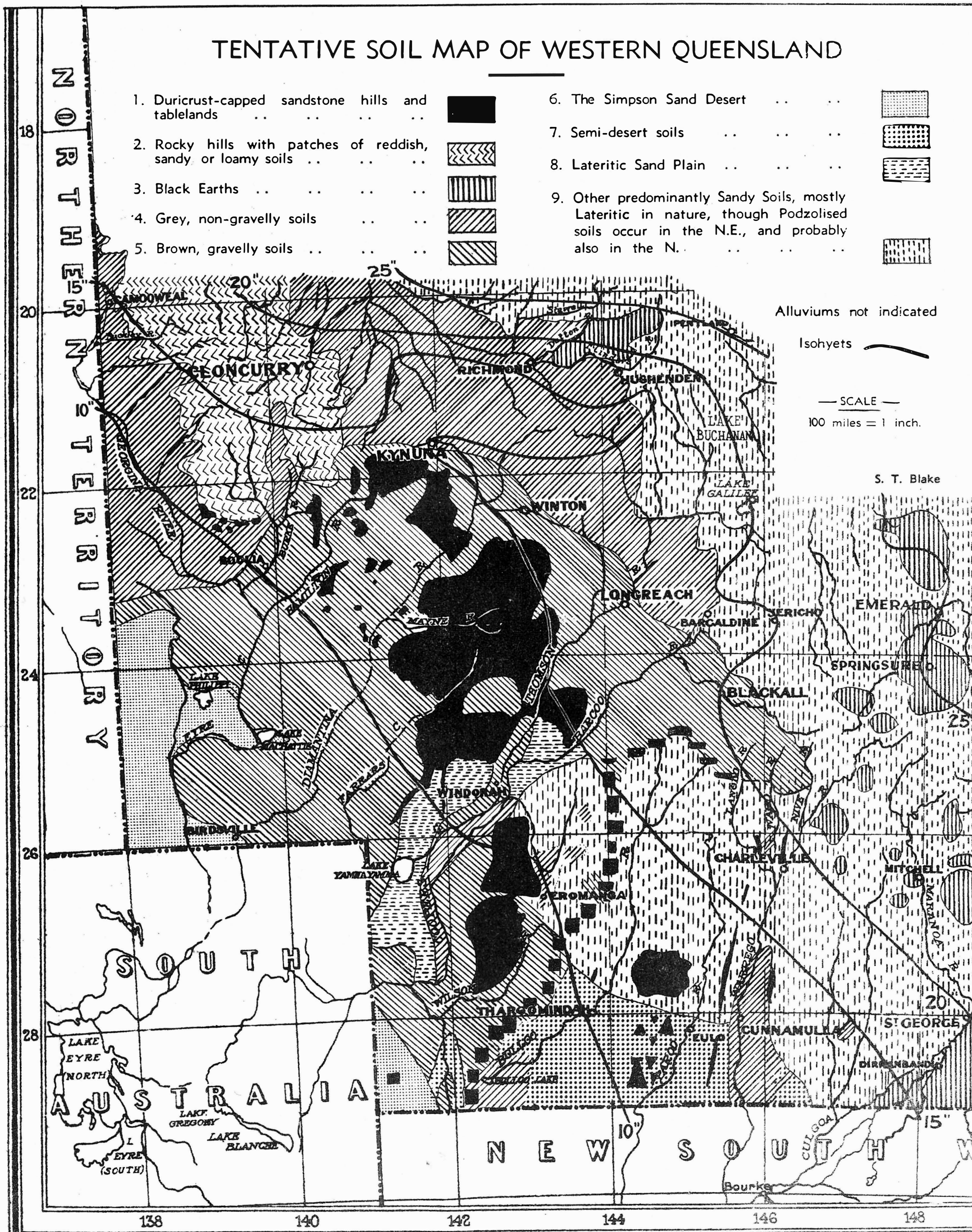
TENTATIVE SOIL MAP OF WESTERN QUEENSLAND
1. Duricrust-capped sandstone hills and tablelands
2. Rocky hills with patches of reddish, sandy or loamy soils
3. Black Earths
4. Grey, non-gravelly soils
5. Brown, gravelly soils
6. The Simpson Sand Desert
7. Semi-desert soils
8. Lateritic Sand Plain
9. Other predominantly Sandy Soils, mostly Lateritic in nature, though Podzolised soils occur in the N.E., and probably also in the N.
Alluviums not indicated
Isohyets
SCALE
100 miles = 1 inch.
S. T. Blake
NORTHERN TERRITORY
SOUTH AUSTRALIA
NEW SOUTH W
CAMOOWEAL
CLONCURRY
RICHMOND
HUGHENDEN
PENTLAND
LAKE BUCHANAN
LAKE GALILEE
KYNUNA
WINTON
BOULIA
LONGREACH
BARCALDINE
JERICHO
EMERALD
SPRINGSURE
BLACKALL
LAKE PHILIPPI
LAKE MACHATTIE
DIAMANTINA
THOMSON
BARCOO
WINDORAH
BIRDSVILLE
LAKE YAMMAYAMMA
EROMANGA
CHARLEVILLE
MITCHELL
THARGOMINDAH
EULO
CUNNAMULLA
ST GEORGE
DIRRANBANDI
LAKE EYRE (NORTH)
LAKE EYRE (SOUTH)
LAKE GREGORY
LAKE BLANCHE
CULGOA
Bourke
18
20
22
24
26
28
138
140
142
144
146
148
25"
20"
15"
10"
25
20

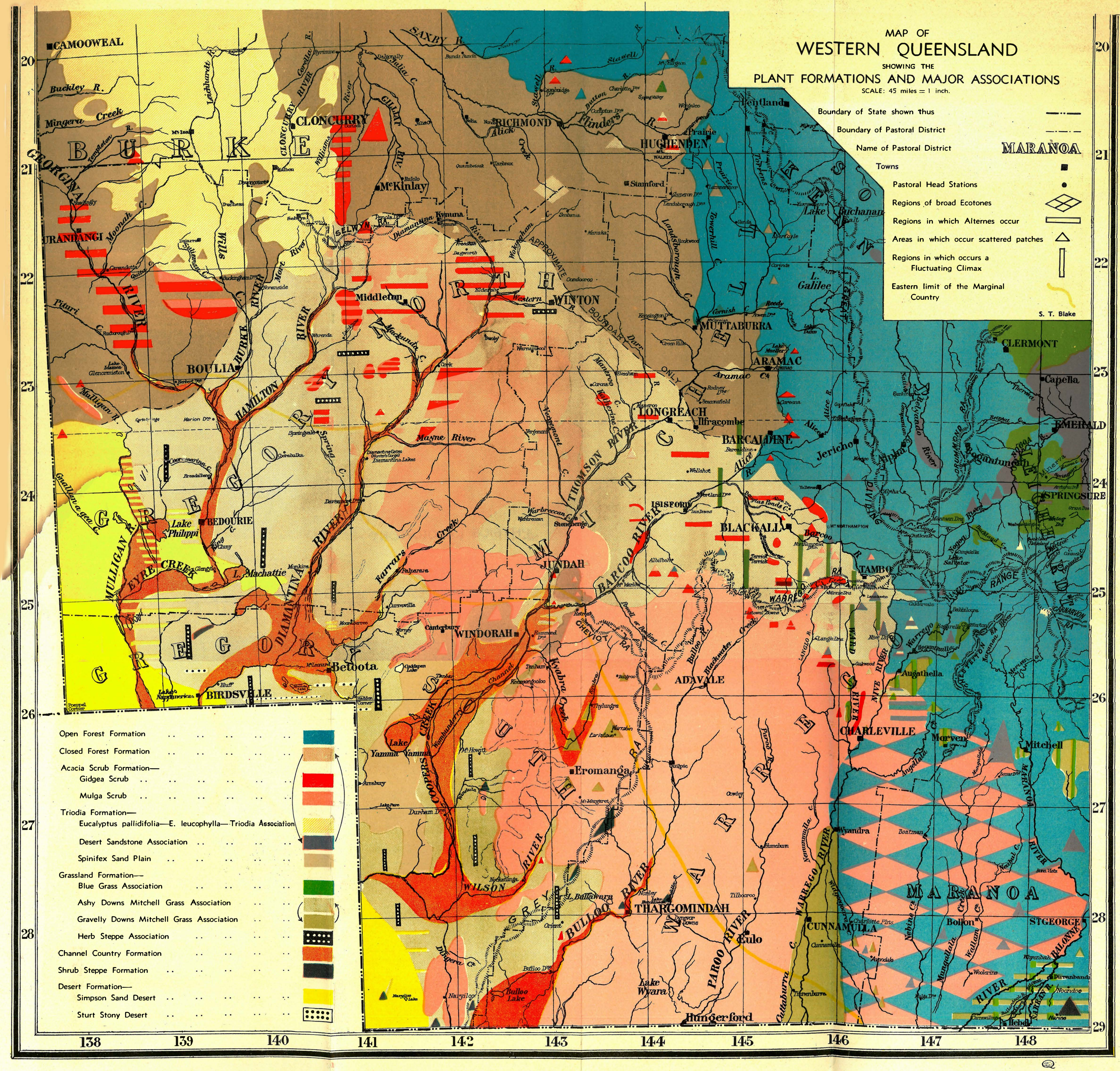
MAP OF
WESTERN QUEENSLAND
SHOWING THE
PLANT FORMATIONS AND MAJOR ASSOCIATIONS
SCALE: 45 miles = 1 inch.
Boundary of State shown thus
Boundary of Pastoral District
Name of Pastoral District
MARANOA
Towns
Pastoral Head Stations
Regions of broad Ecotones
Regions in which Alternes occur
Areas in which occur scattered patches
Regions in which occurs a Fluctuating Climax
Eastern limit of the Marginal Country
S. T. Blake
Open Forest Formation
Closed Forest Formation
Acacia Scrub Formation—
Gidgea Scrub
Mulga Scrub
Triodia Formation—
Eucalyptus pallidifolia—E. leucophylla—Triodia Association
Desert Sandstone Association
Spinifex Sand Plain
Grassland Formation—
Blue Grass Association
Ashy Downs Mitchell Grass Association
Gravelly Downs Mitchell Grass Association
Herb Steppe Association
Channel Country Formation
Shrub Steppe Formation
Desert Formation—
Simpson Sand Desert
Sturt Stony Desert
BURKE
NORTH GREGORY
SOUTH GREGORY
GREGORY
MITCHELL
WARREGO
LEICHHARDT
KENNEDY
MARANOA
CAMOOWEAL
CLONCURRY
RICHMOND
HUGHENDEN
McKinlay
URANDANGI
BOULIA
Middleton
WINTON
MUTTABURRA
ARAMAC
LONGREACH
Ilfracombe
BARCALDINE
Jericho
Alpha
CLERMONT
Capella
EMERALD
SPRINGSURE
BEDOURIE
Lake Philippi
ISISFORD
BLACKALL
TAMBO
JUNDAH
WINDORAH
Betoota
BIRDSVILLE
ADAVALE
Augathella
CHARLEVILLE
Morven
Mitchell
Eromanga
Lake Yamma Yamma
THARGOMINDAH
Eulo
CUNNAMULLA
Hungerford
Bullo Lake
Lake Wyara
Bollon
ST GEORGE
Pentland
Prairie
Stamford
Galilee
Lake Buchanan
DIAMANTINA RIVER
GEORGINA RIVER
THOMSON RIVER
BARCOO RIVER
WARREGO RIVER
PAROO RIVER
BULLOO RIVER
COOPERS CREEK
WILSON RIVER
MULLIGAN R.
EYRE CREEK
HAMILTON
138
139
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Fig. 1.—Near Barcaldine. Junction of the "desert" (the sandy forest country on the left) and the "downs" (the grassland on heavy soil to the right. A gidgea scrub is visible in the extreme distance).

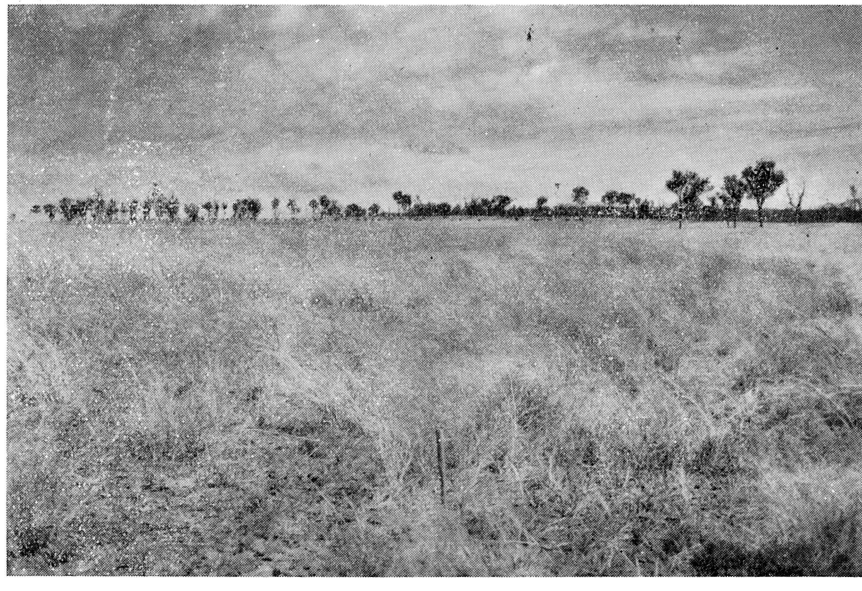

Fig. 2.—Chesterton. Blue-grass grassland with chiefly *Dichanthium sericeum*, *Thellungia advena*, *Aristida leptopoda*, *Bothriochloa erianthoides*, and *Themeda avenacea*; *Eucalyptus melanophloia* in the distance.

Fig. 3.—Frensham, near Kynuna. Ashy Downs with *Astrebla elymoides, A. lappacea, Iseilema* spp., and other plants.

Fig. 4.—About twenty miles south of Wyandra. Ashy Downs (on old alluvium) showing *Astrebla lappacea, A. elymoides, Iseilema* spp. and other plants. Fringing forest in the background.

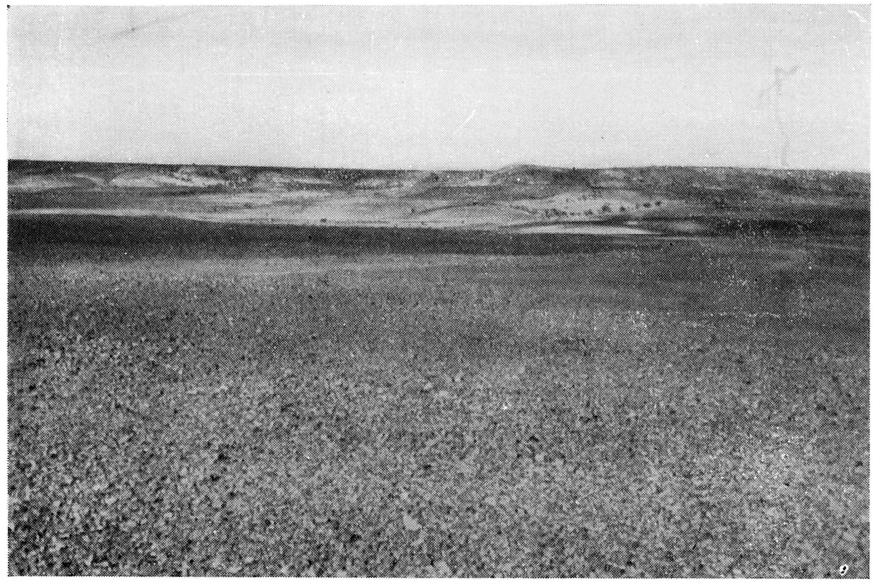

Fig. 5.—East of Birdsville, lat. 25° 45′ S. long. 140° E. on Sturt's Stony Desert; vegetation restricted almost entirely to a few shrubs of *Eremophila Latrobei* in the gullies of the ridges. A solitary plant of *Bassia* sp. aff. *divaricata* in left foreground.

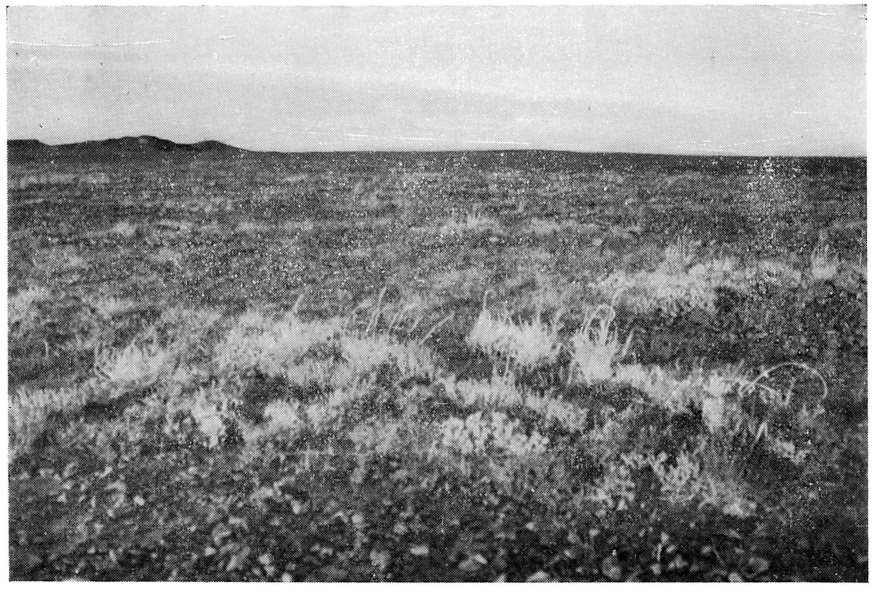

Fig. 6.—South-east of Haddon Corner. Gravelly Downs showing crabholes; the plants, chiefly *Astrebla pectinata*, *Sporobolus actinocladus*, *Bassia* spp., and *Atriplex* spp., are restricted to the crabholes.

Fig. 7.—Elderslie Station, west of Winton. Gravelly Downs showing alterne of *Bassia lanicuspis* (in foreground) and *Astrebla pectinata*. Gidgea (*Acacia Cambagei*) in far distance.

Fig. 8.—Elderslie Station, west of Winton. Gravelly Downs showing heavy coating of Mitchell grass, &c., chiefly *Astrebla pectinata* and *A. elymoides* with *A. squarrosa* in crabholes (as at bottom right), together with *Iseilema membranaceum*, *Panicum Whitei*, *Abutilon malvifolium*, &c.

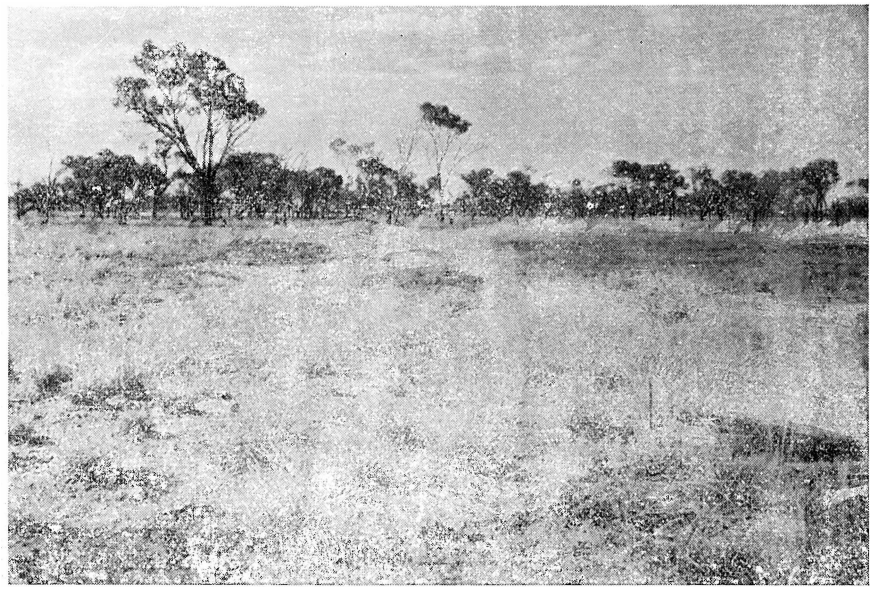

Fig. 9.—Near Longreach. Gidgea—boree Downs showing grazed Mitchell grass, chiefly *Astrebla pectinata* and *A. lappacea*, with *A. squarrosa* in crabholes; young *Atriplex Muelleri*, *Bassia echinopsila*, and *Salsola* also present. Most of the trees are gidgea, with boree in centre distance.

Fig. 10.—Kalkadoon Station, south-west of Winton. Gidgea and *Bassia* spp. being replaced by grass (the whitish plants).

Fig. 11.—West of Thargomindah on western slope of Grey Range. Gravelly Downs, herb steppe stage; chiefly *Bassia* spp. and *Atriplex* spp., with a few plants of *Astrebla pectinata* (whitish plants) and, in foreground, dead dwarf gidgea. In the distance is a gidgea-fringed creek, and on the skyline a range of desert sandstone hills.

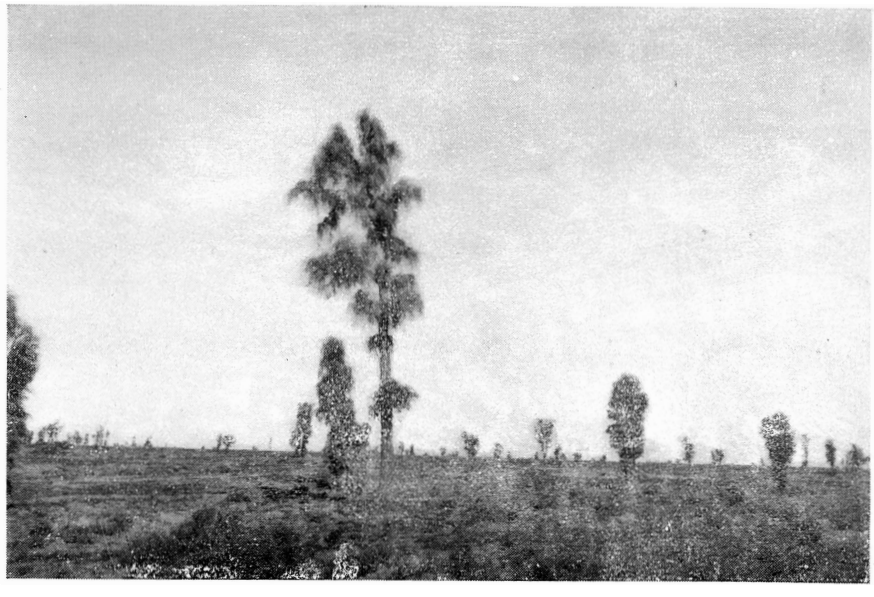

Fig. 12.—About ten miles north of Birdsville. Gravelly Downs with drift sand carrying waddy (*Acacia Peuce*, the tree), *Kochia* sp., *Cassia* sp., *Stenopetalum lineare*, *Iseilema eremaeum*, and other plants.

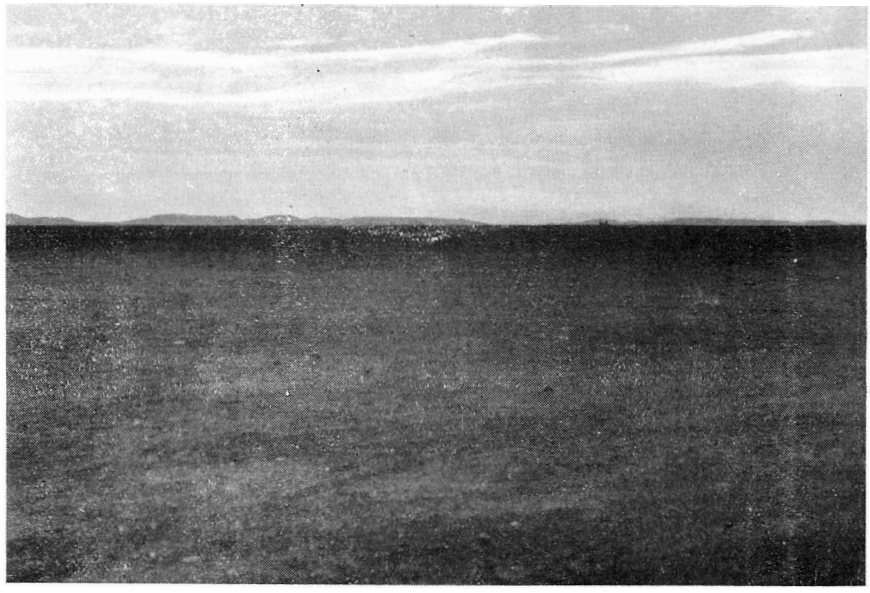

Fig. 13.—Near Middleton. Stock route on Gravelly Downs overgrazed to bareness. Hills of desert sandstone in the distance.

Fig. 14.—Cunnamulla. A claypan in an old alluvium, showing a sandy "island" with annual plants, including *Tragus biflorus, Aristida anthoxanthoides, Dactyloctenium radulans,* and *Bassia lanicuspis.* Fringing forest of *Eucalyptus coolabah* in the background.

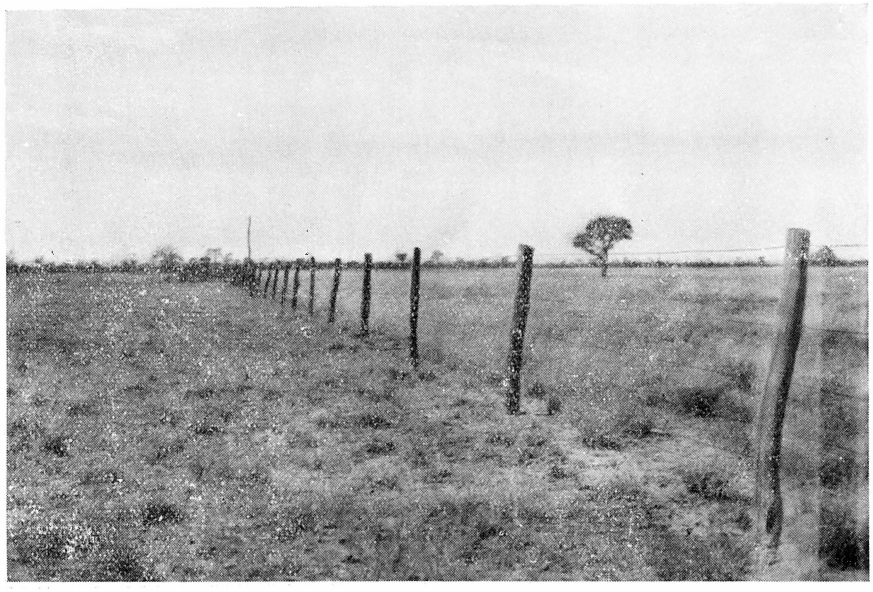

Fig. 15.—Near Barcaldine. A boundary fence on Ashy Downs; on the right is a heavily-stocked paddock, showing a good growth of Mitchell grass; while on the left is vacant ground with a sparse vegetation of chiefly *Salsola* and *Euphorbia Stevenii*.

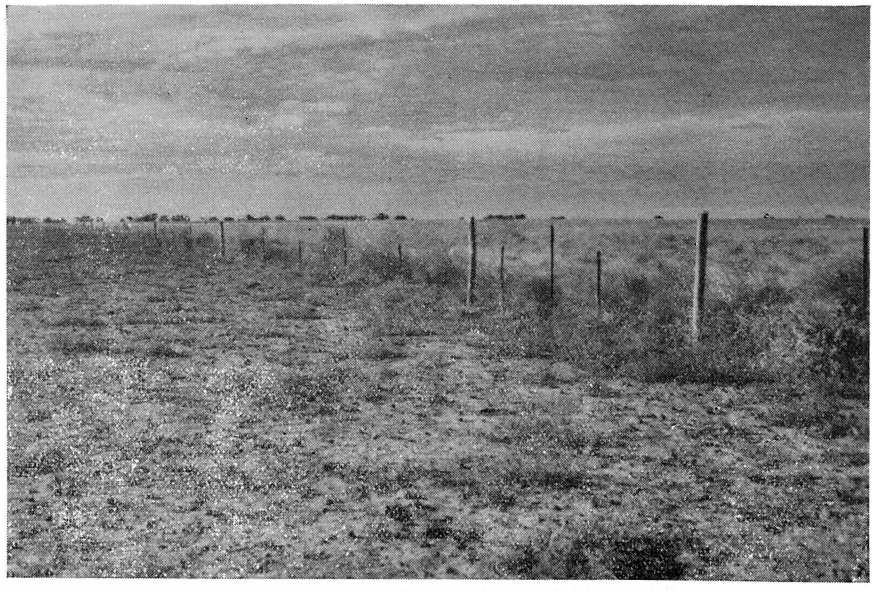

Fig. 16.—Essex Downs, south of Richmond. Dividing fence on grassland, running north-south between two paddocks which have been similarly stocked. The near side has been overgrazed, and the far side but slightly grazed, due to the tendency for sheep to graze into the prevailing easterly wind. The country is intermediate between true gravelly downs and ashy downs, but approaches the former.

Fig. 17.—Twenty-five miles south of Wyandra. Gidgea scrub with a sparse ground cover of *Tripogon loliiformis, Atriplex* spp. and *Salsola*. *Eremophila Mitchellii* in right middle distance.

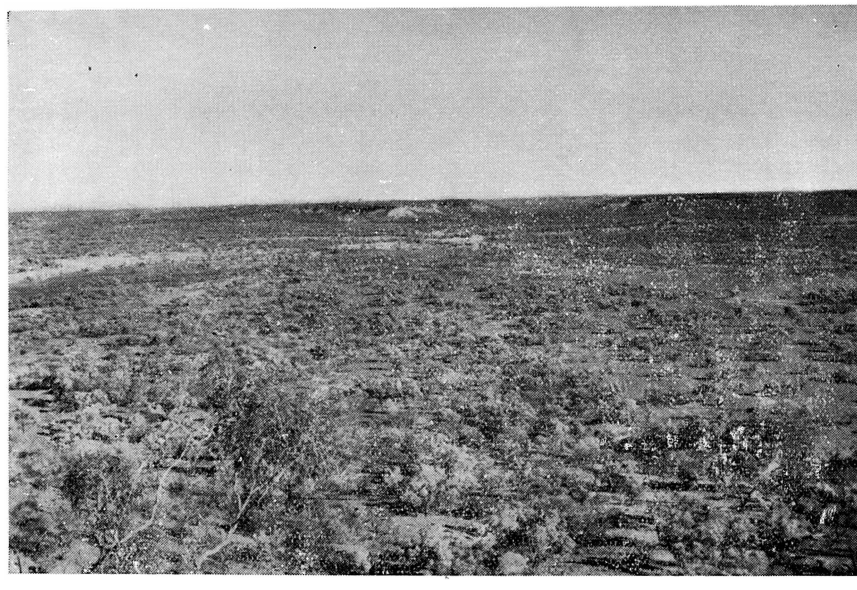

Fig. 18.—West of Eromanga, in hilly sandstone country. Overlooking mulga scrub, showing the spatial distribution of the trees. In the left foreground can be seen *Eucalyptus Thozetiana* growing on the side of the hill.

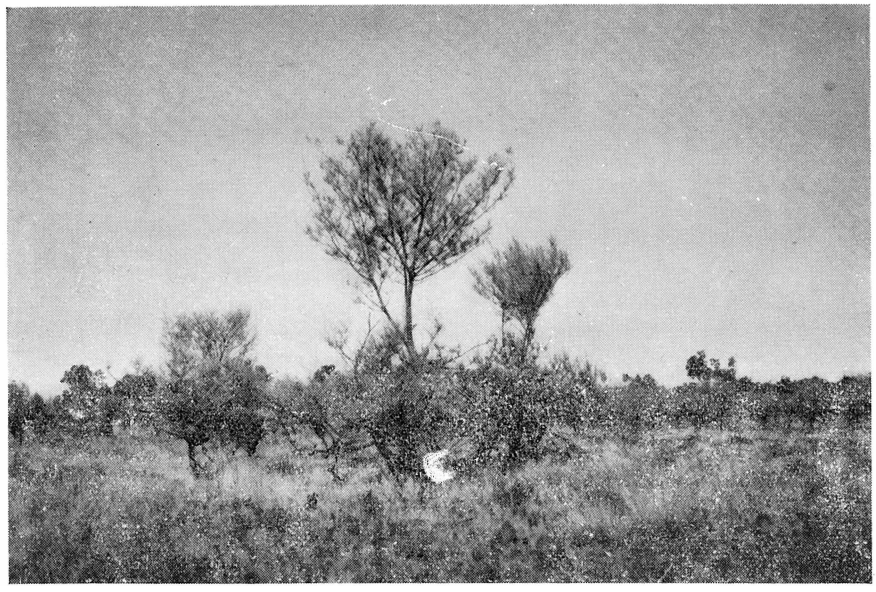

Fig. 19.—About twenty miles west of Cunnamulla. Mulga regenerating from pruning; *Enneapogon* sp., *Bassia* spp., and *Salsola* in foreground.

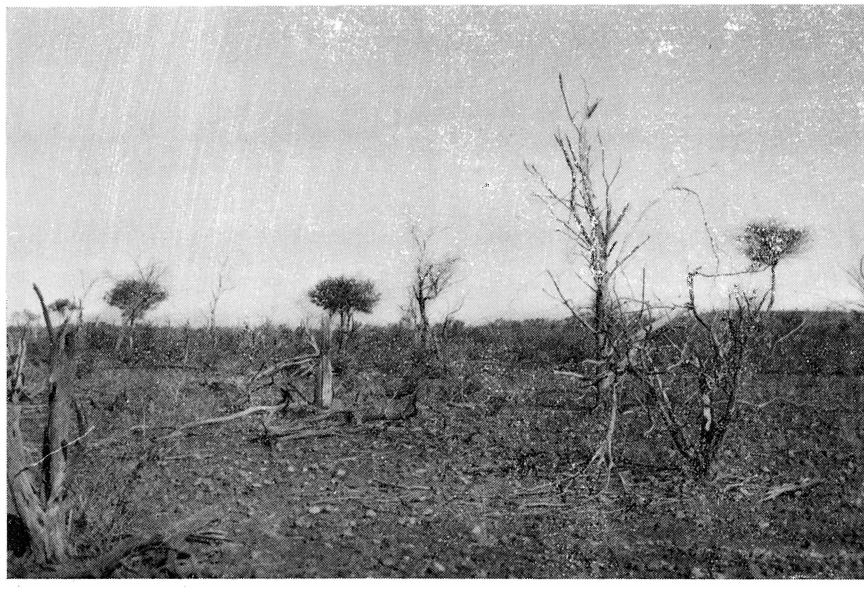

Fig. 20.—About forty miles south of Eromanga. Mulga country showing destruction caused by improper methods of cutting.

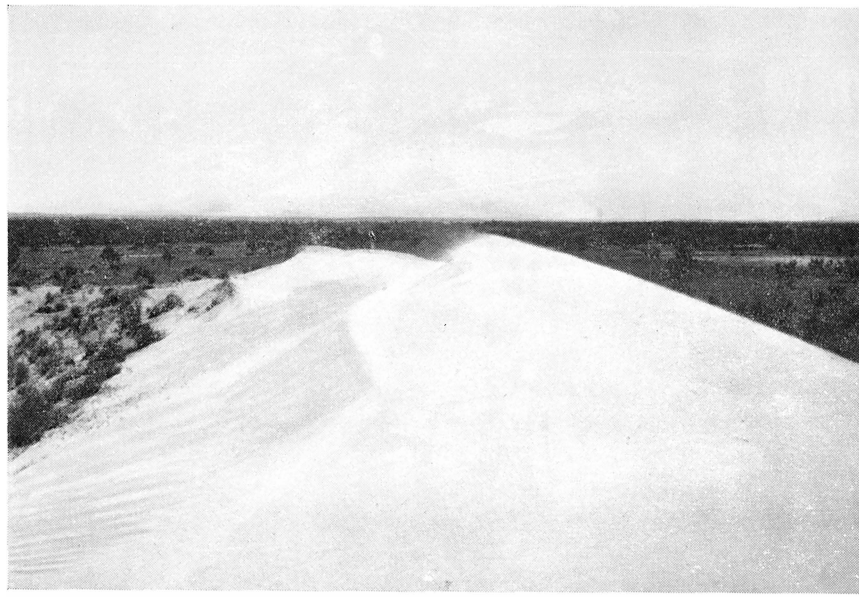

Fig. 21.—Near Birdsville. Sandhill desert; north end of sandhill showing sand blowing. Channel country of the Diamantina beyond.

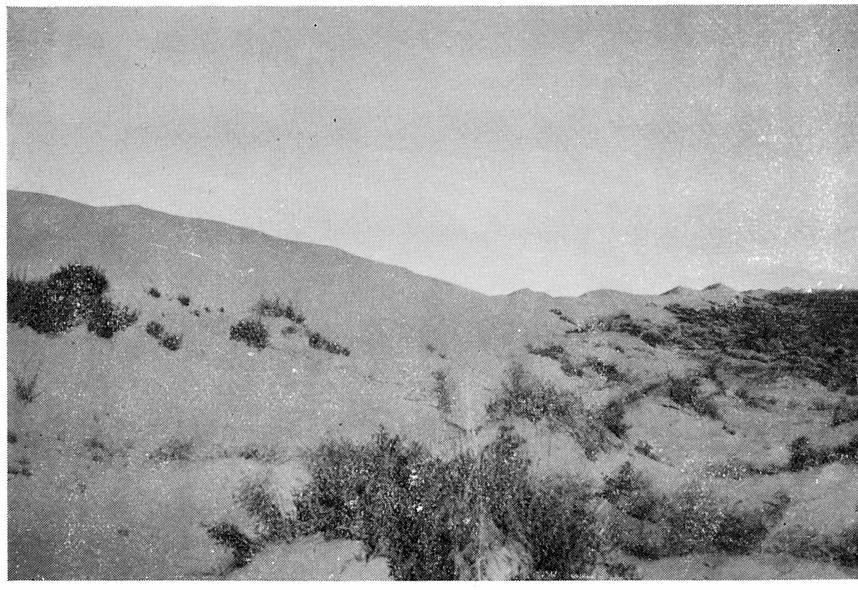

Fig. 22.—Near Birdsville. View along the length of the sandhill figured above (western side), showing the characteristic naked crest, and the sandhill canegrass (*Spinifex paradoxus*) holding the sand on the lower slopes.

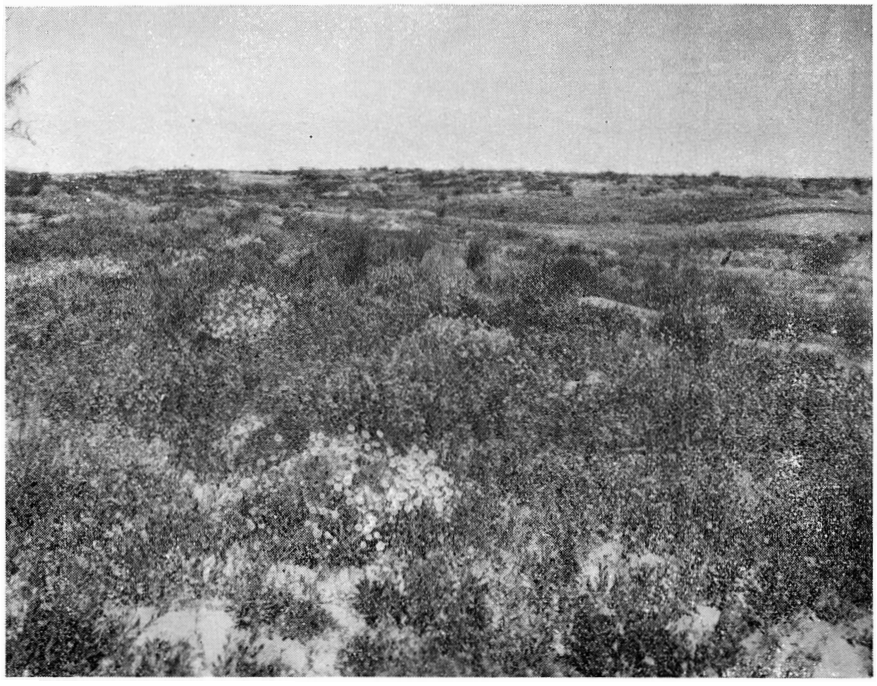

Fig. 23.—Near Birdsville. Near the base of the sandhill in Figs. 21 and 22, showing wealth of flowering annuals, chiefly *Goodenia cycloptera* ? (small flowers), and *Myriocephalus Stuartii* (with large flowers), together with *Blennodia canescens* and *Spinifex paradoxus* (the shrubby plants in centre).

Fig. 24.—Nockatunga country. A sandhill of the marginal country, with *Plagiosetum refractum* colonising the bare side and a shrub of *Acacia ligulata* on top. Note the irregular direction of the hill.

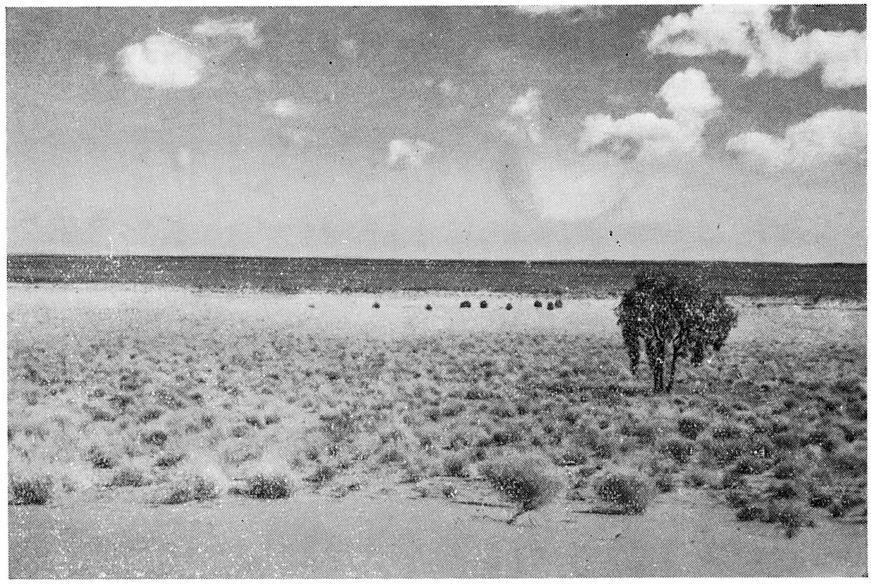

Fig. 25.—Mount Howitt. Marginal country showing "spread" of sandhill. The extent of the "spread" is shown by the whitish area carrying a mixed partly perennial vegetation, of which *Crotolaria eremaea* (small shrubs in foreground), *Eriachne* spp., *Aristida* spp., *Neurachne* sp., and *Salsola* are most prominent. The tree is a bloodwood (*Eucalyptus pyrophora*), the dark shrubs in the middistance are *Cassia* spp., and beyond is open plain (gravelly downs, *Bassia* stage).

Fig. 26.—Mount Howitt. A shallow lake, not yet dry, actually in a sandhill, with pigweed (*Portulaca* sp.) and nardoo (*Marsilea Drummondii*), while beyond is a heavily-vegetated part of the ridge carrying, among other plants, *Hakea leucoptera* and *Rhagodia parabolica*.

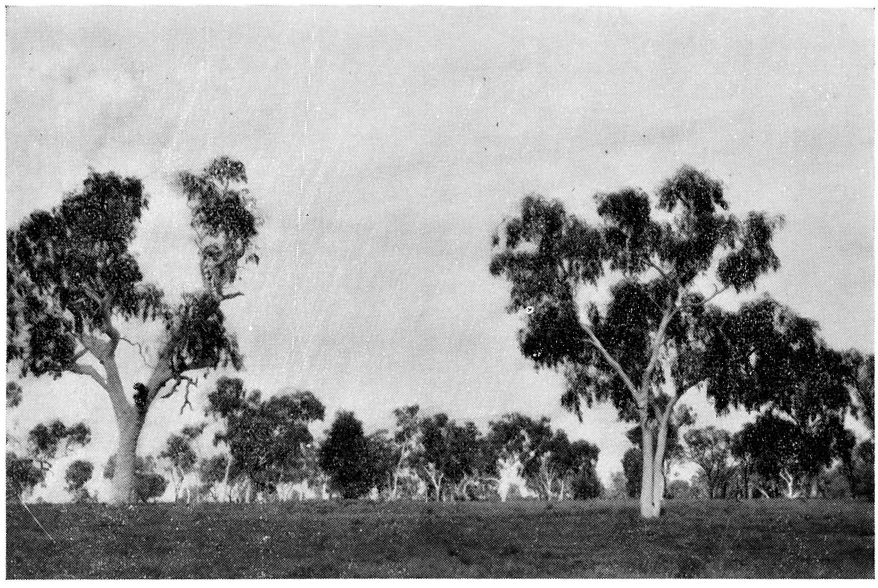

Fig. 27.—Near (south of) Boulia. The final stage in the degradation of the desert sandhills; a low, scarcely perceptible ridge of sand with large trees of *Eucalyptus papuana*.

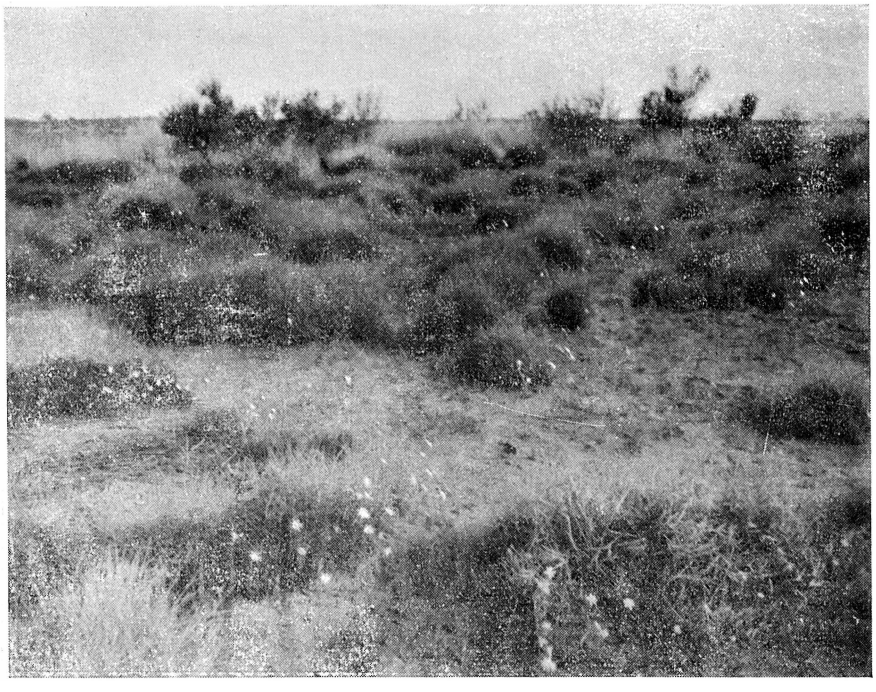

Fig. 28.—Tanbar country, south-west of Windorah. Spinifex sand-plain with *Triodia Basedowii*, *Senecio Gregorii* (the small, large-flowered plant) and shrubs of *Hakea Ivoryi* behind.

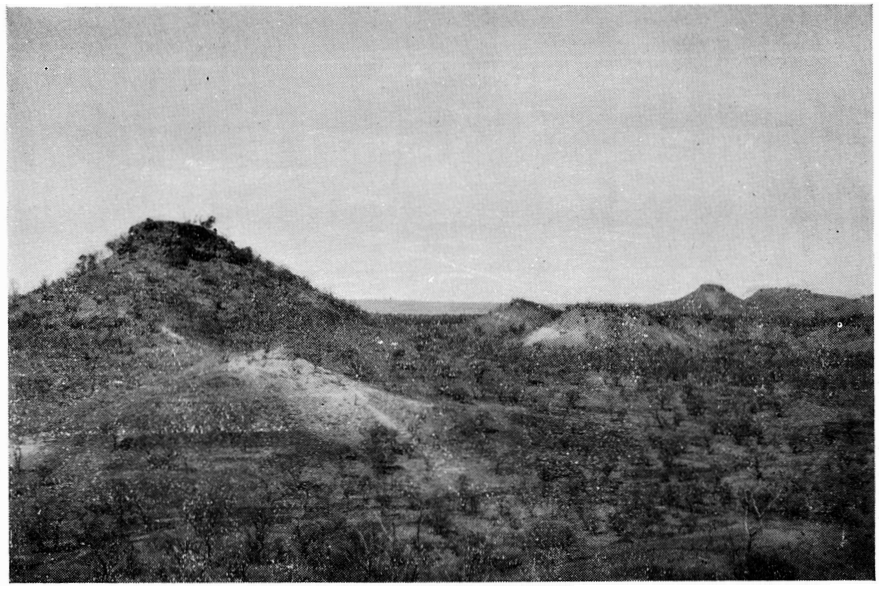

Fig. 29.—Tranby. Edge of part of the Desert Sandstone showing the characteristic flat-topped, duricrust-capped hills in various stages of weathering and vegetated by gidgea, lancewood, and *Triodia*.

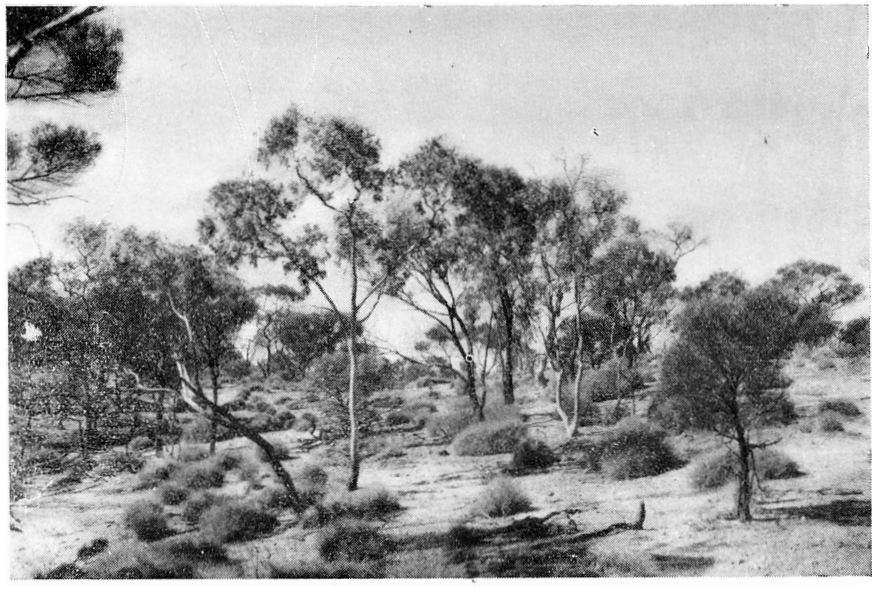

Fig. 30.—Tranby. Desert Sandstone tableland with lancewood and *Triodia*; *Eucalyptus* sp. in centre.

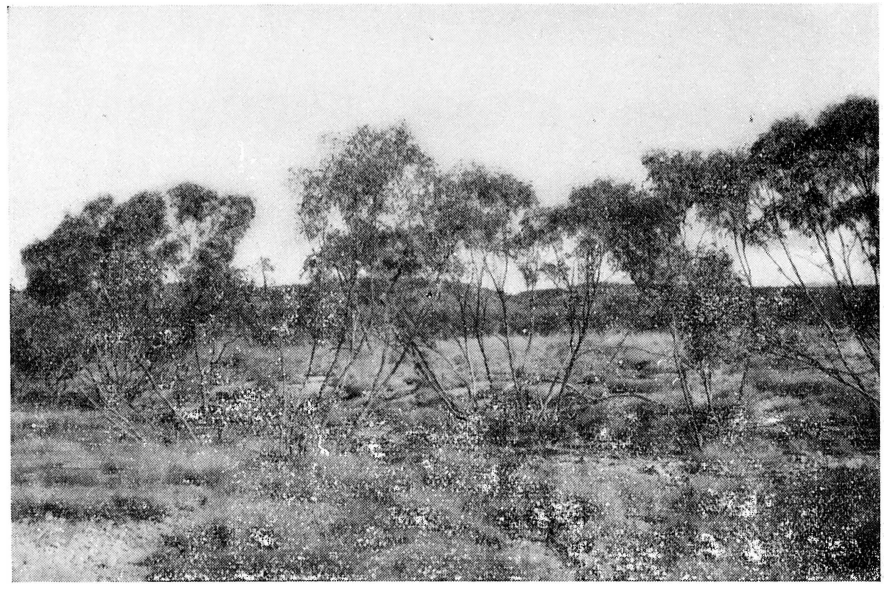

Fig. 31.—Tranby. A valley in the Desert Sandstone with *Eucalyptus normantonensis* and *Triodia.*

Fig. 32.—Between Duchess and Malbon. *Eucalyptus pallidifolia* and *Triodia pungens* with *Cassia* sp., and *Trichinium* sp.

Fig. 33.—Near Alice. *Eucalyptus erythrophloia* and *Triodia Mitchellii* on red sand.

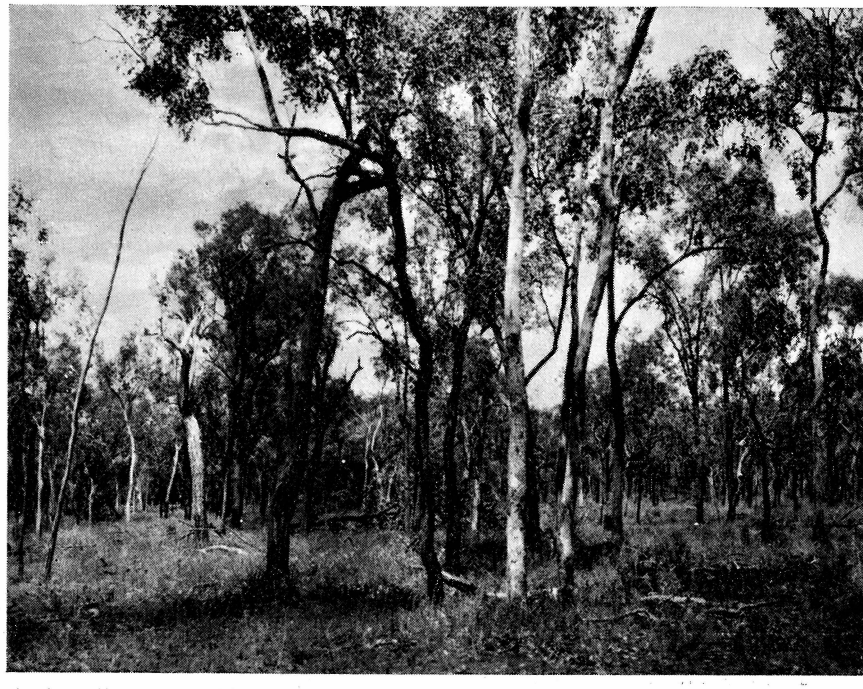

Fig. 34.—Minerva, north of Springsure. *Eucalyptus populifolia—E. melanophloia* forest.

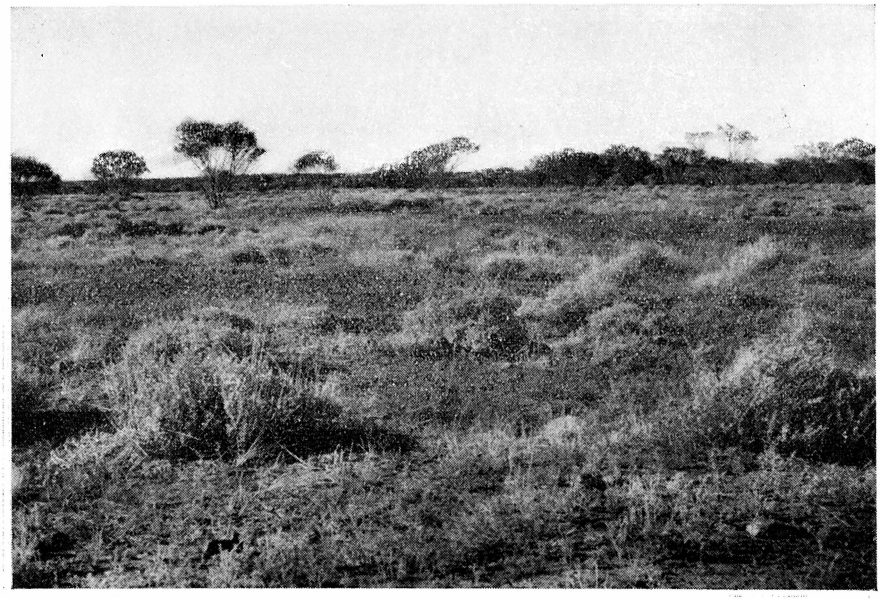

Fig. 35.—West of Thargomindah on slopes of the Grey Range. Saltbush steppe; the large bushes are *Atriplex vesicaria*, with chiefly annual spp. of *Atriplex* and *Bassia* between; in the centre distance is *Eremophila Dalyana* (shrubby trees) with gidgea beyond.

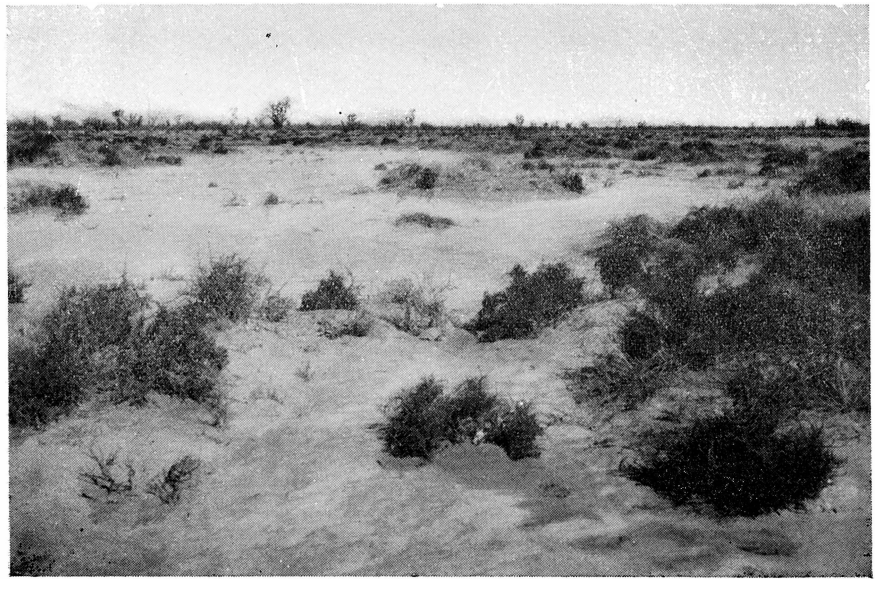

Fig. 36.—Nockatunga. Shrub steppe on silt bed, with *Kochia aphylla*, *Bassia* spp. *Eragrostis Dielsii* and spp. and other plants. Yapunyah (*Eucalyptus ochrophloia*) in the distance.

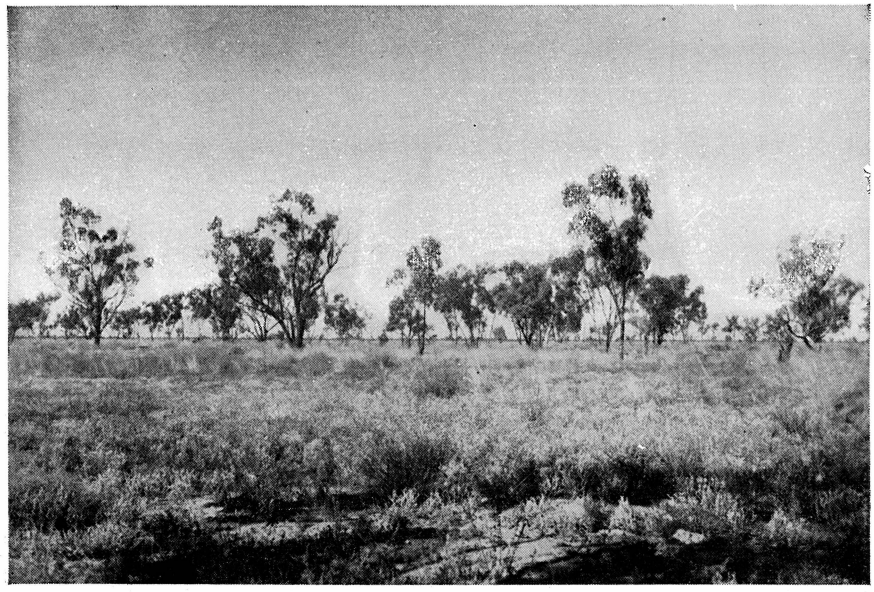

Fig. 37.—Nockatunga. Channel country of the Wilson River, showing a slight fringing forest of yapunyah (*Eucalyptus ochrophloia*) and coolibah (*E. coolabah*), bluebush, numerous annual chenopods, pepper grass, and *Eragrostis* spp.

Fig. 38.—Mount Howitt. Channel country of Cooper's Creek with *Trigonella suavissima*, *Blennodia* spp., numerous composites, and pepper grass. In the distance is a low sandridge.

Fig. 39.—About sixty miles east of Birdsville overlooking the Diamantina River in partial flood. Lignum swamp in the foreground with fringing forest of *Eucalyptus coolabah* behind.

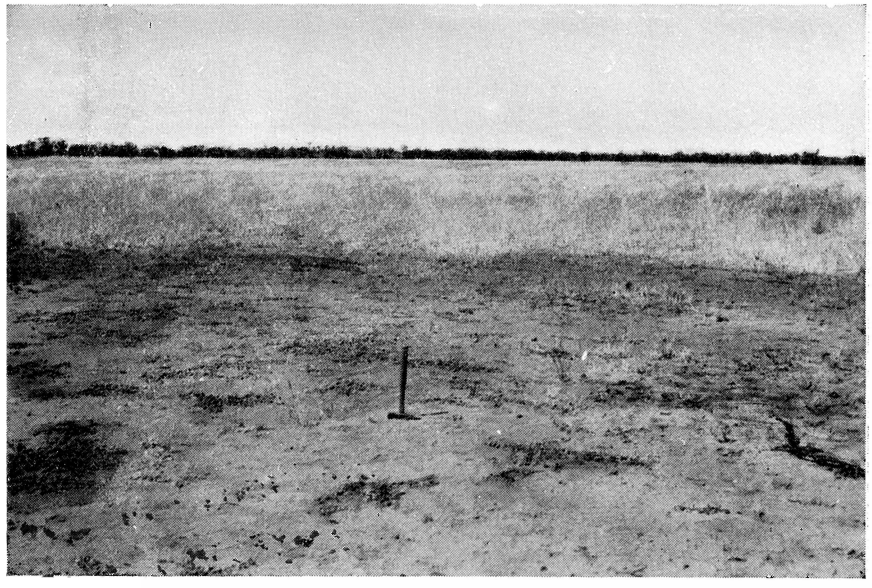

Fig. 40.—About twenty miles south of Wyandra. A claypan in grassland being colonised by pigweed, *Aristida anthoxanthoides, Bassia lanicuspis,* and button grass (*Dactyloctenium radulans*).