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THE INTERRELATIONSHIPS OF THE PLANT COMMUNITIES OF QUEENSLAND.

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THE INTERRELATIONSHIPS OF THE PLANT COMMUNITIES OF QUEENSLAND.

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INTRODUCTION.

In North-Eastern Australia, approximately that area lying within the boundaries of the State of Queensland, is to be found a wide variety of plant-communities, from very heavy rain-forest to desert, and from mangrove forest to high mountain scrub and moorland. The relationships of many of these communities, both between themselves and to other factors, are particularly interesting, and in this paper it is proposed to offer interpretations to some of these relationships. The communities to be found in the inland areas have been described and discussed in a previous paper (Blake, 1938), the rain-forests have been discussed by Domin (1910) and Francis (1929), but many of the important communities in the region have not yet been satisfactorily described, and some are but poorly known.

GENERAL FEATURES.

The most important factors influencing vegetation in the region are the nature of the soil and available moisture. Soil type is chiefly dependent on rock-type, modified and sometimes controlled by climate in the coastal and subcoastal areas, but apparently almost or quite independent of it in the interior. Topography may also be a modifying factor, but where this does not enter into things the lines of demarcation of soil types and the vegetation types supported thereby are often amazingly sharp. The available moisture depends in some degree on the amount of rainfall, more so on its distribution (mean annual rainfall has comparatively little significance except in extremes, chiefly in the lower end of the scale), on the retentive capacity and the depth of the latter, and on drainage. Rate of evaporation is a powerful modifying factor. Temperature affects the development of communities to some extent, though chiefly as extremes, such as at high altitudes.

One very interesting feature which controls the distribution of the communities of the interior is afforded by the peculiar topography of the country. The slope, and therefore the flow of the rivers is in a general south-west direction towards the centre of the continent. This is almost at right angles to the trend of the isohyets, so that the streams, flowing through progressively drier and flatter country, tend to lose themselves in extensive flood plains. Furthermore, across the direction of flow of these rivers in the middle part of their courses, but not at right angles with them, is a large system of sandstone hills, ranges, and tablelands through which the streams pass, usually by means of valleys of greater or less width, or very occasionally by means of steep gorges. The slopes of these hills are mostly very steep and erosion goes on at a relatively rapid rate, so that after storms and heavy showers a supply of silt is regularly delivered to the main streams to be deposited later over the flood plains of their lower courses.

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It is on these silt plains, watered by the periodical floods from the rains falling over the upper parts of the watersheds, that there is developed the diversified and economically valuable vegetation of the channel country, consisting of fringing forest, swamps, claypans, and luxuriant herb meadow. The existence of the formation depends, not on the amount of rain falling over the area, but on the water retained in the soil during and after the subsidence of flood waters.

RAIN FOREST.

The antithesis of this is shown by the rain forest or jungle of the eastern coastal belt, chiefly developed in areas where the yearly rainfall is 60 inches or over, more or less evenly distributed, and which are not unduly exposed to gales. Rain forest may be developed in places with a considerably lower rainfall provided that edaphic conditions compensate for this lack, as along stream banks, in sheltered valleys, and upon the deep red loams so characteristic of the basalt-capped tablelands and ranges of the coastal districts. The effect of exposure to sea breezes is well seen near Cape Moreton. Here, with a fairly evenly distributed yearly rainfall of 63 inches but on a shallow sandy soil exposed to every gale, a low shrubbery allied to wallum is developed, scarcely 2 feet high and sometimes lower. The chief woody plants are *Casuarina suberosa* and *Banksia aemula,* species which are normally trees, but are here overtopped by grasses (chiefly *Themeda australis*) though fruiting freely. In less exposed places the shrubs are higher and *Tristania conferta,* a prominent member of the rain-forest ecotone, comes in, firstly as a small shrub.

All rain forest is characterised by a wealth of lianas and epiphytes and the nearly or complete absence of annuals. In the very wet regions the numbers and variety of these epiphytes and lianas are enormous, but in developments in relatively low rainfall they are few, while the characteristic *Hymenophyllaceae* disappear.

The forest canopy usually consists of two or more stories, the net result of which is that the floor is densely shaded, though the individual trees in each story may be relatively widely spaced.

MONSOON FOREST AND BRIGALOW SCRUB.

In regions with a smaller and less equable water-supply, monsoon forest may be developed. Such forest is to be found in places throughout the coastal and sub-coastal areas from at least near the New South Wales border northwards, and in the country surrounding the Gulf of Carpentaria. In the northern parts a pronounced dry winter season and in the south the cold of the winter affects the continuity of the water supply. The communities usually occur on hillsides or hilltops, and in the limestone region in the Chillagoe-Mungana district, they occupy the karst hills as well as granite slopes. As in other community-types in the region, variations in composition occur, and though these are often considerable the general features remain fairly constant. These are essentially an upper story of broad-leaved deciduous or partly deciduous trees, an understory of dense, evergreen, sometimes prickly shrubs and small trees with rather small and hard leaves, one or two somewhat shrubby grasses, and a paucity of lianas and epiphytes. The latter are almost restricted to bryophytes and lichens. The relationships with the open forest in which the communities are often found

are not understood. They often occupy sites apparently similar to others occupied by Eucalyptus forest, yet there is frequently and, perhaps, usually a remarkable absence of ecotone.

Brigalow scrub has usually been regarded as a community of the semi-arid type, but its affinities appear to lie with monsoon forest of which it may be regarded as an extreme phase. The term "scrub" in Queensland is usually applied to a community in which the woody plants grow very close together, and is used irrespective of their size. Thus rain forest and monsoon forest are both popularly referred to as "scrub," sometimes with the distinction of "vine scrub" for the former and "dry scrub" for the latter.

In a well-developed brigalow scrub the trees attain 30 feet or more, and associated are species commonly found in monsoon forests, such as the deciduous trees *Brachychiton rupestre* and *B. trichosiphon,* the smaller hard-leaved evergreens *Canthium vaccinifolium, Celastrus* sp., *Capparis nobilis,* and the shrubby grasses *Panicum uncinulatum* and *Eragrostis megalosperma.* The dominant species of the "scrub" are the brigalow itself (*Acacia harpophylla*) which is leafless (phyllodineous) except in the seedling stage, and the belah (*Casuarina lepidophloia*) which has minute scale-leaves only. The richer scrubs differ little from monsoon forest except that the brigalow, with or without belah, replaces one or more of the trees of the upper story of the latter.

Relatively pure stands of brigalow are to be found, and in most such cases the trees are low.

In South Queensland, brigalow scrub is commonly found on a nearly black very heavy soil in which depressions known as "melon-holes" or "gilgais" are numerous and often are of considerable size. Jensen (1921-1922) has claimed that the heavy nature of the soil is due to a relatively high content of sodium carbonate, and has further postulated that brigalow *requires* a soda-rich soil. Many of Jensen's claims can be refuted by evidence from the very area he traversed—Roma and northwards. My own observations would indicate that brigalow has no very particular soil requirements and it is not uncommon to find communities on stony ridges and even on sand. It is, however, quite certain that brigalow scrub is a distinctly aggressive community and will invade and suppress both open forest and grassland. Pure stands of brigalow usually indicate a young community. As the community ages, the nature of the soil changes to the characteristic blackish, heavy, melon-holey soil. When the community invaded was forest on sandy soil this change is very marked. Old stumps of box (*Eucalyptus populifolia*) within tall scrub now indicates areas thus invaded, though various stages can be seen in many localities. Historial records afford further evidence. When grassland is invaded the changes are, as a rule, not so marked, owing to the nature of the grassland soil from which, however, melon-holes are absent. This invasion is proceeding westward into relatively dry areas (within the 15-inch isohyet) and this will be noticed again later.

OPEN FOREST, SPINIFEX COUNTRY, AND WALLUM.

Open forest in some form or other occupies large areas of North-Eastern Australia. The term forest is used here in rather a wide sense and includes the savannah forest, savannah woodland, and woodland of various authors. Owing to the diverse use of the word

"Savannah" it has seemed preferable not to employ it in this connection. Genuine forest certainly occurs in many places, particularly in areas within which rain forest is developed, and not infrequently the canopy is practically closed. Edaphic conditions, possibly assisted by fire, prevent the establishment of rain forest. In the other extreme the trees are scattered and often irregular. The term "parkland" is used to designate this phase, but it is suggested that some such term as "semi-forest" could be employed to designate the very common state of affairs in which the trees are somewhat distant but by no means scattered. As thus employed, the different terms forest, semi-forest, and parkland, have merely a physiognomic significance. In many places all gradations occur with no apparent difference other than tree-frequency.

Open forests are developed chiefly on soils of light texture, though a clayey subsoil may be present. Parkland occasionally occurs on soils of heavier texture, though such are usually shallow and the community is often an ecotone between forest and grassland. Myrtaceae are usually dominant in these forests, commonly species of *Eucalyptus, Melaleuca, Tristania, Angophora,* and *Syncarpia.* Practically all species are evergreen. Towards the North *Grevillea* becomes prominent, likewise a few deciduous trees such as species of *Terminalia* and *Albizzia,* and annual herbs become more numerous.

Towards the drier parts in the South, open forest passes gradually into mulga scrub, and in the wetter parts generally it passes into, or is replaced by, rain forest. If there is a broad ecotone it frequently consists of a tall, almost closed forest of *Eucalyptus grandis* and *Tristania conferta.* Near the rain-forest edge is an undergrowth of shrubs and trees partly belonging to rain-forest species, partly to species almost restricted to the ecotone. If edaphic differences are not too extreme in such cases there is a tendency for the rain forest to advance. In the very wet parts of the north-east edaphic factors are not so important, and rain forest has been advancing rather rapidly within historical times, modifying the nature of the soil somewhat in its progress, chiefly by the addition of humus and the slowing down of leaching processes.

The ecotone, however, is often very narrow, and this is especially seen in many parts of South-Eastern Queensland where a common occurrence is for sandstone or trachyte mountains and tablelands to be capped with basalt. The latter produces a deep red loam which supports rain forest. The sandstone and trachyte give rise to sandy often shallow soils and support open forest. Occasionally an ecotone is present when conditions are modified somewhat by slope or exposure.

More closely allied to the open forests than to any other formation are the majority of the *Triodia*-dominant communities usually referred to as "spinifex country." Much of this spinifex country is merely open forest, chiefly Eucalyptus forest, in which, owing to slight variations in edaphic factors, *Triodia* dominates or partly replaces the usual grasses of the forest floor. Of such a nature is much of the spinifex country in the so-called "desert country" of Central Queensland.* The species of *Triodia,* many of which are undescribed, usually grow on a highly siliceous substrate, either sand or such rocks as sandstone and granite. Occasionally communities are developed on silt beds subject

* This so-called desert is open forest to parkland supported by sandy soils, and much of it is little different in aspect from some coastal communities.

to flooding, and near the Gulf of Carpentaria they extend into swampy areas, the species being associated with coolibah (*Eucalyptus microtheca*) or tea-tree (*Melaleuca* spp.).

Another group of communities, collectively known as "wallum country," occurs along the east coast on sandy soil, consisting of swamps, *Melaleuca* forests, heath-like shrub-lands (wallum flats), and mixed forest. The communities are well known floristically, but their exact relationships are not quite clear. Drainage appears to be an important factor, the succession from wet to dry being open swamp, *Melaleuca* swamp, *Melaleuca* forest, wallum flats, open forest with undergrowth (wallum scrub), open forest with little undergrowth. *Melaleuca* forest is often present only as a narrow band, and one or other of the communities may not be developed. There is sometimes also a tendency to the development of rain forest, either direct from *Melaleuca* swamp or forest, or through wallum scrub.

Related to wallum in floristic composition and physiognomy is a series of communities developed on and near the crest of certain parts of the Great Dividing Range and its offshoots where the underlying rock is granite or sandstone or other highly siliceous rock. What soil there is, is of course sandy, but it is often very shallow and the surface of the ground is often broken and occasionally rugged. One or other species of *Triodia* is often associated and it may well be that the wallum country is the east-coast equivalent of the inland spinifex country.

GRASSLAND AND STEPPE.

The extensive grasslands of the interior are to be found on heavy brown, grey, or black soils, chiefly in areas with a mean annual rainfall not greatly exceeding 30 inches. In the neighbourhood of the Gulf of Carpentaria, broad-leaved deciduous small trees are usually prominent and the communities answer very well to descriptions and photographs of the "orchard country" of Tropical Africa (Tansley, 1926). There is usually a broad ecotone between the communities and the more prevalent open forest. The nature of the soil, dependent on the underlying rock, is the governing factor.

Further south there is practically no ecotone between grassland and forest, and the amazingly sharp division between these formations to the west of the Great Dividing Range in Central Queensland is one of the most remarkable features in the region and what must be one of the most remarkable features of its kind anywhere. Forest trees occasionally stray into the blue-grass country which is found chiefly to the east of the Divide or in the south. In Mitchell grass country, however, if one excepts the ubiquitous gidgea (*Acacia Cambagei*), the few scattered trees which are found in certain places are not trees usually found in forests.

Over much of the grassland areas the rainfall varies considerably from year to year, and this variation sometimes affects the vegetation considerably. But variations occur which are at least partly independent of rainfall. Firstly the annual and ephemeral members of the associations vary in nature and relative frequency from year to year. One year a certain species may be physiognomically dominant, in the following year an entirely different species takes its place, while the former may be rare or virtually absent for some years, and then again suddenly assume dominance. Stocking certainly affects this "seasonal dominance" to a considerable extent but is not entirely responsible for

it, as records indicate that it occurred before settlement took place. Just what are the governing factors is not yet known, though an after-ripening period of the seed, incidence of rainfall, and the soil changes discussed below may be among the most important.

These changes in the frequency of the annual members of the grasslands have a counterpart in the more subtle but profound variations in the perennial composition of the communities. As the result of long-period cyclic changes, there occurs in some districts a fluctuation between blue grass-dominant and Mitchell grass-dominant communities, and in other districts a comparable fluctuation between Mitchell grass-dominant communities and herb-steppe. To these systems the term "fluctuating climax" has been applied, as it is believed that at any given time the community is essentially in equilibrium with its environment (Blake, 1938).

The complete mechanism is not yet clear, but on the evidence available it seems that the changes go on independently of rainfall and stocking, but are influenced by each. The most important factor seems to be bound up with cyclic changes in the nature of the soil, particularly in regard to its salt content. It is now a well-established fact that in soils of arid and semi-arid regions there is a tendency for salts to accumulate in the upper parts of the soil (Vageler, 1933). It is presumed that each of the dominant species, *Dichanthium sericeum*, *Astrebla* spp., and the chenopodiaceous members of the herb steppe, has a definite upper limit of tolerance to salinity. When this concentration is approached in any locality, the dominant species (and the community) is replaced by the community with a higher tolerance. (In the extreme case, salt desert would be produced. This condition is not attained in Queensland, but an approach to it is to be seen in the claypans of the far south-west, and parts of the stony desert are probably comparable). Later, the salt content decreases and the communities of lower tolerance can then establish themselves. Alternes are not infrequent as intermediate stages, but often the changes appear to take place with remarkable suddenness.

Removal of salt could take place either by the removal of the plants themselves, or by the action of water. Heavy showers of rain would wash surface and subsurface salt to lower ground (where claypans so often occur) or down the cracks in the soil itself.

THE DESERT.

In the truly desert parts of the region, there are two very diverse developments. The Stony Desert is little less than the most arid extreme of the gravelly downs with which it is more or less complementary through herb steppe. The sandhill region, commonly known as the Arunta Desert until it was renamed Simpson Desert by Madigan, has been described from various standpoints by different writers (Blake, 1938, Madigan, 1936, and Ratcliffe, 1936, 1937). Whatever may be its origin—and I believe with Madigan that the Desert Sandstone has produced the bulk of the sand—and whatever may be the factors controlling its extent, there seems little doubt that the north-eastern portion is essentially stable. There is no sharp boundary line. Beyond the desert proper, dunes occur to the east and north, either as isolated ridges or as groups of ridges. Those near the desert proper are included in what Ratcliffe has called the "marginal country," but there is a far wider occurrence of these scattered ridges than this, extending eastward as

they do almost to the Great Dividing Range. As their distance east and north from the desert increases, the dunes become smaller and smaller and gradually more widely scattered, until finally they degenerate to mere mounds of sand. There is likewise a progressive change in the vegetation supported by these dunes, passing from the characteristic vegetation of the desert with its *Spinifex paradoxus, Triodia, Acacia ligulata,* &c., and annuals, through hop-bush (*Dodonaea*) and mulga scrub to cypress pine (*Callitris*) forest in the south, and Eucalyptus forest or mixed forest further north. When one considers the apparent stability of the whole, the evidences of considerable age of the dunes in the marginal country, such as their occurrence between river channels and the presence of small lakes within some groups of them, the nature and density of the trees and shrubs upon the isolated dunes, one is forced to the conclusion that these dunes are the remnants of a desert which at one time occupied a much larger area than it does to-day.

And there appears to be no evidence for a present expansion of the desert. The boundaries of this appear to be defined by the direction of the prevailing winds and by river channels. There is no evidence of particular instability at the desert margin either as to sand or vegetation. The facts hitherto adduced as evidence of increasing aridity and desert advance are quite readily explained in other ways. Sandstorms are a natural phenomenon of such regions, and sand accumulates only where there is some obstruction, such as a fence or building. There is no record or other evidence that a new sandhill has been formed elsewhere.

The great rivers of the interior—Cooper's Creek, the Diamantina, the Mulligan—used to pour their flood waters into Lake Eyre, but rarely reach the lake now. This seems to be due to the fact that the flood plains and channel beds are being gradually built up by the normal deposition of silt, so that it is becoming increasingly difficult for the stream, always very slow in this excessively flat area, to force its way along, and it usually loses itself over the plain. The dying-off of trees along the channels, which is so often stressed, may be due in part to old age and partly to this same raising of the river bed further upstream.

Evidence of another nature is afforded by brigalow scrub. It has been shown above that this association is akin to relatively wet-country communities and is at present extending westward. This westward extension would scarcely occur if the interior were drying up.

THE BIOTIC FACTOR.

So far little has been said as to the relationships of the communities to man. In many places settlement has resulted in the complete destruction of the indigenous vegetation, which has been replaced by orchards, farms, artificial pastures, &c. Open forest has often been thinned out to parkland or even grassland by removal of trees, and in hilly country the increased run-off thus induced has resulted in soil erosion becoming a real menace. Soil erosion is even more pronounced where steep hillsides (sometimes originally clad with rain forest) have been given over to banana farms. In the cleared or partly cleared forest country, the herbaceous vegetation is usually more or less modified by the presence of exotic species, sometimes as the result of deliberate planting. Brigalow scrub is being removed in places to make way for argiculture or induced or artificial grassland. In pastoral districts, the white man's introduced animals are affecting the vegetation to a greater or less

extent, and where overstocking has been common, definite communities have resulted. The primitive communities react to stocking in such diverse ways that it would require much more time to discuss them than is available. From an economic point of view, the changes wrought by heavy stocking are not always adverse. Definite improvement in pasture has been noticed to result from heavy stocking in some districts. Extremely adverse reactions are to be observed along stock routes, and it would seem that in many cases these are due to salt-poisoning as the result of the excessive manuring and urination the ground receives as much as to trampling and over-grazing.

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