THE BLACK SPEAR GRASS (*HETEROPOGON CONTORTUS*) PROBLEM OF THE SHEEP COUNTRY IN CENTRAL-WESTERN QUEENSLAND

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SUMMARY

Results of a study of black spear grass in a semi-arid area of Queensland are reported.

The grass occurs mainly on open eucalypt forest country on which the dominant climax grass is *Themeda australis*.

Increase and recession have been associated with rainfall, increase occurring during a series of years with above-average rainfall and recession during a period with below-average rainfall.

The increase noted since 1949 is attributed largely to favourable seasonal conditions, reduced grazing pressure, and the degraded condition of the pastures. A widespread changeover from sheep to cattle has aided the increase by removing the necessity for heavy grazing to control seeding.

Burning of pastures is not essential to the spread of black spear grass in the central-west.

Under heavy grazing, black spear grass is replaced by less palatable grasses and the recession may proceed further through species of *Bassia* to bare ground.

Exotic grasses found suitable for the climatic conditions of the region are not sufficiently aggressive to compete with black spear grass except in limited areas.

I. INTRODUCTION

Heteropogon contortus (L.) Beauv. (black spear grass, also known as bunch spear grass or spear grass) is indigenous to tropical and subtropical regions of the world, including Australia. Native pastures in which this species is dominant are widespread over a large area of coastal and subcoastal forest country in eastern Queensland, and in consequence this area is referred to as the "spear grass region" (Shaw and Bisset 1955). Inland from the spear grass region, black spear grass is less prominent, but it is quite common as far west as Barcaldine, and some is also present around Longreach.

In that part of the spear grass region which is utilized for cattle grazing, black spear grass provides the bulk of the grazing. However, experimental work in progress by the Queensland Department of Agriculture and Stock and the Commonwealth Scientific and Industrial Research Organization aims at replacing this and other native species by sown pastures of higher nutritive quality.

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In the sheep country of the west, black spear grass is a better feed for sheep than the species with which it commonly grows, such as wire grasses (species of *Aristida*) and pitted blue grass (*Bothriochloa decipiens*), but it is troublesome because of its seed, which is one of the worst plant pests of wool. Infested wool requires expensive treatment before it can be used for manufacturing. Also, this seed can penetrate the skin, the flesh, and even the internal organs of sheep with disastrous results.

Much of the southern portion of the spear grass region was originally stocked with sheep. Increase in black spear grass was one of the factors, along with worms, dingoes and scab, claimed to have been responsible for their withdrawal in favour of cattle (Shaw 1957).

During 1955 concern was expressed by some sheep graziers in the area from Emerald to west of Longreach regarding the possible degree of spread of black spear grass in this region. It was generally realized that exceptionally good rainfalls in 1950, 1954 and 1955 (and since then 1956) were probably a big factor in aiding the apparent spread of the grass. However, some graziers were of the opinion that it would eventually become so prevalent as to drive sheep out of the whole area. Of particular concern to some was its presence on the open downs (hitherto claimed to be free of it) and the likelihood of eventual spread over all of this type of country.

This paper deals with an investigation into the problem undertaken as a result of an approach to the Department by the Central and Northern Graziers' Association in 1955. The investigation, which was carried out from Emerald over the period 1956-1961, has taken the form of discussion with graziers, broad field observations and consideration of the findings in relation to previous research results on black spear grass, and some site observations at Longreach.

II. THE ENVIRONMENT

The area (Figure 1) lies roughly between 22½ and 25° S. latitude and 143½ and 148½° E. longitude. Except for the relatively small area associated with the Great Dividing and Drummond Ranges, the topography is flat, with elevation ranging from 600 to 1200 ft.

The mean annual rainfall ranges from 26·97 in. at Clermont to 16·52 in. at Longreach. The rainfall pattern is characterized by a pronounced summer incidence and a high degree of variability. Farmer, Everist, and Moule (1947) defined a month with effective rainfall as one with P/E equal to or greater than 0·2 (October-March) or 0·3 (April-September). On this basis they divided Queensland into zones according to the number of months of effective rainfall ("wet" months) in summer and winter for 75, 66 and 50 per cent. of the years on record (50 years or more). Clermont has 4 or more wet summer months and 2 or more wet winter months in 75 per cent. of years on record. Longreach has 2 or more wet summer months in 75 per cent. of years and is near the western extremity of the zone having 2 or more wet winter months in 50 per cent. of years.

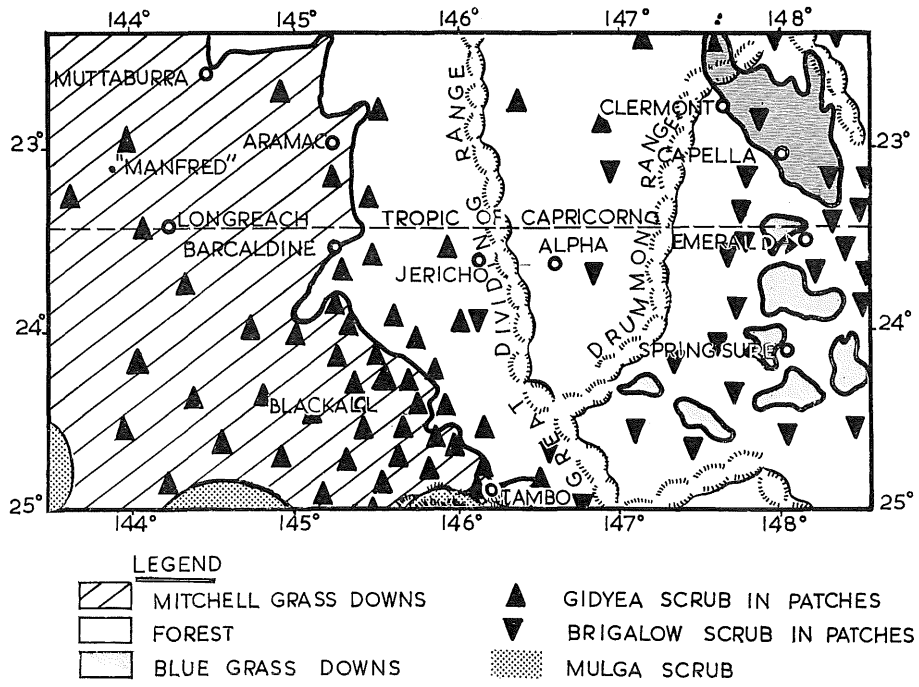


Fig. 1.—Regional distribution of main vegetation types. (1 in. = 72 miles).

The mean maximum temperature (January-February) is 92·5°F at Clermont and 98·3°F at Longreach; the mean minimum temperature (June-July) is 44·4°F at Clermont and 45·4°F at Longreach (Farmer, Everist, and Moule 1947). Throughout the region frosts occur during the winter months.

The vegetation types of central-western Queensland have been described by Blake (1938) and Everist and Marriott (1955). Broadly speaking, there are three main types in the region under discussion, namely,

(1) Grassland or downs, with Mitchell grasses (species of *Astrebla*) dominant on sedimentary pedocalcic clays in areas of less than 20 in. mean annual rainfall, and Queensland blue grass (*Dichanthium sericeum*) dominant on black earths in areas of 20–25 in. mean annual rainfall.

(2) Forest, comprising an open formation dominated by species of *Eucalyptus,* with a grassy understory.

(3) Scrubs with gidyea (*Acacia cambagei*) dominant in areas of less than about 22 in. mean annual rainfall and brigalow (*Acacia harpophylla*) dominant in areas of more than about 22 in. mean annual rainfall.

Figure 1 shows the distribution of the vegetation types.

The forest occurs as a vast belt in the centre of the area and is actually an extension of the open forest of the spear grass region. In its more western portions it is known as "desert". The Mitchell grass downs occurs immediately to the west of the "desert", and is part of a great belt which runs north-west from Tambo to the Gulf of Carpentaria. The towns of Tambo, Barcaldine, Aramac and Muttaburra are situated on the boundary of the downs and "desert". The Queensland blue grass downs occurs as islands occupying a total of some $2\frac{3}{4}$ million acres in the Springsure/Emerald/Clermont area and brigalow scrub occupies some $4\frac{1}{2}$ million acres in the same area (Skerman 1953). The area of gidyea scrub has not been calculated; its main occurrence is around Tambo, Blackall and Barcaldine, and north of Clermont.

III. SURVEY RESULTS

(a) Habitat

Throughout the region the main occurrence of black spear grass is on forest country. On downs country it is confined to atypical sites such as erosion gullies, ridges of shallow soil and areas of outcropping stone (see Figure 2). A peculiar pattern exists in the linear gilgai formation which occurs on some of the gently sloping downs country in the Springsure/Emerald/Clermont area. Here, black spear grass is confined to the ridges ("puffs").

Fig. 2.—Black spear grass dominant on timbered crest but absent from open Queensland bluegrass (*Dichanthium sericeum*) grassland (foreground). Emerald district. The trees are mountain coolibah (*Eucalyptus orgadophila*).

Black spear grass is virtually absent from scrub country with a heavy soil, irrespective of state of clearing. It is, however, common on the lighter soils of the ecotone between scrub and forest.

The correlation of black spear grass occurrence with the type of country is very marked along railway lines, particularly in the eastern part of the region where the grass is more abundant. Where the line passes over the heavy soil of the downs or scrubs, black spear grass is confined to the ballasted zone of the track.

(b) Records

In an early account of the vegetation of the Springsure district, O'Shanesy (1881) stated "the spear grass *Heteropogon contortus* is common on the downs but not abundant." It is presumed that O'Shanesy was referring to the "downs" in the broad sense, which would include the low timbered ridges (Figure 2). (If this assumption is not correct it would indicate a decrease in incidence of spear grass on the downs since 1881.)

Some graziers believe that black spear grass has been in the Longreach area only a relatively short time, i.e. 20–40 years. The writer has not seen any botanical records which throw light on this aspect.

(c) Dispersal

Reproduction of black spear grass is by seed (fruit) alone. The seed is not adapted to wind dispersal but has a pronounced tendency to adhere to hair and clothing. Thus, the main means of dispersal is by attachment to animals and other moving objects and subsequent dropping off. The introduction of domesticated animals, and also vehicles, has provided increased opportunity for seed dispersal.

It is a common practice in times of drought for sheep from the Mitchell grass downs country to be moved eastward to the "desert" country for agistment. Some graziers claim that black spear grass has been introduced to their properties by such sheep on their return. No check has been made on this aspect. From personal observation, however, it can be stated that considerable areas of the "desert" country are virtually free of black spear grass.

In order to test claims by some graziers that ballast used by the railways is an important factor in the spread of black spear grass in the Longreach area, an inspection of the quarries from which this ballast was obtained was made. These were situated in "desert" country at Lochnagar (near Barcaldine) and in a sandy creek bed near Longreach; both sites were found to be virtually free of black spear grass. The occurrence of the grass in patches along the railway line west of Barcaldine is thus merely a matter of suitability of the ballast as a growth medium for seed brought there by other means (such as stock trains).

Collection of black spear grass seed by seed-harvesting ants has been noted in the Emerald district, and could result in the destruction of appreciable quantities.

(d) Burning

Annual burning during the winter/spring period is widely practised in the spear grass region, and it is generally accepted that this is an important factor favouring the grass. The effect of annual burning in the absence of grazing on the native pasture of a sandy forest ridge at Lawes, in south-eastern Queensland, was studied by Shaw (1957) over a period of eight years. The experimental site was on an area that previously had been burnt occasionally but never regularly, and had been heavily grazed. At the commencement of the experimental period black spear grass and pitted blue grass were co-dominant. The main effect of annual burning in September was to give dominance by black spear grass and this appeared to be due to three main causes: established plants of the grass were resistant to fire; fire favoured the germination of seed; and fire reduced the basal ground cover of other species. Mowing and raking off the cut grass also caused black spear grass dominance but to a smaller extent than did burning. In discussing the effects of burning, Shaw pointed out that railway enclosures and country cemeteries, both of which are regularly burnt, are commonly dominated by kangaroo grass (*Themeda australis*). He concluded that absence of grazing, in conjunction with fire, is the probable cause of this, it being widely agreed that this grass is easily damaged by grazing. He noted that kangaroo grass was not present in or near the experimental area. Another climax species found to be resistant to burning was forest blue grass (*Bothriochloa intermedia*).

Where black spear grass is present in forest country used for sheep (east of Barcaldine), burning is commonly practised during the period from late winter to early summer to remove the bulk of unacceptable dry grass (as in the spear grass region), and it is commonly stated that the sheep do well on the burnt country. The frequency of burning is influenced by seasonal conditions and is of course greater in the higher rainfall areas of the east. Even here, however, it is rarely that the same patch of ground is burnt in two consecutive years.

Many instances of spread of black spear grass in the absence of burning have been noted by the writer in central-western Queensland. In fact, west of Barcaldine the only fires that occur are due to accident or lightning. Some of the areas on which spread of black spear grass has been observed have not been burnt for 12 years and others for at least 30 years. Reduction of ground cover by grazing is the obvious feature favouring the increase in black spear grass in these instances.

(e) Seasons

Everist and Moule (1952) stated that in the years 1930-1940 summer rainfall in the Springsure/Emerald/Clermont area was below average and the distribution was abnormal, resulting in considerable replacement of the dominant Queensland blue grass by Mitchell grass. From 1947 to 1950, summer rainfall was good and well distributed and Queensland blue grass once more became completely dominant.

Prior to 1949 most parts of central-western Queensland experienced a run of several mediocre to bad years. Old residents state that there was a recession of black spear grass during that period. Then came a run of three good years, including the exceptional year 1949-50. After two sub-average years there followed a run of three years which constituted the wettest period on record. As an example, Barcaldine, which has an average annual rainfall of 19·70 in., received 35·01 in., 43·26 in. and 30·15 in. during the years 1953-54, 1954-55 and 1955-56 respectively.

In view of the above rainfall pattern it is understandable that people who had come into the district since about 1946 should become alarmed about spear grass. Graziers of long residence said that a return to normal seasons which would include some drought years would again see a recession of black spear grass.

Other elements of the western vegetation responded to the exceptional rainfall periods mentioned. For instance, there was considerable regeneration of gidyea and boree (*Acacia cana*) (Davidson 1954). According to S. L. Everist (personal communication 1961), regeneration of boree is a particularly rare occurrence.

(f) Grazing

In the spear grass region of eastern Queensland increase in black spear grass density following settlement has been largely a process of replacement of kangaroo grass under a system of annual burning followed by immediate grazing (Everist and Marriott 1955).

Moore (1959), writing of forest country in southern Australia, referred to the ubiquity of kangaroo grass (*Themeda australis*) in the original ground flora. He pointed out that this species has largely disappeared under sheep grazing and is now found only in ungrazed areas, railway enclosures, cemeteries, etc.

Arndt and Norman (1959), in dealing with tropical tall grass pasture at Katherine (Northern Territory), referred to *Heteropogon contortus* as being a species of little importance in undisturbed lightly grazed pasture but tending to become prominent when competition from the dominant perennials is reduced. They did not mention whether or not the case is one of specific replacement of *Themeda australis* but they did state that this species is one of the three dominant perennials.

Moore (1959) made the point: "in general cattle are less destructive to vegetation than sheep, and it is noteworthy that kangaroo grass is more persistent in cattle country". Although most of the early settlers in the southern portion of the spear grass region of Queensland originally stocked their properties with

sheep, cattle are now run exclusively. Thus, if cattle are not the original cause of the replacement of kangaroo grass by black spear grass, they are at least preventing the return of the kangaroo grass over considerable areas of the region.

Experimental and observational evidence from the spear grass region shows that under heavy grazing black spear grass is replaced by the less palatable pitted blue grass and weeds (Blake 1944; Miles 1949). In Shaw's plots (Shaw 1957) pitted blue grass was co-dominant with black spear grass at the beginning of the experiment (under conditions of heavy grazing by dairy cattle), but was almost eliminated after eight years' exclosure.

Numerous fence-line comparisons made by the writer show that replacement of kangaroo grass by black spear grass as a result of grazing is a common occurrence as far west as Barcaldine. Since kangaroo grass has a wide distribution, including the banks of seasonal watercourses in Central Australia (Hayman 1960), this replacement may well apply in the more western country. Kangaroo grass is present in a belt of forest country at Longreach, and it has also been recorded from the Mitchell grass downs (Davidson 1954).

Fig. 3.—The paddock on the left (lightly stocked with cattle) is mainly black spear grass with some kangaroo grass (*Themeda australis*). Heavy stocking with sheep for over 40 years has caused the replacement of black spear grass by wire grass (a species of *Aristida*) in the paddock on the right. Box (*Eucalyptus populnea*) forest country near Capella.

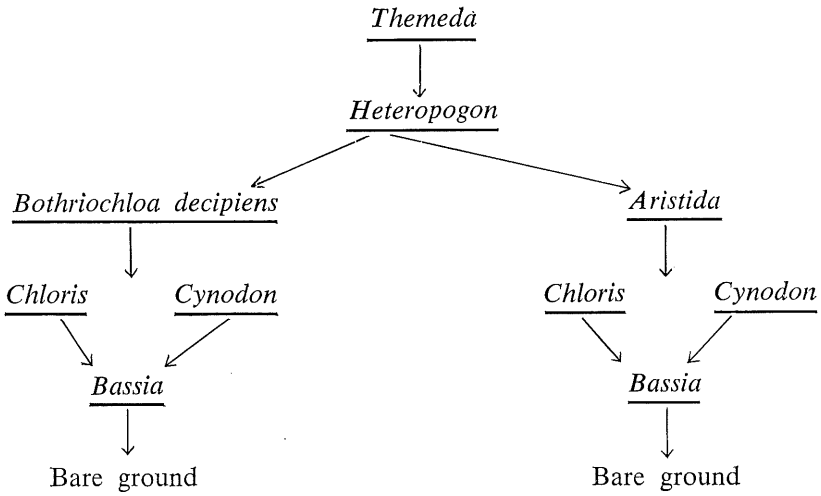
Obviously, kangaroo grass and black spear grass have similar edaphic requirements in central-western Queensland. Not all forest country in the region is kangaroo grass country. Considerable areas are dominated by desert blue grass

(*Bothriochloa ewartiana*) and spinifex (*Triodia pungens*), while in the east there are appreciable areas of forest blue grass (*Bothriochloa intermedia*). Basalt tableland country in the Springsure/Emerald/Clermont area has species of *Dichanthium* as dominants in lightly grazed places. Instances of apparent replacement of these species by black spear grass have been found on closer examination to be confined to transition zones showing marginal soil conditions. Moreover, the presence of kangaroo grass in these zones in lightly grazed country suggests that the replacement may be still largely of this species. In some cases the transition zones are fairly extensive.

Observations made by the writer between Emerald and Barcaldine show that under heavy grazing black spear grass is replaced by the less palatable pitted blue grass or wire grasses, according to type of country (Figure 3). With still heavier grazing these latter species are replaced by dwarf species such as *Chloris divaricata* and couch grass (*Cynodon dactylon*); such heavy grazing is mainly restricted to the areas near yards and watering points, and the trampling factor would also be important. In extreme cases these dwarf grasses give way to weed species such as galvanized burr (*Bassia birchii*) and goathead (*Bassia bicornis*) (Figure 4), and finally bare ground.

Fig. 4.—In this eastern fringe of a paddock, heavy grazing has led to replacement of black spear grass by goathead (*Bassia bicornis*) and galvanized burr (*Bassia birchii*), right foreground. Better moisture conditions in a gully (middle left) have enabled black spear grass to outstrip the grazing pressure and seed. Buffel grass established in the background after culivation in 1956 will not eliminate black spear grass but constitutes a much better pasture than goathead and galvanized burr. "Red ridge" country, Blackall district.

The following 5-stage recession diagram has been constructed to show the degradation of *Themeda* communities under grazing:—



Reduction in grazing pressure allows the community to proceed back towards the *Themeda* stage provided rainfall is adequate. In considering grazing pressure, due allowance must be made for the effects of fire and rainfall. Thus, apart from straight-out overcrowding of paddocks, grazing pressure can be aggravated by a reduction in the total amount of forage due to drought, or by allowing stock access to newly burnt pasture, particularly where burning is confined to small strips. On the other hand, grazing pressure can be alleviated not only by reducing stock numbers but by burning whole paddocks rather than small portions, and resting before allowing stock access, or by abundance of rainfall which allows the grass to outstrip the capacity of the available animals to graze it severely.

Procession and recession do not always occur through all the five stages shown above. For example, instances have been observed of procession from *Cynodon* direct to *Heteropogon*. Environmental conditions at the time, including absence of seed of intermediate stages, could be the explanation for such short-cuts. In the absence of grazing, burning can increase the speed of procession to the *Heteropogon* stage, but is not essential to it, particularly in the drier areas of the west. Instances can be seen where despite absence of grazing for several years the community is still *Heteropogon*-dominant with no trace of *Themeda*. Dominance of *Themeda* on apparently similar country elsewhere suggests the situation as being one of arrested procession due to the complete elimination of *Themeda*.

(g) Management

Experienced graziers in forest country east of Barcaldine maintain that in average seasons they can control black spear grass by grazing with sheep. The control is aided by the fact that this grass flowers later in sequence than the main species that replace it under grazing (pitted blue and wire grasses); black

spear grass is thus able to present preflowering growth for a longer period than these grasses. Palatability declines with flowering, so this control method demands heavy grazing in early summer to delay flowering. The degree of control achieved depends on the type of season; if it is favourable to black spear grass the grass outstrips the grazing pressure in late summer and flowers profusely. Presence of seed above a small quantity necessitates removal of the sheep towards the end of March. They cannot be returned with safety until the seed drops (which is often well into August) or is removed by burning. In addition to removal of seed, burning, as previously stated, is done to remove the useless residue of mature growth, thereby making the new growth available for grazing. Black spear grass that has been burnt flowers later than if unburnt; and flowering is further delayed by grazing the young growth.

The greatly increased growth of black spear grass during the heavy rainfall years 1949-50, and from 1953-54 to 1956-57, together with the fact that sheep numbers remained static, resulted in a breakdown of the control previously obtained by grazing with occasional burning. This led to an increase in the frequency of burning, which would have aided the black spear grass still further.

(h) Change in Land Use

Another factor which has caused an increase in black spear grass is the progressive changeover from sheep to cattle that has occurred since about 1945 in forest country between Emerald and Barcaldine. East of the Great Dividing Range this country is now almost exclusively devoted to cattle. Without the urgent need to prevent the black spear grass from seeding, grazing by cattle tends to be less intense. It is easy to distinguish cattle properties from sheep properties when travelling through the "desert" country by the botanical composition of the pastures. Cattle country has not only more black spear grass but also more of the better quality species, including desert blue grass, forest blue grass and kangaroo grass. It thus represents a higher stage in the succession.

The changeover from sheep to cattle has been due to several factors. Black spear grass is stated to have been important in some cases but other equally important factors were dingoes, the lower labour requirements of cattle and an improvement in the relative economic return from cattle as compared with sheep. The isolation of individual sheep properties as the changeover progressed has accentuated the importance of dingoes.

(i) Clearing

It has already been stated that black spear grass will not grow on brigalow country with a heavy soil even after clearing. However, in the ecotone between the scrub and forest, black spear grass can easily become dominant after clearing. The reason appears to be that in the uncleared state the grazing pressure of stock keeps the ground flora in a low state of succession. Clearing results in a sudden release of grazing pressure, so black spear grass is able to increase.

Observations on areas that have been cleared for a long time show a common tendency for the pastures to revert to their former degraded state (dominance by pitted blue grass and wire grasses).

Careful observation has failed to show any instances where clearing of purely forest country has on its own caused any increase in black spear grass. This grass and kangaroo grass seem equally at home in cleared and uncleared forest, and so also do other climax species such as desert blue grass and Queensland blue grass.

(j) Observations at Longreach

The Mitchell grass association of the Longreach district has been described in detail by Davidson (1954) from observations made during 1952-53. The other major vegetation associations have also been dealt with but in less detail; these include the gidyea association, the coolibah (*Eucalyptus microtheca*) association, and the ghost gum (or cabbage-gum) (*Eucalyptus papuana*)/bloodwood (*E. terminalis*) community.

Davidson mentioned the existence of a distinctly different soil/vegetation association on some ridges running through the Mitchell grass downs. Here on a firm shaly soil (known as "hard" country in contradistinction to the "black soil" country), Mitchell grasses are absent and the dominant grass is neverfail (*Eragrostis setifolia*). This "hard" country has a counterpart in the Blackall district known as "red ridge" country (Figure 4).

The rareness of black spear grass in the Mitchell grass association of the Longreach district is indicated by its lack of mention in Davidson's species list, which includes all but rare species. The only type of country for which it was recorded was the cabbage-gum/bloodwood community.

In October 1958 an inspection was made of several patches of black spear grass downs country on "Manfred" in the company of Miss Davidson, who was able to provide plant counts made in 1952 for two of these stands. These, together with some quantitative assessments made at five sites by the writer on this and a subsequent visit, are set out in Table 1.

The occurrence of black spear grass on downs country was pointed out by Miss Davidson to be confined to atypical areas such as the firm soil country on the ridges, or, in the case of the "black soil" country, rock outcrops and erosion gullies. The largest area was on a ridge in North Ram paddock (Site 1) and it so happened that Miss Davidson had recorded 60 tussocks for this area in 1952. The number of tussocks was in 1958 too large to count (at least several hundred), and the stand occupied an area of roughly $\frac{1}{10}$ acre. The stands on "black soil" country were only a few square yards in area. Miss Davidson pointed out that the soil of the outcrop areas appeared somewhat more yellow in colour than the grey-brown soil of the rock-free areas. No black spear grass tussocks were found more than 6 ft away from the edge of any stony area, and of these approximately half were growing among tussocks of Mitchell grass. On one particular rock

TABLE 1

STAND ASSESSMENTS OF BLACK SPEAR GRASS (*Heteropogon contortus*) AT 5 SITES AROUND LONGREACH IN 1952, 1958 AND 1961

Type of Country and Location	Site 1	Site 2	Site 3	Site 4	Site 5
	Cabbage gum/ bloodwood sand ridge	Downs ridge with firm soil	Black soil of downs adjacent to stony outcrop	Similar to Site 3	Black soil of coolibah forest
1952*	No count	60 tussocks	No count	1 tussock	No count
1958	Patch of approximately $\frac{1}{4}$ acre	Several hundred tussocks spread over 1 square chain	40-50 tussocks	Approximately 100 tussocks	1 large tussock + 14 small ones
1961	Some reduction (up to 20%) in area of stand	Some reduction (up to 30%) in area of stand	5 tussocks	2 tussocks	None present

* 1952 counts provided by Miss D. Davidson

outcrop area a patch of about 100 plants scattered over several square yards was noted (Site 4). Miss Davidson mentioned having recorded one tussock on this site in 1952.

It was maintained by the late R. L. Davidson, a grazier of long residence in the area, that the large increase in black spear grass between 1952 and 1958 as indicated by comparison of plant counts was not a reliable indication of trend because of the abnormal run of seasons included in the period. At his suggestion a patch of 40–50 tussocks spread over about 3 sq. yd. on black soil adjacent to a rock outcrop was marked for future reference (Site 3).

Black spear grass was also very rare on the coolibah country. A patch of one large tussock surrounded by 14 smaller tussocks was noted in the railway enclosure near the Darr River bridge (Site 5).

The grass was fairly common over part of the cabbage-gum/bloodwood community which occurs on a narrow belt of red sandy soil some 15 miles north-west of Longreach. Patches ranged in size from a few square yards to about a quarter of an acre. One of these larger patches was marked (Site 1).

The next inspection of the black spear grass stands was made in August 1961. Miss Davidson was present during the inspection of the stands on "Manfred". Seasonal conditions for Longreach for the period 1941-42 to 1960-61 are shown in Table 2. From the rainfall pattern (Table 2) it will be seen that the 1958 counts followed a period of four good years, including two exceptionally good years. The 1961 counts followed a more normal run of years, including a bad one (1959-60).

TABLE 2

YEARLY RAINFALL TOTALS, ESTIMATED EFFECTIVE MONTHLY REQUIREMENTS, AND PATTERN OF EFFECTIVE RAINFALL THROUGH THE YEARS FROM 1941-42 TO 1960-61 AT LONGREACH (FROM EVERIST AND MOULE TO 1950-51, THEREAFTER COMPILED FROM METEOROLOGICAL BUREAU FIGURES)

	O.	N.	D.	J.	F.	M.	A.	M.	J.	J.	A.	S.	Yearly Totals
E	2·36	2·05	2·21	2·08	1·76	1·96	1·48	1·49	·96	1·06	1·44	1·72	(in.)
1941–42 ..		*			*			*					16·34
1942–43 ..		*	*	*								*	15·20
1943–44 ..					*					*			19·37
1944–45 ..			*						*	*			11·07
1945–46 ..				*									7·92
1946–47 ..					*						*	*	15·77
1947–48 ..			*										10·63
1948–49 ..			*	*	*	*							17·89
1949–50 ..	*		*	*	*	*	*	*	*	*			43·65
1950–51 ..	*	*	*	*					*				24·72
1951–52 ..			*					*					10·68
1952–53 ..				*	*			*					14·78
1953–54 ..				*	*		*		*	*	*		19·34
1954–55 ..	*		*	*	*	*		*		*			35·96
1955–56 ..				*	*	*	*		*	*			32·91
1956–57 ..		*	*	*		*			*	*			19·31
1957–58 ..	*			*			*		*				17·15
1958–59 ..			*	*		*	*	*					22·72
1959–60 ..			*		*			*					12·16
1960–61 ..			*	*	*		*						19·29

E = minimum monthly requirement for effective rain in inches.

* denotes a month which received estimated effective rainfall.

Table 1 shows the effects of soil type and seasonal conditions. Sites 1 and 2 are on firm soils, while Sites 3, 4 and 5 are on "black" (self-mulching) soils. Comparison of the results for Sites 2 and 4 shows that on both soils a considerable increase in black spear grass plants took place as a result of the abnormally good seasons from 1953-54 to 1956-57. Comparison of the 1961 counts with those for 1958 shows that on all soils a reduction took place following sub-average rainfall in 1959-60. However, while this reduction was slight to moderate on the firm soils of Sites 1 and 2, it was extremely large on the black soils of Sites 3, 4 and 5. The results for Sites 3, 4 and 5 point to the reason for the virtual absence of black spear grass from true Mitchell grass downs country; only under exceptional seasonal conditions can it spread on such country, and it is unable to survive a sub-average season.

(k) Competition by Exotic Species

The success achieved with buffel grass (*Cenchrus ciliaris*) (Fitzgerald 1955) and kapok bush (*Aerua persica*) (Nunn and Suijdendorp 1954) as pasture species under minimum-cultivation establishment techniques in arid pastoral country in the north-west of Western Australia suggested that these plants might be of value as competitors to black spear grass in central-western Queensland.

Buffel grass and Birdwood grass (*Cenchrus setigerus*) were widely planted by western graziers in both small and large trial plots from 1954 onwards. Observations made on a considerable number of these and on several plantings made by the writer indicated that buffel grass will not invade black spear grass communities to any significant extent; the only way in which it can be established is by cultivation to remove the latter. Subsequently the performance of buffel grass is governed by the suitability of the soil. Some re-invasion by black spear grass usually occurs but on the best buffel grass soils the buffel grass can maintain dominance. However, most of the forest country prone to black spear grass growth is too poor with respect to nitrogen, and to a lesser extent phosphorus, to support a vigorous growth of buffel grass (Figure 5). On black spear grass soils which support a reasonable growth of buffel grass, a state of co-existence of the two species is the best that can be achieved. Some black spear grass plants die during droughts but this is offset by seedling establishment in the next good season.

Fig. 5.—A 3-year-old stand of buffel grass (*Cenchrus ciliaris*), established by cultivation on ironbark (*Eucalyptus melanophloia*) country near Emerald, showing reduced vigour and consequent re-invasion by black spear grass.

Irrespective of the limitations of buffel grass as a competitor of black spear grass, its superior nutritional value as compared with many of the native grasses warrants its establishment wherever economically practicable.

Trial plantings of commercially available strains of buffel grass and Birdwood grass have shown the Biloela and Gayndah strains of the former to possess a greater degree of resistance to invasion by black spear grass than the Cloncurry and Western Australian strains and Birdwood grass.

D. I. Sillar (personal communication 1960) reported claims by a grazier in north-western Queensland of buffel grass replacing black spear grass on frontage country of the Cloncurry River. He qualified this by pointing out that (1) the soil type on the site in question is what he considers to be the ideal for buffel grass, and (2) black spear grass is one of the last native species to be replaced by buffel grass.

Attempts by the writer and by various graziers to establish kapok bush in black spear grass country by broadcasting with and without burning, and by drilling, have all failed. The only instances of successful establishment known were in cleared gidyea scrub after burning; moreover, the kapok bush has not persisted in competition with buffel grass.

Fig. 6.—Natural replacement of black spear grass by Indian blue grass (*Bothriochloa pertusa*) in box (*Eucalyptus populnea*) forest country near Capella.

Indian blue grass (*Bothriochloa pertusa*), a naturally occurring exotic species, has shown ability to replace black spear grass in the eastern portion of the district, several naturalized stands of this species, including one of several acres, occurring around Capella (Figure 6). These stands are presumed to have originated from the former C.S.I.R.O. Plant Introduction Station near Rockhampton. Unfortunately, this species appears to have a low acceptability to sheep. However, it could be of possible value on sheep properties in the eastern part of the region for use in small "islands" of black spear grass country occurring on a property comprising virtually all resistant country.

IV. GENERAL DISCUSSION

In the spear grass region of coastal and subcoastal Queensland, increase in black spear grass density in certain types of forest country following pastoral settlement has been largely a matter of replacement of kangaroo grass under a system of annual burning followed by immediate grazing. That burning alone is not responsible is obvious from the dominance of kangaroo grass in railway enclosures.

Observations by the writer indicate that the process has also occurred in the more inland areas. However, under the drier conditions, together with heavy grazing by sheep to control the flowering of black spear grass, it has gone a stage further in that there has been a varying degree of replacement of black spear grass by inferior species of grasses and weeds. Pastures in such a degraded condition are susceptible to re-invasion by black spear grass when opportunity occurs.

Meteorological records show that prior to 1949 most parts of central-western Queensland experienced a run of several mediocre to bad seasons. Old residents state that there was a recession of black spear grass during that period due to grazing pressure, and, in the more western areas, drought. Then came a run of three good years, including the exceptional year 1950. After two sub-average years there followed a run of three years which constituted the wettest period on record. It is thus understandable that black spear grass should have increased considerably during these years. In the eastern portion of the district, increased frequency of burning necessitated by the abnormal growth would have been another predisposing factor. Burning has not been a factor in the more western areas, however, as considerable spread of black spear grass has been observed in its absence.

Since 1956-57, rainfalls have returned to a more normal pattern and observations at Longreach have shown a definite recession of black spear grass following a sub-average year in 1959-60.

Replacement of black spear grass by buffel grass or Birdwood grass is applicable on a limited scale only. The main difficulty is that most of the country on which black spear grass grows is not sufficiently well suited to buffel grass and Birdwood grass to enable them to spread naturally even under the degraded condition of the pastures. Cultivation is necessary and persistence is often poor. Kapok bush has also failed to show any promise for control of black spear grass. Indian blue grass has shown some promise for small-scale use in the Emerald area.

It should be accepted that country prone to excessive black spear grass growth has limitations for sheep running. The question of whether to deal with the grass by heavy grazing, changing over to cattle or establishing buffel grass has to be decided according to the particular set of circumstances existing on individual properties. Perhaps the most important feature is the necessity for an alternative pasture during the period when black spear grass is in seed, namely, from

mid-March to mid-August. With the development of farming in the Springsure/Emerald/Clermont area, grazing crops, particularly members of the genus *Sorghum,* are seen to have considerable potential in this regard.

Black spear grass is mainly confined to forest country, particularly certain types. It does not occur to any significant extent on true "black soil" downs country. Observation has shown that exceptionally good seasonal conditions are necessary to enable it to establish on such country and it will not survive a drought. Inspection of cases of apparent presence of the grass on open downs country has always disclosed atypical conditions such as stony outcrops or erosion gullies, patches of firm soil on ridges or transition between open downs and forest.

The unsuitability of the heavy soils of the downs and scrub country to black spear grass is an important factor limiting its spread in central-western Queensland.

Black spear grass is not regarded as a problem in the Longreach area at the present time. However, it is considered that continuation of observations on the known stands over a still longer period of time is warranted.

Research is also needed to determine the extent to which climax grass species other than kangaroo grass are replaced by black spear grass. The species concerned are spinifex, desert blue grass, forest blue grass and Queensland blue grass. The ability of these species to withstand grazing better than kangaroo grass suggests that effective use could be made of any management practices which would increase the proportion of them in marginal country.

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