AN ECOLOGICAL STUDY OF DECCAN GRASSLAND

By W. Burns, D.Sc., and G. M. Chakradev, B.A.

Introduction.

Previous work on the improvement of grazing lands made it clear that an intense ecological study of these lands is desirable. The present paper is a short account of the first season of such a study.

We have been able to lease for five years a piece of the worst Deccan grazing land near Poona, (*See plate*). This plot measures seven acres. Its surface is very uneven. On two sides it is raised into small hills, through which the rock shows. A central part is traversed by a nullah and has a piece of deeper soil in it. The whole area has been subjected to grazing and trampling by cattle from time immemorial, and it is usually accidentally burned every hot weather. It was so burned just before we took it over, and hence we were provided with a partially denuded area.

On the hilly portions the soil has been washed to such an extent that the existing plants are growing in *murum*, the partially disintegrated trap rock which lies about in fragments large and small. The lower areas have much more soil. Analyses of the soil taken at three different points are given in Appendix A. The low content of humus in the poorer samples is worth notice.

The area is about 1,800 ft. above sea level. The annual rainfall averages 27 inches, falling between June and October, both months included. During the rest of the year the climate is moderate as Indian conditions go, except for the intensely drying hot wind that blows from the west in the three months preceding the monsoon.

Operations on the Area.

The main thing in our research was to keep off cattle, prevent burning, and stop grass-cutting for such time as would enable us to study the possibilities of the vegetation if left to itself. A strong barbed wire fence was therefore erected, and a line of *Agave sisalana* planted inside it. To minimise erosion due to rain, small ridges of six to twelve inches high were erected along the contours at about each three-foot rise, and these ridges were reinforced by the loose stones of the area. The existing nullahs were blocked at various places to prevent the water rushing through them and

carrying away soil. A preliminary survey was made for the sake of ascertaining the above-mentioned contours, and another, more accurate, was made latter on, for a map. Approximately one-third of the whole area, consisting of a strip in the middle 250 feet broad, running from end to end of the area, was ploughed and harrowed in April 1920, and in June seeded with the grasses mentioned in Appendix B. The idea of this sowing was to see whether by seeding we could hasten the production of good grass on the area, and the extirpation of the existing poor grasses. In addition, three strips of land at right angles to this seeded strip were sown with bajri (*Pennisetum typhoideum*). This seed was broadcasted on the strips, and no cultivation was given except that which had been already given for the other grass seeding. Bajri is the natural crop of such poor land in the Deccan, and seeds were put in as it was thought that the growth of the plant in successive years might give an indication of the improvement of the soil.

Methods of Investigation.

The vegetation was studied by—

(1) marking out and charting quadrats in typical spots.
(2) watching certain individual plants.
(3) studying the plant societies of the area.

The method of investigation by quadrats is now well known to all ecological workers. To make our meaning clear, we venture, however, to give a brief explanation of it.

A quadrat is a square plot. It may be of any size, but is usually one metre square. It is sub-divided into 100 decimetre squares. All plants in the quadrat are plotted on to paper squared to represent the lines marked on the soil. Clements' method of laying out a quadrat is by tapes. We have constructed a wire grid of a metre side with cross wires at the decimetres. This grid when laid on the ground marks out the quadrat at once. In tall vegetation this grid is apt to be unhandy, but in low vegetation it is easily handled.

Six quadrats were studied inside the area and two outside it for comparison. Each was located in a different consocies, to use Clements' term. The quadrats were permanently marked by driving in pegs at the corners. Certain typical plants were transferred to the Agricultural College and there planted for further study.

General Observations.

The rains broke on June 2. Appendix C gives an idea of the season's rainfall. There was, as will be seen, a good preliminary fall, a long break, another good fall, another break, and finally rain in time to save the vegetation. On June 15, there was general greenness, and

the appearance of *Scilla indica*, *Boerhaavia diffusa*, and *Evolvulus alsinoides* in flower. On July 7th, vegetation was in profuse growth. In addition *Kyllinga triceps* was in flower in the uncultivated part, and an enormous number of *Lochnera pusilla* in the cultivated strip. On July 21, *Cyanotis tuberosa* and *Commelina Forskalæi* were a marked feature of the area, and among the grasses *Tripogon Roxburghianus* was in flower, marking with its brown colour the poorer spots. The larger and coarser grasses seemed to be about to flower, and *Andropogon monticola* had shown some inflorescences. *Striga densiflora* was visible on August 8, in flower. *Cyanotis fasciculata* flowered on August 19 particularly on the poor and rocky spots, and on the same date *Andropogon contortus*, the main spear-grass, began to flower all over the area. On August 21, *Striga lutea* and *Lagasea mollis* flowered, and later in the month *Leucas longifolius*, *Pulicaria Wightiana*, and *Andropogon pertusus*. In September *Tripogon Roxburghianus* was drying up, but *Heliotropium merifolium* and *Zornia diphylla* were in flower, along with *Alysicarpus* species, and *Indigofera* species. The *Evolvulus alsinoides* was not less prominent. Later appeared *Lepidagathis cristata*, *Apluda varia*, *Heylandia latebrosa*, *Panicum flavidum*. and *Andropogon triticeus*. *Tripogon Roxburghianus* was, on October 21, putting out new growth on account of the late rains. On this date also *Thelepogon elegans* was in flower, and *Anthistiria ciliata* and *Andropogon pumilus* were also flowering.

The above very rough list will give some idea of the facies of the vegetation at various times of the season. It will be noted that there are three kinds of plants. (1) shortlived vernal plants like Scilla; (2) late season plants like *Heylandia*; and (3) plants of the whole season like *Evolvulus*.

The Quadrats.

Quadrat 1 is on poor soil. Before the rains broke it had on it mats of an unknown grass in a dry condition. These never sprouted, but appear to be of *Andropogon contortus*. On the break of the rains a sparse vegetation broke out all over the quadrat. One plant of *Evolvulus alsinoides* took possession of a central position, and gradually spread its arms over the greater part of the square. The early grass of the quadrat was *Tripogon Roxburghianus*, and the late one *Andropogon contortus*. A few plants of *Oropetium Thomæum*, a minute and exceedingly xerophytic grass, were also found. This quadrat was twice nearly dried out.

Quadrat 2 is situated on a spot much lower down with more water and soil. The difference in vegetation is striking. The early grasses were *Cynodon dactylon* and *Setaria glauca*. Later appeared,

Panicum ramosum, *Eleusine ægyptiaca*, *Tripogon Jacquemontii* *Anthistiria ciliata*. and *Panicum colonum*. There was no *Andropogon contortus*. The grass was up to three feet high.

Quadrat 3 is the most xerophytic of all. It is situated partly on sheer rock. The early rains brought out *Kyllinga triceps* and a plant of *Chlorophytum tuberosum*. *Oropetium Thomaeum* was present, and later a mass of *Cyanotis fasciculata*. *Gracilea Royleana* was also seen.

Quadrat 4 is situated at the base of the slope down from the last quadrat. *Tripogon Roxburghianus* is absent. The early vegetation consisted of *Panicum ramosum*, *P. javanicum*, and *Gracilea Royleana*. Later appeared *Eleusine aegyptiaca*. *Paspalum sanguinale*, *Aristida redacta*, *A. funiculata*, *Setaria glauca*. *Manisuris granularis*, *Sporobolus diandra*, *Eragrostis tenella*, *Andropogon pumilus*, *Indigofera cordifolia*, *Zornia diphylla*, *Commelina Forskalaei*, *Celosia argentia*, *Phaseolus trilobus*. *Spermacoce stricta*, *Striga species* and *Pulicaria Wightiana*. Here we have a very varied assortment of plants.

Quadrat 5 is situated on a low-lying but well-drained part representing a *Boerhaavia* society. This plant was in flower throughout the season. The other species found were *Gracilea Royleana*, *Zornia diphylla*, *Eleusine ægyptiaca*, *Tridax procumbens* and *Striga densiflora*. In September *Andropogon contortus* was dominant in this quadrat.

Quadrat No. 6 was taken in a distinctly hygrophytic spot in a low-lying place where water stood for a time after heavy rain. It contained large tufts of grass which did not flower till late when they proved to be *Andropogon caricosus*, var. *mollicomus* (dominant), *A. annulatus* (dominant) and *A. contortus*. Previous to this, in July, there had been in flower *Polygala chinensis*, and *Alysicarpus tetragonolobus*. *Acacia arabica* seedlings were visible on the plot in the early part of the rains, but with two exceptions disappeared later, being probably drowned out.

Outside Quadrats.

Quadrat X 1. This plot was chosen outside the fenced area on ground as similar as possible to that where Quadrat 1 is sited. From the start it showed a very even vegetation, consisting of grass seedlings and *Evolvulus alsinoides*. The grass turned out to be *Andropogon contortus* and remained stunted. *Indigofera linifolia* later occupied a fair part of the quadrat. Cattle wandered over this quadrat. We were never present when actual feeding took place on it, and there were no tooth marks visible on the grass blades. It was, however, almost certainly grazed at some period.

Quadrat X. 2 was chosen on a piece of land approximating in nature and conditions to that of Quadrat 2. It was in a low-lying area

and the grasses on it flowered late. In it were found *Polygala chinensis*, *Alysicarpus rugosus*, *Justicia quinquefolia* and *Alysicarpus tetragonolobus*. The grasses visible in October were *Tripogon Jacquemonti*, *Iseilema laxum*, *Andropogon pumilus*, *A. caricosus*, *Apluda varia*, *Lophopogon tridentatus*, and the sedge *Fimbrystylis diphylla*. These outside quadrats will be kept up as controls to see what happens outside as compared with the protected area. It is also proposed to denude a quadrat each year at the side of the already mapped quadrats in order to see the nature of the succession more clearly.

From the first year's work on the vegetation by means of the quadrats just described we learn, of course, little except the composition of the vegetation. The most interesting thing is the great variation to be found within a quite small area, if the soil conditions alter. The lower part of the plot is filled with excellent grass in good quantity. There is therefore considerable hope that if the actual soil conditions can be altered by judicious treatment, there is nothing in the climate to prevent the development of really good grass land out of the present useless surfaces, in years of normal rainfall.

Study of Individual Plants.

This study has not yielded anything very startling, except the fact that there are definite races of *Evolvulus alsinoides*, *Andropogon contortus* and *A. monticola*. These are being further investigated.

Study of Societies.

This study is also not far advanced. One or two societies have been delimited and their spread or otherwise will be watched. The boundary between the hill flora and that of the lowlying area has been carefully marked.

The Cultivated Middle Strip.

In the early part of the season plant-growth on this strip was sparse as compared with that on the untouched strips. This was due to the thorough ploughing and harrowing given, and the apparently feeble germination of the sown seeds. The plant *Lochnera pusilla* however appeared in profusion, probably from seeds buried in the soil. By Sept. 1, the *Lochnera* had disappeared. Of the artificially sown grasses only one, *Andropogon purpureo-sericeus*, came up thickly. It has done best on the lower levels, and made little progress on the hill. It has again proved its value as a pioneer grass in artificial seedings, as it had previously done in the Ganeshkhind experiments.

Andropogon contortus appeared on the cultivated area but in patches only. *Andropogon monticola* was prominent in the cultivated area, some of this from the sown, and some from the original seeds probably. The same remark applies to *A. annulatus* and *A. caricosus*. Other grasses of the strip were *Paspalum sanguinale*, *Manisuris granularis*, *Iseilema anothophoroides*, *Aristida redacta*, *A. adscensionis* *A. funiculata*, *Panicum ramosum*, *P. javanicum*, *Eleusine aegyptiaca*, and *Thelepogon elegans*.

The bajri appeared very late, and then only as a few scattered dwarf plants.

Summary and Conclusions.

We have followed for one rainy season the behaviour of a small piece of bad land in the Deccan. We are struck with the variation of vegetation in so small an area, the soil conditions determining the species. In rocky and eroded soil found on high levels certain poor grasses dominate, in the deeper and moister soils of the lower levels, the vegetations consists of good fodder grasses.

Even in the higher and rocky parts however, the good fodder grasses *Iseilema laxum* and *Andropogon monticola* have firmly established themselves. Both are perennials. It is not too much to hope that they will gradually dominate the higher levels, thereby fixing the soil, and gradually producing the conditions suitable for the more tender *Andropogon annulatus* and *Andropogon caricosus*.

There is nothing in the climate, except when the rains fail to prevent these excellent fodder grasses establishing themselves if the land conditions are right. The question appears to resolve itself into one of permanent land improvement.

The question arises: What stage of the succession are we at? It can hardly be the climax, in an area so trampled, burned and grazed as this is. Is it the very first stage of the *sere*, to use Clements' term? It is difficult to say, but in certain parts of the area we cannot be far off the initial stage, marked in this case by the small short-lived and xerophytic grasses *Oropetium Thomaeum* and *Tripogon Roxburghanus*. Future years will enable us to pronounce on this point with more decision.

What may we expect as the climax, woodland or grassland? The climate is typically neither a woodland nor a grassland climate. Rainfall is confined to five months of the year. In the hot months all the aerial parts of grasses die. Trees have to be of the most xerophytic character to stand these dry months also. From observations of the neighbourhood, it would appear likely that the climax is *Acacia arabica* forest. *Acacia arabica* is checked in its young stages

by the browsing of goats. In later stages, of course, its pods make excellent goat fodder and its wood is invaluable for fuel and for country implements. An ideal condition of this land would be grassland containing the better fodder grasses with a scattered growth of *Acacia arabica*, not sufficient to shade more than a tenth of the land. Is there any reason why this condition of things should not come about?

There is one reason only. That is, the present difficulty, we do not say impossibility, of keeping cattle and men off any part of such areas in order to allow them even for a year to recuperate. Fencing, is necessary, and the goodwill and co-operation of the people concerned. There is, however, one village in the Nasik district where without fencing, the people annually set apart certain portions of their grazing lands for a rest. If this can be done in one village why should it not be done in all, with or without fencing?

At present it seems as if wire fencing were out of the question. There seems to us no reason why prickly pear (*Opuntia elatior*) already found in quantity near every village should not be used as a live fence. It may be objected that to plant this is spreading a pest. We may point out that it is easily kept in control, and that it also gives a useful ration in famine years.

The question is not insoluble, and it has *got* to be solved.

Cattle are the foundation of India's Agricultural wealth. Without cattle, tillage, manure, milk, and money crops are impossible. The question of the improvement of grasslands is therefore fundamental, and we hope that our feeble contribution to its solution may be of some little use.

APPENDIX A.

Analyses of three soil samples from the Kalas Plot.

Physical Analyses	Soil sample	Percentages	
	1	2	3
Finest silt and fine silt ...	14·86	19·24	14·66
Medium silt	3·19	3·89	1·55
Coarse silt	10·15	11·34	6·90
Fine sand	23·90	14·70	15·97
Coarse sand, including stones ...	47·90	50·83	60.92
	100.00	100·00	100·00
Humus in same samples ...	0·44	1·50	0·50

APPENDIX B.

Grasses and legumes sown on the cultivated strip.

Name	Amount in lbs.
Andropogon purpureo-sericeus	70
A. monticola	20
A. caricosus	10
A. pertusus	10
Thelepogon elegans	25
Anthistiria ciliata	20
Ischaemum sulcatum	20
Apluda varia	20
Tephrosia purpurea	2
Psoralea corylifolia	1
Indigofera glandulosa	5

Rainfall at Kalas.

June—October, 1920.

APPENDIX C.

Date.	June	July	Aug.	Sept.	Oct.	Date.	June	July	Aug.	Sept.	Oct.
1	*Nil*	*Nil*	0·49	*Nil*	0 04	17	*Nil*	0·05	*Nil*	*Nil*	*Nil*
2	0·15	,,	0·39	,,	,,	18	,,	0 09	,,	,,	0 08
3	0·26	1·90	0·09	,,	*Nil*	19	,,	*Nil*	,,	0·35	1·32
4	*Nil*	*Nil*	0·10	*Nil*	,,	20	,,	0·10	,,	1·72	0·08
5	,,	0·09	*Nil*	0·12	,,	21	0·09	0·04	,,	1·82	*Nil*
6	2·29	0·12	0·34	*Nil*	0·01	22	*Nil*	0·08	,,	0·66	0·06
7	*Nil*	0·07	*Nil*	,,	0·04	23	,,	*Nil*	,,	0·26	*Nil*
8	,,	1·38	,,	,,	,,	24	,,	0·15	,,	0·43	,,
9	0·11	0·42	,,	,,	*Nil*	25	,,	*Nil*	,,	0·02	,,
10	*Nil*	0·18	,,	,,	,,	26	,,	0·10	,,	0·47	,,
11	0·20	0·09	,,	0·01	,,	27	0·05	0·12	,,	0·68	,,
12	0·22	0·10	0·07	0·33	,,	28	*Nil*	0·05	,,	0·09	,,
13	0·71	0·09	,,	*Nil*	,,	29	,,	*Nil*	0·11	0·27	,,
14	*Nil*	0·07	0·02	,,	,,	30	,,	0·03	0·06	*Nil*	,,
15	*Nil*	0·06	0·02	,,	,,	31	...	0·33	0·17	...	,,
16	0·22	0·1	*Nil*	,,	0·16						