The flora that matched the fauna

J. P. H. ACOCKS*

ABSTRACT

An attempt is made to reconstruct the vegetation of the plains, plateaux, mountains and rivers of the semi-arid to arid western half of the Republic of South Africa as it was before it came under the influence of any type of man other than the Bushman and the Hottentot. Species of plants that were likely to have been important are listed, even if they are rare today. Particular attention is paid to the riverine vegetation. Features of the vegetation and topography that might have influenced the fauna are noted.

RÉSUMÉ

LA FLORE ASSORTIE À LA FAUNE

On s'est efforcé de reconstituer la végétation des plaines, plateaux, montagnes et rivières de la moitié occidentale, semi-aride à aride, de la République d'Afrique du Sud telle qu'elle existait avant d'avoir subi l'influence humaine (à l'éxception des Boschimans et des Hottentots). On a dressé une liste des plantes qui, même si elles sont rares aujourd'hui, ont probablement eu de l'importance. La végétation riveraine a fait l'objet d'une attention particulière. Les caractéristiques de la végétation et de la topographie susceptibles d'avoir influencé la faune sont notées.

INTRODUCTION

To conserve and manage our fauna and vegetation successfully, it is desirable to know what the vegetation was like before the White man appeared on the scene some 200-300 years ago. In short, a reconstruction of the original vegetation is required. The area under consideration is the western half of the Republic, i.e. roughly west of longitude 26 °E, where the vegetation has suffered the greatest changes and where the indigenous animal population has all but disappeared. Only by a process of deduction will it be possible to determine what the state of vegetation was when the Hottentots, Bushmen and game had the veld all to themselves. By the time the scientific description of flora and vegetation first became possible, much of the vegetation and soil had been damaged or was well on its way to being damaged. The vague descriptions and references to grass and the absence of grass that we have at our disposal help very little and tend rather to be confusing. Burchell's (1822-1824) attempt to list the flora in Griqualand West shows how little was known in 1810, at a time when the White and Coloured pastoralists had already penetrated to all parts of this western half except the far north, and there the Black man had long been established.

Because of the topography, some of the vegetation types tend to occur in continuous belts, extending over hundreds of kilometres even if very narrow, rather than in isolated patches. Evidence of seasonal migration of game must be sought where these belts extend across the boundary between summer- and winter-rainfall regions. If the belts also extend from cold high altitudes to warm low altitudes, the probability of migration is increased. On the other hand, greater swampiness along the rivers, or denser gallery forests and thickets, may well have hampered the movements of some species.

Hunters and gatherers are no longer a factor in the environment, but in the eastern half of the country we can still see how the vegetation reacts to Man advanced beyond the hunting and gathering stage. One does not have to be a botanist to notr, for instance, that in a few decades the purple-pink winter colour of a climax *Themeda*-veld can change to the white of a pioneer *Eragrostis*-veld to the mottled

c/o Grootfontein College of Agriculture, Middelburg, 5900

green and white of a *Chrysocoma-Aristida*-bareground-desert type of false karoo. One will also note that, physiognomically, the end result in an area receiving 600 or 750 mm of rain a year will hardly differ from that in an area annually receiving 175 or 200 mm hundreds of kilometres away to the west or south, except that there will perhaps be no dongas in the latter because no soil remains.

A second great change that inevitably follows thinning or destruction of a grass cover is the erosion of the soil by water and wind. This erosion is not so obvious on the flats until one notices that some of the longer-lived bushes, like Lycium, Pteronia and Rhigozum, are standing on 30 cm stilts. Where the soil is deep, for example on apron slopes of the mountains and along the valleys, this is particularly noticeable. The capacity of the country to support the animals through the dry season is reduced by the disappearance of swamps and river flats formerly too wet for use in the rainy season. Much of the scanty and erratic rainfall, particularly the heavy rain which does not fall very often, is also lost down the dongas. For this reason, one hears the farmers complaining about "dry rain". Donga erosion is the biggest obstacle to restoring the vegetation, mainly because the uneven surface cannot hold the rain long enough for it to soak into the soil, and thus to promote the growth of plants.

A third great change that anyone can observe is the whittling away of forest for cultivation, roadbuilding and so on, and by veld-burning. On a small scale, perhaps, because western South Africa had only a small area of forest then and a very small area now. Forest is nevertheless a vegetation type that must be added and some types of thicket, too, for instance Spekboomveld, which is being nibbled away by goats.

A fourth noticeable change is conversion of grassveld (grassland) and grassy woodland into thorny thickets, either by invasion or by thickening up of local species such as *Acacia karroo*, *A. mellifera* subsp. *detinens* and *Rhigozum trichotomum*. Another aspect of this is invasion of karoo and fynbos by exotics such as species of *Prosopis*, *Pinus*, *Hakea* and *Acacia*. Therefore thickets of the wrong type and occurring in wrong places, also forest if it is artificial, should be removed from the vegetation picture before we can arrive at the original condition of the vegetation. A fifth important and universal change, but not always obvious and often difficult to assess, is change in species composition even where there is not change in vegetation type. This can be caused by selective overgrazing, by too frequent burning, or by selective use for timber, firewood, medicine, etc., some species tending to disappear and others tending to increase by taking their place.

A very serious problem arises in those regions where forest, fynbos and grassveld meet, because neither fynbos nor grassveld can survive under a forest canopy even if it is only a scrub-forest, nor can grassveld survive in a fully developed fynbos. The difficulty is that in any particular area many of the fynbos species, in particular, are endemic and so cannot be replaced from outside that area. The only solution appears to be to invoke a "rotating climax", depending on fire at appropriate intervals under a climate of such a nature as to prevent the forest from advancing beyond a scrub-forest or thicket stage that becomes inflammable in a severe drought. The rotation would be: scrub-forest-fire-grassveld-fynbosscrub-forest. For several reasons, fire as an environmental factor can hardly be eliminated. For, however long or short a period fire-using man has been around, it is difficult to visualize a climate without lightning, nor can spontaneous combustion be ruled out in a mixture of animal droppings and damp grass.

TOPOGRAPHICAL REGIONS AND THEIR VEGETATION

The country under consideration consists topographically of the following regions (see Fig. 1):

- (a) a coastal plain on the west side;
- (b) a low coastal plateau on the south side, with little coastal plain;
- (c) mountain ranges running north and south on the western side (Kamiesberg, Cedarberg, etc.), east and west on the south side (Langeberg, etc.) near the coast;
- (d) an inland mountain range (Swartberg) running east and west parallel with the coastal range of the south coast;
- (e) the Great Escarpment of the upper plateau, running more or less parallel with the Swartberg and Cedarberg;
- (f) a series of basins between or within the mountain ranges:
 - (i) the Worcester-Robertson Karoo.
 - (ii) the Little Karoo
 - (iii) the Great Karoo
 - (iv) the Ceres-Tanqua Karoo
 - (v) the Warm Bokkeveld; and
 - (vi) the Cold Bokkeveld;
- (g) the upper plateau.

In this account, the number of species mentioned in parentheses after the veld type number is the number of species located in that veld type during the survey, lists of which will be published in due course. It is not claimed that these lists are complete, but as there was presumably some member of the fauna capable of utilizing every species of plant, it may be as well to know of as many of them as possible. The number following the species number represents the mean altitude in metres of the samples taken in that veld type.

(a) West-coast plain

The west-coast plain receives a winter rainfall ranging from about 300 mm in the south to 50 mm or less in the north. It is poorly drained, however, so that little run-off reaches the sea and evaporation is relatively low by South African standards. Hollows and watercourses retain moisture in summer and some of the main streams, cut off from the sea by sand-bars, remain as swamps or even as narrow lakes. The possibilities for grassiness are thus greater than might be supposed from the amount and nature of the rainfall.

The veld type that shows signs of the most grassiness is what is now Coastal Renosterbosveld 46.1 (c. 900 species, 205 m) on clayey soils. This would have been a fairly dense *Themeda*-dominated grassveld for a few years after a fire until a thick sprinkling of small shrubs of many species grew out again; the grassiness would, however, have been permanent and the renosterbos not yet dominant. Ploughing has been so thorough that all that is left of this veld is on hills too steep to be ploughed and on outcrops of hard rock.

The grasses included: Cymbopogon marginatus Cynodon dactylon Ehrharta calycina E. capensis E. melicoides E. villosa Eragrostis curvula Festuca scabra Hemarthria altissima Hyparrhenia hirta Karroochloa curva Koeleria cristata

Lasiochloa longifolia Merxmuellera arundinacea M. rufa M. stricta Pennisetum macrourum Pentaschistis curvifolia P. thunbergii etc. Phragmites australis Plagiochloa uniolae Sporobolus virginicus Stipagrostis capensis Themeda triandra

The shrubs and small trees of stream-banks, rocky places and "heuweltjies" included:

Diospyros glabra Dodonaea viscosa var. angustifolia Euclea tomentosa Lycium ferocissimum Maytenus heterophylla M. oleoides Montinia caryophyllacea Olea africana Printzia polifolia Rhus angustifolia R. dissecta R. incisa R. laevigata R. rosmarinifolia Salvia africana-caerulea Solanum guineense Wiborgia mucronata

Lotononis prostrata etc. Mohria caffrorum

Of these, *Olea africana* was dominant, while representative bushes, forbs and geophytes of the Western Coastal Renosterbosveld were the following:

Agathosma cerefolium Aizoon sarmentosum Albuca altissima Anthospermum aethiopicum Antizoma capensis Arctopus monacanthus etc. Aspalathus spp. Asparagus spp. Berkheya armata Castalis nudicaulis Cliffortia juniperina etc. Corymbium villosum Crassula subulata etc. Cyanella capensis Cyphia digitata etc. Diosma hirsuta Echiostachys spicatus Euphorbia genistoides Ficinia bracteata etc. Galenia fruticosa Helichrysum revolutum etc. Hermannia althaeifolia etc. Indigofera procumbens etc. Lachnospermum ericoides Lapeirousia corymbosa Lessertia rigida Lobostemon fruticosus etc.

Monsonia speciosa Moraea villosa etc. Muraltia heisteria Nenax hirta Ornithogalum thyrsoides etc. Oxalis obtusa etc. Pelargonium rapaceum etc. Pellaea auriculata Peucedanum capillaceum etc. Phylica rigidifolia etc. Polygala affinis Pteronia hirsuta etc. Restio cuspidatus Scirpus maritimus Senecio hastatus etc. Tetragonia spicata Trachyandra spp. Typha latifolia subsp. capensis. Ursinia chrysanthemoides Zantedeschia aethiopica Zygophyllum sessilifolium

The other veld types in this coast belt are on sandy soils. They are the Strandveld 34 (1 038 species, 58 m), the West Coastal Fynbos 47.1 (1 374 species, 74 m) and northwards on firmer red sandy soil the Succulent Karoo 31.1 (600 species, 183 m). These veld types were more suitable for the browsers in







that they were essentially shrubby. They would only locally, however, have been too dense for a good deal of grass, including species peculiar to sand, e.g. Ehrharta villosa, Eragrostis spinosa, Pentaschistis involuta, Sporobolus virginicus, Tricholaena arenaria, Chaetobromus dregeanus and Eragrostis cyperoides.

To the south, Restionaceae were important, e.g. Willdenowia striata and, in wet hollows, species of Chondropetalum and Thamnochortus.

High forest cannot have existed in this semi-arid region, but there was a little short forest in the shape of gallery forest along the permanent streams, not to mention the curious "Lilliputian forest" of the coastal dunes and the short thorny thickets on limestone in the Saldanha Bay area. In the gallery forest, species included:

Olea africana	Rhus angustifolia
Podocarpus elongatus	R. laevigata
Pterocelastrus tricuspidatus	Sideroxylon inerme (south- wards)
Colpoon compressum	Euclea racemosa
Maytenus heterophylla Acacia karroo (northwards)	E. tomentosa

The "Lilliputian forest" and the limestone thicket of the Strandveld included:

Cassine eucleaefori	mis
Euclea racemosa	
Pterocelastus tricus	pidatus
Pteronia divaricata	
Putterlickia pyraca	ntha
Rhus glauca	
Chrysanthemoides	monili-
fera	

Lycium cinereum aggr. Pelargonium gibbosum Solanum guineense Euphorbia burmannii Colpoon compressum Zygophyllum morgsana Limonium perigrinum

Away from the coast, the Strandveld is of Fynbos form, but includes more of the bushy succulents like Cotyledon paniculata, Euphorbia burmannii, Ruschia cymosa, R. utilis, Othonna floribunda, Pelargonium fulgidum, P. gibbosum and Zygophyllum morgsana.

Also present are some shrubs not found in the Fynbos, such as Pteronia onobromoides, Jasminum glaucum, Eriocephalus racemosus, Justicia orchioides, Lebeckia multiflora and L. sericea, but it lacks Protea, Leucadendron, Leucospermum and Serruria of the Coastal Fynbos.

In the West Coast Fynbos, the grasses included the following:

Chaetobromus dregeanus Cymbopogon marginatus Cynodon dactylon

Diplachne fusca Ehrharta calycina E. villosa Eragrostis curvula E. sarmentosa Hemarthria altissima Imperata cylindrica Lasiochloa longifolia Pentaschistis curvifolia P. thunbergii Plagiochloa uniolae

The shrubs of the West Coast Fynbos included:

Berzelia abrotanoides Diospyros austro-africana var. rugosa D. glabra Euclea racemosa E. tomentosa Leucadendron salignum L. imbricatum L. pubescens etc. Leucospermum rodolentum Lycium afrum L. ferocissimum

the following: Agathosma capensis etc. Anthospermum aethiopicum Aspalathus quinquefolia subsp. virgata A. ternata etc. Cliffortia spp. Diosma oppositifolia etc. Erica mammosa etc. Euphorbia tuberculata Felicia fruticosa Hermannia diffusa etc. Ifloga ambigua Lachnea capitata Lachnospermum ericoides Leucospermum hypophyllum Lobostemon glaucophyllus Microdon capitatus Nylandtia spinosa

tha Schismus barbatus Sporobolus virginicus Stenotaphrum secundatum Stipagrostis capensis Themeda triandra ast Fynbos included: Maytenus heterophylla Metalasia muricata Olea africana

Pseudopentameris macran-

Metalasia muricata Olea africana Podalyria spp. Protea repens Putterlickia pyracantha Rhus dissecta R. glauca R. laevigata Salvia africana-lutea Wiborgia obcordata

The bushes of the West Coast Fynbos included

Passerina glomerata Pharnaceum incanum Phylica cephalantha P. rigidifolia P. stipularis etc. Polygala garcinii Priestleya sericea Protea scolymocephala Rafnia spp. Serruria spp. Solanum guineense Staavia radiata Stoebe fusca etc. Tetragonia fruticosa Thesium scabrum etc. Viscum capense Zygophyllum spinosum

Forbs and geophytes of the West Coast Fynbos included:

Aizoon paniculatum Antholyza ringens Argyrolobium velutinum Asparagus asparagoides Babiana spp. Caesia dregeana Chlorophytum viscosum etc. Chondropetalum tectorum

Cyanella capensis Cynanchum africanum Euphorbia tuberosa Ferraria divaricata Ficinia bulbosa etc. Gladiolus alatus G. carinatus etc. Helichrysum spp. Lachenalia bulbifera etc. Lapeirousia fabricii etc. Lebeckia carnosa etc. Limonium longifolium Lobelia coronopifolia Melasphaerula ramosa Microloma sagittatum Moraea fugax etc.



FIG. 2.—Coastal Fynbos with Leucadendron sericocephalum, L. imbricatum, L. salignum, Leucospermum rodolentum, Serruria adscendens and many more. Ornithogalum thyrsoides etc.

Osteospermum imbricatum etc. Othonna perfoliata etc. Oxalis purpurea etc. Pelargonium triste etc. Petalacte coronata Restio filiformis etc.

Romulea rosea etc.

Rumex cordatus

Senecio glabrifolius etc. Staberoha distachya Tetragonia portulacoides Thamnochortusdichotomus Trachyandra scabra etc. Ursinia chrysanthemoides Wachendorfia paniculata Watsonia coccinea Willdenowia arescens W. striata Zantedeschia aethiopica

One may suppose that the pastoral Hottentots made free use of fire in order to take advantage of the ability of a high proportion of the shrubs to coppice from the crown. This new growth of nearly all species of bush and Restiads is palatable to cattle (and to bontebok at least of the wild animals, as can be seen in the Bontebok Park), even though the old growth of nearly all species now present is unpalatable.

Change in species composition in apparently unaltered veld is difficult to assess in this part, because little grazing is now done to give one an idea of which species are likely to have been reduced by overgrazing in the past. One has to suppose that in important genera like *Aspalathus*, *Erica* and *Cliffortia* there were many species that were palatable to the wild animals, but one can feel sure that the species which are now dominant, as a result of selective grazing by domestic livestock, were not the original dominants.

Northwards beyond the Olifants River, the country is very arid and in summer more suited to the animals that do not need to drink, except perhaps near the mountains and near the coast. The high proportion of succulents in the Succulent Karoo would be a help, assuming they were palatable. Here again, the dominants of today were not the original dominants, while the proportion of non-succulent shrubs and grasses was higher than it is now. More widespread species in the Succulent Karoo are now:

Adromischus mammilaris Amphiglossa tomentosa Aridaria noctiflora Sphalmanthus tetramera Asparagus capensis Berkheya fruticosa Cotyledon reticulata C. wallichii Drosanthemum framesii Euphorbia burmanni E. mauritanica Galenia africana C. fruticosa Hermannia cuneifolia var. cuneifolia Hirpicium alienatum Hoplophyllum spinosum Lampranthus uniflorus Lycium ferocissimum Monochlamys albicans Osteospermum sinuatum Psilocaulon utile Pteronia heterocarpa Ruschia caroli R. cymosa R. frutescens Salsola zeyheri Tetragonia namaquana T. robusta Zygophyllum spinosum Z. stapffii

Grassiness is sometimes conspicuous, but today it is mainly annual, consisting of an annual form of *Ehrharta calycina*, with *Stipa capensis* (particularly on the "heuweltjies"), *Bromus japonicus*, *Lasiochloa echinata*, *Pentaschistis capillacea* and others. Besides these annuals, perennial grasses included *Ehrharta calycina*, *E. barbinodis*, *Chaetobromus dregeanus*, *Tricholaena arenaria* and *Stipa capensis* and would formerly have been more plentiful.

Soil erosion would have been of little importance here because of the generally soft nature of the rainfall. Winds are strong from the north-west and south-east, but as they blow along the coast rather than inland, their effect is less than might be expected.

It should be noted that the rounded mountains of the Escarpment in Namaqualand do not constitute the barrier to eastward migration that the mountains do southwards, and the gap between the Kamiesberg and the Langeberg provides an open passage to the grassy Bushmanland plateau. There is, moreover, considerable drainage from the Kamiesberg in a southerly and south-easterly direction into this gap.

A feature of the west-coast belt is an immense geophyte flora. Bulbs, corms, tubers and rhizomes often give the impression of being more plentiful than soil in the top few centimetres. Another feature is the occurrence, both in clayey and sandy parts, of the low mounds known as "heuweltjies", which may or may not have been termitaria. Bush-clumps are associated with them in parts that are not too thoroughly denuded.

The picture one can form of the vegetation is thus a grassy shrubland up to two or three metres tall, open and densely grassy only in the southeastern portion which is now (or was until ploughed up) Renosterbosveld. Intersecting it would be belts of short forest and thicket along the major drainage channels, another type of shorter thicket occurring all along the coast, while bush-clumps were dotted around too. The lower courses of some of the rivers which arise in the mountains were possibly deep

FIG. 3.—Succulent Karoo about 20 km south-east of Klawer, with Zygophyllum morgsana and Euphorbia mauritanica conspicuous. or swampy enough to constitute barriers to movement of most kinds of game. As the whole area received a winter rainfall there was little climatic variation.

South of the Olifants River, movement of game would probably have been restricted to concentration in summer around places where there was permanent water and enough moisture in the soil to permit growth of grass in particular, perhaps on the mountain sides too, with game dispersed in winter. In the arid part north of the Olifants River, movement of animals, especially those not dependent on drinking water, was more or less unrestricted because of easy access to the upper plateau.

One can safely say that there was a place for all kinds of animals except those of high forest.

(b) Coastal plateau

The plateau of the south coast is similar in general characteristics, but is less arid and receives a proportion of summer rainfall sufficient to support a more vigorous growth of grass, large shrubs and small trees. There is no material climatic variation.

Topography is more broken, with the main rivers, which rise in the mountains, sunk in deep gorges for much of their courses. Even the minor streams arising locally often have deep, narrow channels. The underlying rock being either tilted shale or calcareous tufa, not much of the generally soft rainfall is lost to the sea.

Movement of animals east and west would be relatively unobstructed along the watershed running east from Caledon as far as the Vreede River and along the watershed running south-east from Caledon to the Duineveld of Bredasdorp; also west of Caledon into the valleys of the Zwart, Bot and Riviersonderend Rivers, with extensive swamps along the rivers.

The vegetation is again of two major types, Renosterbosveld 46.2 (1 320 species, 183 m) on clayey soils and Fynbos 47.2 (1055 species, 115 m) on sandy soils, in part overlying calcareous tufa. Gallery forest occurs along the rivers and thickets of sub-tropical Valley Bushveld type. Dune Forest 1(d) and 2 (\pm 850 species, 10 m) of eastern type is found along the coast, well developed in sheltered places, but stunted to even lower stature than the Strandveld "forest" of the west coast in parts particularly exposed to sea winds. It may become so reduced that Freesia is able to grow out through the crowns of trees like Sideroxylon inerme. Much of it has been destroyed by movement of the dunes, which has become more active than on the west coast.

This region falls within the climatic zone already mentioned, where fire may have to be invoked to keep short forest, fynbos and grassveld in being in a "rotating climax". There can be no doubt about the grassiness of the Renosterbosveld, because the whole farms are still dense Themeda-dominated grassveld requiring only an occasional fire to keep the renosterbos under control. Single small trees of Sideroxylon inerme are, however, scattered all through, often in the corners of lands, and relics of relatively non-thorny thicket occur here and there at higher altitudes. Euclea undulata is the dominant, with the following:

Olea africana Sideroxylon inerme Rhus longispina Pterocelastrus tricuspidatus Aloe ferox A. arborescens

Carissa haematocarpa Maytenus heterophylla M. capitata Schotia afra Sarcostemma viminale

A short closed forest, of which relics remain, may possibly have covered all of the more or less sandcovered limestone ridges of the Duineveld of Bredasdorp. Swellendam, Heidelberg, Riversdale and Albertinia, and merged into the Dune Forest of the coast. Relics include:

Cassine crocea
C. peragua
C. aethiopica
Sideroxylon inerme
Colpoon compressum
Euclea racemosa (as a tree)
Maytenus heterophylla

Pterocelastrus tricuspidatus Olea exasperata O. capensis O. africana Linociera foveolata Zanthoxylum capensis Clausena anisata

This sort of short forest rotated with tall Protea Fynbos and Themeda-dominated grassveld, but could not have been a permanent climax because of the large number of fynbos endemics. The grassveld phase may have been shorter-lived than in the Renosterbosveld, but it should be noted that Themeda here is capable of becoming a scrambler, with leafy stems up to $1\frac{1}{2}$ metres long. It has the same shrub-(and restiad-) smothering ability as *Ehrharta bar-*binodis in Namaqualand. General sandiness notwithstanding, in places one finds a suggestion of a black humus soil on the limestone, held in position now by the thinly twiggy but strongly rhizomatous Ehrharta rehmannii.

Besides Themeda and Ehrharta rehmannii, the grasses of the Duineveld included the following:

Andropogon appendicula-
tus
Aristida diffusa var. burkei
Cymbopogon marginatus
C. plurinodis
Cynodon dactylon
Diplachne fusca
Ehrharta calycina
E. villosa
Eragrostis curvula
Eustachys mutica
Festuca scabra
Hemarthria altissima
Koeleria cristata

Lasiochloa longifolia Melica racemosa Panicum stapfianum Pentameris sp. Pentaschistis curvifolia P. patulifloraP. thunbergii Phragmites australis Plagiochloa uniolae Setaria flabellata Sporobolus capensis Stenotaphrum secundatum Stipa capensis

Besides the trees and shrubs of the short forest. the shrubs and lianas of the Duineveld included:

Aspalathus pinguis subsp. Metalasia brevifolia longissima M. muricata Carissa bispinosa Mimetes elata Podalyria cuneifolia Cassine tetragona var. laxa Chrysanthemoides monilife-Polygala myrtifolia Protea lanceolata ега Cliffortia ilicifolia P. obtusifolia P. repens Cynanchum ellipticum Diospyros dichropylla P. susannae Dipogon lignosus Psoralea pinnata Leudadendron muirii Rhus glauca R. laevigata L. coniferum R. lucida L. rubrum Leucospermum attenuatum L. truncatum The bushes of the Duineveld included the following:

Acmadenia psilopetala etc. Adenandra obtusata Agathosma scaberula etc. Amphithalea ericaefolia Anthospermum aethiopicum Aspalathus alopecurus A. calcarea A. crassisepala A. nigra etc. Asparagus rubicundus Chascanum cernuum Cliffortia falcata etc. Clutia ericoides Cryptadenia filicaulis Dianthus albens Erica coccinea E. curtophylla E. spectabilis etc. Eroeda imbricata

Salvia africana-lutea Solanum geniculatum

Euphorbia artifolia E. muirii Felicia filifolia subsp. bodkinii etc. Gnidia chrysophylla etc. Helichrysum chlorochrysum H. paniculatum etc. Helipterum argyropsis Hermannia joubertiana H. rudis H. trifoliata etc. Indigofera brachystachya Lampranthus glaucus subsp. aurantiacus Lebeckia sessilifolia Lightfootia calcarea Lobostemon curvicolis etc. Muraltia empleuridioides etc. Myrica quercifolia

Myrsine africana Nenax hirta Nylandtia spinosa Passerina galpinii P. glomerata Pelargonium betulinum etc. Pentzia sp. = A 23142, 23959 Pharnaceum incanum Phylica dodii P. parviflora etc. Polygala bracteolata P. peduncularis etc.

The forbs and geophytes included:

Albuca cooperi Antizoma capensis Arctopus echinatus Argyrolobium lanceolatum Aristea africana Babiana nana etc. Berkheya coriacea Brunsvigia orientalis Cassytha ciliolata Castalis nudicaulis Centella difformis Chironia tetragona Chondropetalum microcarpum Corymbium glabrum Crassula subulata var. subulata etc. Euphorbia silenifolia Ficinia praemorsa F. truncata etc. Gladiolus floribundus etc. Helichrysum crispum etc. Ifloga ambigua Indigofera costata subsp. macra etc. Ixia orientalis Knowltonia vesicatoria Lachenalia muirii Leonotis leonitis

Prismatocarpus campanuloides Psoralea fruticans Rhyticarpus difformis Stilbe ericoides Stoebe rosea Struthiola macowanii etc. Sutera microphylla etc. Tetragonia fruticosa Thesium spp. Ursinia dentata etc. Viscum capense Zygophyllum fulvum

Limonium scabrum Lobelia capillifolia etc. Microloma sagittatum Moraea sp., cf. M. tripetala Ornithogalum dubium etc. Osteospermum subulatum etc. Othonna perfoliata Oxalis polyphylla etc. Pelargonium myrrhifolium P. ovale P. triste etc. Psoralea decumbens Restio eleocharis Rhynchosia ferulaefolia Romulea rosea Rumex cordatus Scabiosa columbaria Scirpus membranaceus Senecio arnicaeflorus Senecio sp., cf. pinifolius= A 23173 Silene undulata Stachys aethiopica Sutera hispida etc. Sutherlandia frutescens Tetraria cuspidata Thamnochortus dichotomus T. paniculatus

This is a particularly clear-cut veld type with little variation. However, in its present condition it is in detail a complex patchwork of little burn successions, changing from year to year, so that the vegetation is in a state of flux. It is likely, of course, that patchiness of burning, though on a much larger scale and at longer intervals than now, would have been necessary to protect the fynbos and grassveld against the mischance that a general fire might at some time happen too late to save them from suppression by the forest.

On red sandy flats south of Heidelberg there was a shorter type of thicket, again of similar composition, but with a greater proportion of the thorny species like Azima tetracantha, Carissa haematocarpa and Maytenus heterophylla, and associated with few fynbos species. This has almost all been ploughed out, but in 1948 was still quite extensive in patches and was noted to be "absolutely impenetrable" in parts, presumably because grazing and burning were no longer practised.

The Valley Bushveld 23e (942 species, 91 m) of the river gorges is taller and similar to that of the Eastern Cape except that it lacks the arborescent *Euphorbia* spp. Acacia karroo is present, but not Portulacaria afra, except possibly in the Gouritz River gorge. In the drier region at Mossel Bay the bush is dense and stunted, reminiscent of the Fish River Scrub.

Species today include the following:

Acacia karroo Aloe arborescens A. ferox Azima tetracantha Buddleja saligna Carissa haematocarpa Cassine tetragona var. laxa Chrysanthemoides monilifera Cotyledon orbiculata Cynanchum ellipticum Euclea undulata Euphorbia burmannii Ficus burtt-davyi Grewia occidentalis Heteromorpha arborescens Maytenus heterophylla M. capitata Noltea africana Olea africana Pittosporum viridiflorum Pterocelastrus tricuspidatus Sarcostemma viminale Schotia afra Scolopia zeyheri Sideroxylon inerme Tamarix usneoides Tarchonanthus camphoratus Zygophyllum morgsana

The grasses of the Valley Bushveld include:

Cymbopogon marginatus Cynodon dactylon Digitaria eriantha Ehrharta calycina E. capensis E. melicoides E. villosa Eragrostis curvula Eustachys mutica Festuca scabra Hyparrhenia hirta Karroochloa curva Koeleria cristata Melica racemosa Merxmuellera arundinacea M. disticha M. stricta Panicum maximum P. stapfianum Pentaschistis eriostoma Phragmites australis Sporobolus fimbriatus S. ioclados S. virginicus Stipa dregeana var. elongata

Grassiness is important, today at least, because the Valley Bushveld has become open and clumpy and much invaded by *Elytropappus rhinocerotis*.

It is probable that the deep little valleys of streams running north into the Riviersonderend and south into the Breede River were filled with reedswamp, the main rivers being filled with *Prionium* Swamp.

As compared with the West Coast Belt, grassveld was more extensive, denser and longer-lived in the Renosterbosveld of the South Coast Belt, while subtropical thicket, valley bushveld and short closed forest occurred as well as temperate fynbos and renosterbosveld. Geophytes, however, do not occur in such abundance, nor do the "heuweltjies", so it is not quite so favourable a habitat for diggers and burrowers.

The only likely migration route out of the coast belt for most of the animals would seem to be into the Breede River valley past Swellendam. The Knysna forest barred them in the east, mountains barred them in the north and west and the Riversonderend made access to the upper Breede River valley, *via* the Villersdorp gap, difficult.

There was a place for all kinds of animals except those of the desert.

(c) Coastal mountain ranges

These ranges consist of sandstone and quartzite with a poor sandy soil, except in Namaqualand and near Cape Town where granite and shale occur. Very little soil remains today, but presumably when fires were less frequent these ranges were better covered and could carry a denser vegetation, but at best they are precipitous and rugged.

Where rainfall is sufficient, southern lower slopes and kloofs were clothed with high forest of Knysna type. It occurred on Table Mountain, on the mountains around Stellenbosch, and perhaps Fransch Hoek, and was probably continuous from the Riviersonderend Mountains to George except for short gaps in the valley of the Breede River and the gorge of the Gouritz River. On the drier west side and on the lower mountains of Caledon and Bredasdorp, shorter forest is found, but it is difficult to say how extensive it might have been. Today it is confined to screes except for a few relics like the Uilkraal forest near De Kelders. It is true forest rather than thicket, so if it did cover the south slopes, at least, of the mountains of Caledon and Bredasdorp it would have been a permanent climax.

Widdringtonia Forest occurred in a limited area on the Cedarberg and it is not impossible that there was such forest on the south coast mountains in a narrow belt above the Knysna-type forest and extending to the Couga Mountains.

On the west coast ranges the rainfall comes in winter with snow, but in summer only the upper slopes receive a certain amount of moisture from mists. On the south coast ranges rainfall also comes in summer, increasing eastwards, in addition to winter rainfall and snow.

The vegetation throughout, apart from the forest, is Mountain Fynbos, varying greatly in species composition from place to place, but always having such a variety of species of grasses, sedges, restiads, ericoid shrubs, broad-leaved shrubs, forbs and geophytes as to provide for any kind of animal that is prepared to climb. However, there is little place for pure grassveld. The Mountain Fynbos has not been studied in the same way as the Coastal Fynbos and other veld types.

The only reasonably level country within the mountains comprises the Warm Bokkeveld of Ceres, f(v), and a maze of valleys in the Cold Bokkeveld, f(vi), at a higher level to the north. Neither is karoo so they are best considered here. In the flat, open Warm Bokkeveld, shale outcrops have resulted in a heavier soil than the usual white sand and the vegetation is renosterbosveld with relics of *Themeda* Veld surviving. The Cold Bokkeveld is mainly sandy and thus fynbos. Both are well watered, with extensive swamps, which include *Prionium serratum* in their flora as well as *Cladium jamaicense*, *Anthoxanthum dregeanum* and *Pennisetum macrourum*.

The botanist finds it difficult to visualize a fauna of the mountains (klipspringer, vaal rhebok, quagga perhaps?), but in these valleys a numerous and varied fauna seems more possible. Thanks to outcrops of shale along the lower slopes of the mountains, which weather to smooth contours, migration routes into the valleys are provided along the belts of grassy renosterbosveld on the shale. They lead from the western parts of both the Great Karoo and the Little Karoo via the Touws River basin.

The least dry month in the Little Karoo is March, so that it could be expected that the vegetation would be at its best in autumn and early winter. The climate is mild. The Bokkeveld receives its rain in winter, June being the reliably wet month, and although the veld greens up, not much growth is made until the weather warms up in spring. So it would seem that a migration from the Bokkeveld to the Karoo in March and April and a return in August and September could be expected. Of a similar nature, is the routine migration of the farmers of the Roggeveld, from the plateau to the Tanqua Valley and back.

The rounded granite mountains of Namaqualand, which form a coastal range but are actually on the edge of the central plateau, have a different vegetation. Only on the 1 300 to 1 400 m Kamiesberg Plateau is there a patch of fynbos, renosterbosveld and nonsucculent karoo, with narrow belts of renosterbosveld and karoo at lower levels where shale occurs. For the rest, the vegetation, the Namaqualand Broken Veld 33 (1 044 species, 600 m) is physiognomically similar to the luxuriant variation of the Karroid Broken Veld on rocky hillsides in the Little Karoo (pp. 686–688).

The characteristic plant is *Aloe dichotoma*, but today, at least, it is of erratic occurrence. As befits a "broken" veld, all life forms of plants are present. Besides *Aloe dichotoma*, notable plants of more

regular occurrence in the Namaqualand Broken Veld include the following:

Acacia karroo Antizoma miersiana Asparagus retrofractus etc. Berkheya fruticosa Cotyledon paniculata . wallichii etc. Didelta spinosum Euclea tomentosa Euphorbia decussata E. mauritanica Lebeckia sericea Melianthus pectinatus Othonna arbuscula Osteospermum oppositifolium Ozoroa concolor

Pteronia divaricata P. incana Rhus undulata var. Ruschia cymosa R. frutescens etc. Salvia dentata Sarcocaulon l'heritieri Sarcostemma viminale Senecio cotyledonis S. junceus Stachys flavescens Sutera fruticosa Thesium lineatum Zygophyllum foetidum Z. morgsana

The grass flora is by no means negligible, e.g. Ehrharta barbinodis, E. calycina, E. villosa (broadleaved form), Aristida dasydesmis, Chaetobromus dregeanus, Cymbopogon plurinodis, Fingerhuthia africana and Pentaschistis tomentella. There is also an immense flora of Mesems, other succulents, karoo bushes, geophytes and annuals. It is notable that Stipagrostis brevifolia, S. ciliata and S. obtusa are rare, abundant though they are immediately to the east in Bushmanland.

Below the granite "domes" and in deeper kloofs, thickets occur, including:

Rhus undulata var.	Pteronia divaricata
R. horrida	P. undulata
R. populifolia	Freylinia lanceolata
Acacia karroo	Montinia caryophyllacea
Dodonaea viscosa var.	Maytenus oleoides
angustifolia	Salvia dentata
Melianthus pectinatus	Euclea undulata
Pteronia leptospermoides	Erythrophysa undulata

Ficus cordata and F. ilicina occur on rock faces. On the lower slopes, the taller plants fade out, leaving Succulent Karoo.

On the whole, it is country more suited to the browsers than to the grazers.

(d) Second mountain range

The second mountain range, the Swartberg, is higher, up to 2 200 m, and is continuous rather than broken up into separate peaks like the coast range. It receives less rainfall, some of it in summer, and snow in winter. It consists mostly of quartzite and sandstone, very rugged, and the vegetation is fynbos of drier types, especially on the north side. Here the lower slopes and the north sides of parallel foothills both north and south of the main range, are occupied by Spekboomveld 25.3 (724 species, 612 m), an extension of the semi-succulent bushveld of the Eastern Cape. Much of this Spekboomveld has been grazed out, but it must originally have been continuous, past Willowmore, with that of Aberdeen, Graaff-Reinet, Jansenville, Steytlerville and Uitenhage. One might say we are now in good kudu country.

The Spekboomveld today is usually a dense mixture of succulence and thorniness up to a height of 3 m, but in its original state was presumably more grassy and open and less thorny. If it is found on particularly rugged slopes, it is probably only because it could not survive elsewhere.

In the western variation, 25.3, the following grasses are present:

Agrostis semiverticillata Aristida diffusa var. burkei Arundinella nepalensis Cenchrus ciliaris Cymbopogon prolixus Cynodon dactylon C. incompletus Digitaria argyrograpta D. glauca Diplachne fusca Ehrharta calycina E. ramosa var. aphylla Enneapogon scaber E. scoparius Eragrostis curvula Fingerhuthia africana Hemarthria altissima Heteropogon contortus Hyparrhenia hirta Koeleria cristata Merxmuellera stricta Pennisetum macrourum

The trees and shrubs of the western Spekboomveld include the following:

Acacia karroo Aloe ferox Cadaba aphylla Carissa haematocarpa Cussonia spicata Diospyros lycioides Dodonaea viscosa var. angustifolia Euclea undulata Grewia robusta Heteromorpha arborescens Kiggelaria africana Lycium oxycarpum Maytenus acuminata M. heterophylla M. oleoides

M. polyacantha Montinia caryophyllacea Noltea africana Nymania capensis Olea africana Pappea capensis Portulacaria afra Pterocelastrus tricuspidatus Putterlickia pyracantha Rhigozum obovatum Rhus incisa R. lancea R. lucida etc. Salix capensis Sarcostemma viminale Zygophyllum morgsana

Pentaschistis eriostoma

Stenotaphrum secundatum

Stipa dregeana var. elongata

Phragmites australis

Sporobolus capensis

Themeda triandra

S. fimbriatus

Among the bushes and forbs are:

Adromischus maculatus Passerina obtusifolia Pegolettia baccharidifolia Aloe comptonii Asparagus striatus etc. Pelargonium peltatum Berkheya obovata etc. P. zonale etc Pentzia flabelliformis etc. Cotyledon cacalioides Pollichia campestris Polygala myrtifolia etc. Crassula ovata C. cultrata rupestris etc. Prionium serratum Dioscorea hemicrypta Pteronia staehelinoides etc. Euphorbia heptagona etc. Scirpus inanis Garuleum bipinnatum Selago glutinosa Senecio articulatus etc. Helichrysum zeyheri Hermannia linifolia etc. Silene undulata Hirpicium alienatum Sutera stenophylla etc. Indigofera porrecta Tetragonia spicata etc. Limeum aethiopicum Trichodiadema barbatum Melianthus comosus Viscum rotundifolium Monechma pseudopatulum Zygophyllum fulvum etc. Pachypodium succulentum

Apart from the gallery forests in the deep gorges of the rivers which penetrate the range from north to south, there is no forest on the Swartberg, but there is a form of woodland on the dolomite foothills in the Cango area which is distinct from the Karroid Broken Veld.

The gallery forest includes:

- ·	
Olea africana	Kiggelaria africana
Cunonia capensis	Halleria lucida
Ilex mitis	Cussonia spicata
Tarchonanthus camphora-	Clematis brachiata
tus	Sparmannia africana
Freylinia lanceolata	Acacia karroo
Salix capensis	

The Cango woodland includes Olea africana, Aloe ferox, Acacia karroo, Dodonaea viscosa var. angustifolia, Cussonia spicata, Maytenus heterophylla, M. oleoides and Nymania capensis. There is so much grass, so many bushes like Relhania genistaefolia, Euryops lateriflorus and Elytropappus rhinocerotis and so little karoo that it appears it must have been linked up with the grassy belt on south aspects that is now renosterbosveld.

The fynbos of the mountain, as always, includes many species of grass, sedges, restiads and other grass-like plants, the grass having formerly been more plentiful. There is, in fact, still a little *Themeda* Veld along the summit.

Along the flanks of this mountain range, thus, there is a direct connection with the kudu country of the south-eastern Cape. Only in the east, in the Willowmore area, and in the west towards Touwsrivier, is there likely to have been access to the country to the north, if the few gorges through the mountains were then as they are now. One might think that they were too rocky and too choked with gallery forest to be passable, but, on the other hand, it is possible that the rocks were covered with soil held in place by a denser and more vigorous growth of *Prionium serratum* than there is now. If so, the rivers would have had more water because of the damming effect of *Prionium* beds and the hippo, if present, would have had no difficulty in moving along them through the gorges. If hippo really did occur at Zeekoegat on the upper Traka River, they must indeed have done so.

(e) Great Escarpment

Apart from the Namagualand mountains, already discussed, the third mountain range lies along the edge of the Great Escarpment. It starts with the isolated Langeveld, Kubiskow Mountain and Hantamberg, and just south of Calvinia becomes the continuous Roggeveld-Komsberg-Nuweveld Range to some 40 km north-east of Beaufort West, with one small gap at Oukloof Pass. It resumes 90 km to the east near Aberdeen with the Onder-Sneeuberg and Camdeboo Mountains. One branch continues eastwards into the Amatolas, with only minor gaps, or rather indentations, at Graaff-Reinet (Sundays River), Somerset East (Swaershoek Valley) and Cookhouse (Great Fish River). The other branch trends north-eastwards via the Sneeuberg, Kikvorsberg, Suurberg, Bamboesberg and Stormberg towards the Drakensberg.

The western part lies in arid country, half receiving winter rainfall, the other half receiving late-summer rainfall, and all receiving winter snow. The eastern part is less arid, the climate in the Aberdeen area being already wet enough to support gallery forest of *Celtis africana* in kloofs and to support spekboomveld at Graaff-Reinet. From there it becomes progressively wetter to Somerset East, where the subtropical forest starts on the south slopes and the Döhne Sourveld on the summit of the Bosberg. The main rainy season is still late summer and snow regularly falls in winter.

The vegetation almost throughout was grassveld with very little woody vegetation. In the winter-rainfall area, as far east as Theekloof, it was dominated by Secale africanum, Ehrharta spp., Helictotrichon namaquense and such grasses to form the Namaqualand variation 43.1 (613 species, 1 430 m) and the Roggeveld variation 43.2 (803 species, 1 430 m) of what is now the Mountain Renosterbosveld 43. In the latesummer rainfall area eastwards from Theekloof, it was dominated by Themeda triandra, Tetrachne dregei, Pennisetum sphacelatum, P. thunbergii, and their associates to form what has become the Karroid Merxmuellera Mountain Veld 60 (1 166 species, 1 710 m). This veld merged eastwards into the Döhne Sourveld 44.2 and, via the Stormberg Plateau Sweetveld 59, into the mountain veld of the Drakensberg.

It is a feature of this vegetation that it has a high proportion of temperate winter-green grasses, even eastwards where tropical grasses are dominant and at lower, warmer levels, for instance as follows:

Ehrharta calycina	F. scabra
E. capensis	Poa binata
E. melicoides	Brachypodium bolusii
Helictotrichon spp.	Bromus leptocladus
Festuca caprina	Schismus barbatus

On the mountain tops, this grassveld was replaced by *Merxmuellera*-dominated grassveld: *Merxmuellera dura* in the winter-rainfall area in the Mountain Renosterbosveld and *M. disticha* eastwards in the Karroid Merxmuellera Mountain Veld, and this in turn has been invaded and partially suppressed by renosterbosveld. The latter includes shrubs like Elytropappus rhinocerotis, Euryops spp., Pentzia cooperi, Helichrysum hamulosum, Passerina montana, Chrysocoma tenuifolia, Eumorphia dregeana and Walafrida articulata.

Although a few species of fynbos genera (besides Passerina) occur as rareties (Cliffortia, Muraltia, Leptocarpus, Ficinia, Lobostemon, Agathosma, Erica), there is, surprisingly, nothing that can be called fynbos until one reaches the Katberg and the Drakensberg.

There is, however, a type of thicket, or perhaps originally short forest, peculiar to the western part of the range. It consists of Cliffortia arborea (sterboom), a small tree resembling Leucosidea sericea of the eastern parts rather than *Cliffortia* of the fynbos. Remnants of it occur on scree below the krantzes of the mountains, e.g. at Calvinia and Sutherland.

The renosterbosveld in the winter-rainfall area at lower altitudes around Touwsrivier, 43.3 (715 species, 976 m), and in the year-round rainfall area eastwards, 43.4 (1034 species, 700 m), is found on the lower slopes of the mountains, between the karoo and the fynbos. At these lower levels it became dominated by Elytropappus rhinocerotis, almost singly, retaining a very rich flora, but little of its original grassiness. Locally, Eriocephalus africanus or Pteronia incana may be co-dominant or even dominant.

On the upper plateau the Karroid Merxmuellera Mountain Veld extended a varying distance into the plains (further than shown in the Veld Type map) and has there been converted into Karoo 42 (642 species, 1 463 m) rather than renosterbosveld. As the mountains are mostly not precipitous or rugged on the inland side, there would thus have been a fairly easy passage through this type of grassveld almost across the country from the Drakensberg and Katberg through to the Onder-Sneeuberg near Aberdeen and again from Beaufort West through to Calvinia. Climate ranges from high summer rainfall to low late-summer rainfall and from low late-summer rainfall to low winter rainfall, with altitude remaining high all through. At lower altitudes there was a complex of grassy passages around the Little Karoo under a low year-round rainfall and into the Bokkeveld under a somewhat higher winter rainfall at a higher altitude, in this case provided by what is now the Mountain Renosterbosveld.

At the eastern end of the Escarpment, one can still see the black humus topsoil disappearing and form some idea of the luxuriance, quality and carrying capacity of the original veld; elsewhere there is only subsoil and an occasional handful of topsoil left to indicate that there was such a soil and such a vegetation.

On the south side of the Escarpment above Aberdeen and towards Pearston, the climate is more humid and the vegetation, particularly on high plateaux, was a mountain form of the Eastern Province Grassveld, a very dense Themeda Veld, of which relics survive on the original topsoil. It is, however, much cut up by precipitous gorges. It is breaking down to *Euryops* spp., and a form of Eragrostis curvula rather than to Elytropappus and Merxmuellera.

(f) Four karoo basins

Between these mountain ranges and effectively deprived of rain by them, lie the four karoo basins: (i) the Worcester-Robertson Karoo (really an indentation in the coast range), (ii) the Little Karoo, (iii) the Great Karoo and (iv) the Ceres-Tanqua Karoo. The two non-karoo basins f (v) and f (vi) have been discussed under (c) the coastal mountain ranges.

The essential difference between the original state of the karoo veld and its present state is that then the spaces between the bushes were still occupied by topsoil, held in place by grass, bulbs and the roots of annuals, no matter how short the grass may have been nor how often the annuals themselves may not have been there. The eroding surface of the subsoil today in the false karoo, where the damage is relatively recent, can still show a bristly stubble of such roots and the scales and fibres of the lower halves of bulbs and corms.

(i) The Worcester-Robertson Karoo.—This area lies in the middle valley of the Breede River, open to the coastal plateau at the south-eastern end, but hemmed in by mountains and the Riviersonderend elsewhere. The rainfall is low (below 300 mm), but run-off from the mountains is plentiful along many streams. The river itself and its major tributaries, the Riviersonderend and Hex Rivers, are permanent and would have been deep and slow running, much impeded by Prionium, Typha and Phragmites. They would have had a well-developed gallery forest, more extensive and more continuous than that of today, including such species as:

Podocarpus elongatus	Rapanea melanophloeos
Brabeium stellatifolium	Acacia karroo
Kiggelaria africana	Brachylaena neriifolia
Freylinia lanceolata	Myrica serrata
Melianthus major	Psoralea aphylla
Lachnostylis hirta	Rhus angustifolia
Salix capensis	Ilex mitis

Outside this was Karroid Broken Veld 26.1, a mixture of karoo bush, succulents large and small, grass, shrubs and trees, with thickets of Euclea Carissa haematocarpa, Zygophyllum undulata, foetidum, Putterlickia pyracantha, Euphorbia mauritanica and Cotyledon paniculata thinning out along the less arid foot-slopes of the mountains into the grassy veld, now renosterbosveld, which is transitional to the fynbos of the mountains. It appears that the rainfall in the rain shadow of this valley was insufficient to support high forest. Relics of forest in kloofs are similar to the gallery forest with some additions, like Metrosideros angustifolia, Cunonia capensis, Maytenus acuminata and Rhus lancea.

So it seems that although this valley had some open grassy country for the grazers, it was better suited to hippos and browsers.

(ii) Little Karoo.—Lying between the coast range and the Swartberg, the Little Karoo is drier than the Breede River valley with a rainfall of under 200 mm, dispersed through the year. On the other hand, it is not affected by the desert north-west wind of the upper plateau therefore humidity is not so low, conditions which favour the succulents.

The Sandberg, the Rooiberg and the deep gorges of the Gouritz and Groote Rivers divide it into two basins. The western one, the Ladismith Karoo, is a maze of little shaly hills from which all soil has disappeared, and is cut up by outliers of the main ranges. The Touws and the Groote Rivers traverse it from west to east, receiving many tributaries from the mountain ranges on either side and their outliers. It is thus likely that stock waters were generally available, as was riverine veld, even though the



FIG. 4.—Western Spekboomveld in Olifants River Gorge near confluence with Gouritz River.



FIG. 5.—Karroid Broken Veld on shale hills of the western part of the Little Karoo, about 30 km south-west of Ladismith.

rainfall over most of the area is under 127 mm per year. This meant that in the early days of settlement there was no need to trek away in search of water and grazing. In consequence, no rest would have been given to the relatively scanty hill vegetation, while the riverine vegetation was being "tamed", until soil erosion set in and eliminated the original vegetation. Only remnants of the gallery forest, that survives in the mountain gorges, still occur along the major streams, with such species as Acacia karroo, Rhus lancea, R. pyroides, Buddleja saligna, Salix capensis, Clematis brachiata, Zygophyllum foetidum, Chrysanthemoides monilifera subsp. subcanescens and Phragmites australis.

However, a farm name like Roode Els Bosch between the Rooiberg and the Sandberg suggests that such forest was not confined to places like Seven Weeks Poort.

The vegetation in general is Karroid Broken Veld 26.1 (778 species, 518 m) including all plant forms

from small trees to stone plants, window plants and geophytes, with the Mesembs particularly prominent today. It is an open woodland, the main species including the following:

Acacia karroo Cadaba aphylla Carissa haematocarpa Diospyros austro-africana D. lycioides Euclea undulata Grewia robusta Lycium oxycarpum Lycium sp., cf. L. cinereum aggr. Lycium spp. Mayienus heterophylla Nymania capensis Rhigozum obovatum Rhus lancea R. lucida R. undulata var. undulata

On rocky hillsides, as distinct from the usual stony ones, it is taller and denser, dominated by:

Cotyledon orbiculata C. paniculata C. wallichii Crassula ovata Euclea undulata Euphorbia mauritanica Maytenus heterophylla Nymania capensis Pappea capensis Putterlickia pyracantha Rhigozum obovatum Schotia afra Wiborgia sp. Zygophyllum morgsana

	Tptal	a West Coast plain	b South Coast plateau	c (i) Namaqualand mountains	(ii) W. Coast mountains	(iii) S. Coast mountains	d Swartberg	e (i) Escarpment to Theekloof	(ii) Escarpment to Beaufort West	(iii) Escarpment to Stormberg & Somerset East	f (ia) Little Karoo West	(ib) Little Karoo East	(iia) Great Karoo West	(iib) Great Karoo East	(iii) Ceres-Tanqua Karoo	g (ia) Plateau S. : Arid Karoo	(ib) Plateau S. : Central Upper Karoo & False Arid Karoo	(ic) Plateau S. : False Central Upper Karoo	(iia) Plateau N. : Bushveld	(iib) Plateau N. : Grass & False Central Upper Karoo
	174	10	6		2	1	2	5	2	16	5	Δ	12	9	2	14	23	18	14	23
Keeds	95	10	0	J	J	1	2	3	1	1	3	1	3	9	2	9	15	6	11	18
Sactdoorn	67	2	1				1	2	1	3	6	2	4	9	2	2	13	8	2	8
Grass	50	2	1		4		-		1	1			2		1	8	7	3	8	12
Piosies	35	2		3					-					9		1	14	1	8	3
Matijos	35	3	3	2	4	1	2	3	1			3	1	1		1	7	1	1	1
Blaauwbosch	33	Ū				37		1.1						4		7	8	1	8	5
Canna	31	1									1		1	5		9	5		4	4
Kameelboom	30	2		1												1			13	12
Palmiet	28	1	1	-	2			1	1	3			5	5			1	2	1	5
Taaibos	22	2		1	-			2	-							2	8	3	3	1
Willow	21			1			1	1	2	4	1	1	4	1				3	1	1
Olive	20	1	1	2	1		1			1		1				2		4	1	5
Doorn (unspecified)	19																		19	
Melkbos	14	3	2	1										1	1	3	1		1	1
Lelie	11	1		2						2				1		1			2	2
Aalwvn	10							2		1				2		1	1	2		1
Pampoen	10	3								1					1		5			
Knoffel	9		1					1					3	1			1		1	1
Papkuil	9	3		1							1				1	1			1	1
Ruigte	9									2								4		3
Melkhoutbooom	8	1	7																	
Wilde Als	8																3		5	
etc.																				

TABLE 2.—Vegetation of the western half of South Africa as suggested by names of farms, rivers, mountains etc., as shown on the Department of Water Affairs's 1: 500 000 topographic map

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FIG. 6.—Tall Karroid Broken Veld of rocky hillside between Montagu and Kruispad.



FIG. 7.—*Eragrostis spinosa* on sand in Little Karoo near Klawer.

It has been mentioned how the less arid foothills of the mountain ranges have spekboomveld on the north aspects, providing a link with the semisucculent bushveld of the south-eastern Cape, and renosterbosveld on the south aspects. It was westwards that these originally grassy renosterbosveld belts provided access to the country north of the Swartberg via Touwsrivier, Matjiesfontein and the Klein Roggeveld to the Roggeveld and northwards towards Namaqualand, as well as eastwards along the Great Escarpment.

This denser veld of the rocky hillsides provides another link with Namaqualand. It reaches the Matjiesfontein area via the Buffels River gorge. From there it extends rather intermittently along the lower middle slopes of the Klein Roggeveld and Roggeveld escarpment e.g. at Ganaga Pass and Bloukrans Pass, until it joins the Namaqualand Broken Veld in the Hantam River valley to the north-west of Calvinia. From where this valley debouches onto the coastal plain, remnants again occur southwards, on the lower middle slopes of the Bokkeveld escarpment and the Cedarberg into the Doorn River valley and the Olifants River valley to the Clanwilliam neighbourhood. One may perhaps wonder whether the rhino, with its reputation as a thorneater, in this area regarded *Hoplohyllum spinosum* and *Eragrostis spinosa* as delicacies.

If one can thus visualize the vegetation before it was broken down, it ceases to be surprising or questionable that animals of active disposition but of rather-specialized habitat requirements and of large size, such as kudu, elephant, rhinoceros and hippopotamus, could have lived all through this arid country.

Grassiness is difficult to visualize under such a low rainfall, but when woody and fiercely armed shrubs like *Carissa haematocarpa* and *Maytenus heterophylla* are driven to take shelter in bonsai form in rock crevices along with soft grasses like *Ehrharta calycina* and *Digitaria argyrograpta*, it may be asked whether the distribution of grasses is limited by the eating habits of goats and donkeys rather than by rainfall. Grassiness there certainly is even now. Besides the two perennial species just mentioned, *Aristida diffusa* var. *burkei*, *Cenchrus ciliaris*, *Cynodon dactylon*, *Eragrostis truncata*, *Hyparrhenia hirta* and *Sporobolus fimbriatus*, are still to be found, usually in rock crevices. Their presence is so surprising as to suggest that this, and the western part of the Great Karoo, are places where there really has been a major decline in the rainfall. Short-lived grasses with the ability to regenerate very rapidly from seed, such as *Stipagrostis obtusa*, *S. ciliata*, *S. anomala*, *Fingerhuthia africana* and *Enneapogon scaber*, are more common and less surprising.

The more one studies this veld, the more one suspects that there is also an almost-lost flora of non-succulent grazable bushes. Examples are as follows:

Dicoma fruticosa	Menodora juncea
D. picta	Rosenia spinescens
D. relhanioides	Plumbago tristis
Felicia lasiocarpa	Pteronia oblanceolata
F. macrorrhiza	Ursinia montana subs
Limonium amoenum	apiculata

In addition, the following are still relatively widespread:

Antizoma capensis Berkheya cuneata B. spinosa Cotyledon orbiculata Crassula rupestris Cyphia digitata Dicoma spinosa Drosanthemum lique Eriocephalus ericoides Euphorbia sp., cf. E. rhombifolia Felicia filifolia forma F. ovata Galenia fruticosa Garuleum bipinnatum Hermannia desertorum H. linifolia H. pulverata Hirpicium alienatum Indigofera patens Kochia pubescens Limeum aethiopicum Monechma pseudopatulum Ornithoglossum viride

Osteospermum scariosum Osteospermum sinuatum Penzia sp.=A 14409 Polygala seminuda Pteronia glauca P. sordida Salsola aphylla S. tuberculata Sarcocaulon spp. Sarcostemma viminale Sceletium rigidum Schizobasis intricata Senecio longiflorus Sericocoma avolans Sutera atropurpurea Sutherlandia frutescens Tetragonia arbuscula T. robusta Thesium lineatum Trichodiadema barbatum Viscum capense V. rotundifolium Zygophyllum flexuosum Z. spinosum

One must, moreover, suppose that there were many species of Mesembs as well that were too palatable to goats and donkeys to have survived at all.

The distribution of *Portulacaria afra* (spekboom) is of interest. When it is plentiful on one side of a fence and absent from the other, one may assume a long689

standing difference in grazing management, or the position of watering points relative to the fence. When it covers the north side of a steep, knife-edged ridge but stops short at the crest even though there is no fence, one may assume a micro-climatic difference. However, its survival in some places and total disappearance from other places, when no such considerations apply, is a curious phenomenon that is less easily explained. The farmer is inclined to think that there is a "sour" form of spekboom that is ungrazable even though it looks the same as the normal "sweet" form. My own view is that the spekboom is not a balanced feed, so that when the grasses and non-succulent shrubs have been virtually eradicated it can no longer be fully utilized. This is the reason why it sometimes increases to the point where its tangled overgrown thickets become impenetrable. Where the other plants are in excess, on the other hand, it is in danger of becoming browsed to extinction, even its thick, soft trunks being eaten by goats.

In the light of this, the presence of a solitary patch of dense spekboom high on a bare white quartzite mountain side at the western end of the Klein Swartberg, becomes intelligible as an indicator of the original vegetation of that mountain side and of others like it that lack even the spekboom.

Comparison of bare mountain sides with the vegetation outlined on p. 683 helps one to understand how arid regions can be turned into deserts, and how little time it may take. If the vegetation of steep mountain sides can be thus destroyed, what hope of survival had that of the level and easily accessible valleys and flats? If the mountain sides could carry vegetation of that calibre, what could the valleys not have carried? There was no-one interested in recording what they carried, all being too busy destroying it because it was too coarse or was occupying ground that could be ploughed. Nor was there fencing even if there had been any thought of preserving enough to prevent erosion.

The eastern half of the Little Karoo, centred on Oudtshoorn, has a similar climate but is slightly less arid, and is more open, the hills occurring as chains close to, and parallel with, the mountains to north and south. Well-developed Spekboomveld covers warm aspects as well as parts of the south aspects



FIG. 8.—Effect of overgrazing on Spekboomveld, 13 km south of Beervlei Dam. To the right of fence, woody species like Euclea undulata, Pappea capensis, Rhigozum obovatum and Lycium oxycarpum are left.



FIG. 9.—Eastern part of Little Karoo, 3 km west of Barandas Station, with shale hills below the Swartberg (background).

and of the flats, with renosterbosveld on cool aspects and plateaux just below the main ranges. Karroid Broken Veld is less extensive.

The perennial Olifants River traverses the area from east to west, with many tributaries coming out of the mountains to north and south. Under the somewhat less arid conditions, gallery forest and swampiness must have been well developed. Relics of subtropical grasses like *Hemarthria altissima*, *Stipa dregeana* var. *elongata*, *Arundinella nepalensis* and *Digitaria glauca* make it easier to visualize a good deal of luxuriance of vegetation of river banks and shady slopes.

Eastwards via the renosterbosveld there was access to the Baviaanskloof and to the Langkloof, leading right down to forest country in Humansdorp Division. There was less easy access to the Karroid Broken Veld of the Great Karoo and Steytlerville Karoo near Willowmore.

So the Little Karoo, too, is likely to have been able to provide for all kinds of animals, except those of high forest, even if in limited numbers, but it was particularly suited to the browsers.

(iii) Great Karoo.—This karoo type, lying between the Swartberg and the Great Escarpment, is open country, unobstructed by mountains, deep rivers or forests. Triangular in shape, it extends some 320 km east and west and 160 km north and south, but across the 90 km gap in the Escarpment it is open to the upper plateau. Here would appear to be scope for large herds and large-scale migrations of animals.

The Great Karoo is, however, badly watered as well as arid. In general, the country slopes down from north to south and run-off from the Swartberg goes east or west along the valleys between the parallel foothill ranges and thence south through the gorges of the Buffels, Gamka, Groot and Traka Rivers, to the benefit of the Little Karoo. There is also a pronounced rain shadow below the north side of the Swartberg, accentuated by former overgrazing made possible by the presence of these east- and west-running streams. One has to suppose they were not always as desert-like as they are now.

The mountains of the Escarpment to the north are semi-arid, receiving an average of no more than 370 mm of rain per annum plus some snow, while

the country in the gap receives only 200 to 250 mm, so not much run-off is available. The hilly westernmost part, lying in the basin of the upper Buffels River, receives the run-off from the winter rainfall and snowfall of the Klein Roggeveld and the Komsberg, while the run-off from the extreme western parts of the Nuweveld range, mainly in winter, goes down the Dwyka River through the western part of the Great Karoo. The low ridge running south-east through Merweville diverts run-off from the rest of the Escarpment as far as Beaufort West into the Gamka River, leaving a large area, bounded by the Dwyka and Gamka Rivers and a line from a few kilometres north of Merweville to Fraserburg Road, with no water resources other than its own rainfall of less than 127 mm.

Similarly, a ridge running south past Beaufort West over a low plateau of triangular shape diverts the Gamka River to the south-west and diverts run-off from the Escarpment to the north-east of Beaufort West south-eastwards down the Salt River. This leaves the whole triangular central part of the Great Karoo, from Beaufort West to the neighbourhood of Prince Albert and from there east to the neighbourhood of Willowmore, with only its own rainfall of 127 mm to not more than 200 mm. There is another watershed running south from Three Sisters to near Rietbron and a fourth to the south of Aberdeen, with the result that in the whole of the eastern part, from the Salt River to the Sundays River, only the Kariega River carries water from the mountains across the Great Karoo. In this part, the rainfall is still under 200 mm per annum.

One may suppose that before the reed-beds disappeared, all these rivers that arise in the mountains had at least permanent pools. Even along a minor river like the Upper Traka, which rises on the low plateau to the south of Beaufort West, reeds are to be found here and there. For the rest, the only other permanent waters were springs.

There is no place for high forest in the Great Karoo, but short gallery forest consisting mainly of *Acacia karroo, Rhus lancea, Lycium spp., Rhus pyroides, Phragmites australis, Tamarix usneoides* (westwards) and perhaps *Salix capensis,* existed along the main rivers and even along some of the lesser ones (see p. 696).

The vegetation of the Great Karoo in general was open Karroid Broken Veld in rockier places and Central Lower Karoo elsewhere. Spekboomveld 25.3 (p. 683) occurred on north slopes of the Swartberg and its foothills and on scattered hills and minor mountain ranges in the far eastern part bordering on the Noorsveld 24 (p. 693) and Spekboomveld 25.2 (p. 692) of the south-east Cape. From Aberdeen to Pearston it is likely that a *Setaria neglecta*-dominated grassveld or open shrubland occurred in a narrow belt at the foot of the Escarpment. Such veld also occurred in the Great Fish River valley up to somewhere north of Cradock, there merging into the *Themeda* Veld of the upper plateau. Here would appear to have been a migration route from high, cold country to low, warm country.

Returning to the karoo proper, in the west in the Upper Buffels River basin, in the country around Laingsburg and in the country between the Escarpment and the Gamka River, as well as in a belt along the northern foot of the Swartberg eastwards, the Karroid Broken Veld 26.2 (715 species, 762 m) and 26.3 (485 species, 671 m) is transitional to that of the Little Karoo, with many succulents. The shrubs are fewer, but include the following:

Euclea undulata	Cadaba aphylla
Diospyros lycioides	Grewia robusta
Lycium oxycarpum	Asparagus retrofractus
L. prunus-spinosa	Rhus lancea
Maytenus heterophylla	R. undulata var. tricrenata
Rhigozum obovatum	

Grasses are again notably varied and common such as the perennials Aristida diffusa var. burkei, Heteropogon contortus, Tricholaena capensis, Cenchrus ciliaris, Digitaria argyrograpta and Stipagrostis namaquensis.

Shorter-lived grasses include Stipagrostis ciliata S. anomala, S. obtusa, S. uniplumis, Fingerhuthia africana and Enneapogon scaber.

As one approaches Merweville through the very denuded country along the road from Koup Station, one is surprised to find Heteropogon contortus occurring fairly frequently in crevices of the little shaly ridges-until one remembers that this strip of country below the Escarpment is the true Koup and that Koup is said to mean "luxuriant". It is even more surprising to find that, at the foot of the Escarpment below Theekloof and eastwards and some d stance into the flats, there are relics of a Themeda Ve d of some luxuriance, most of which is now False Karroid Broken Veld 37.4 (643 species, 1 341 m). In the relics, *Themeda triandra* with Digitaria eriantha, Heteropogon contortus, Sporobolus fimbriatus and Panicum maximum grow densely on dolerite outcrops so rugged that apparently only klipspringer would be prepared to go there, but it also occurs sparingly on shale and sandstone where it is accessible to domestic livestock.

These relics show that there is no mistake about the local recollection that in the early years of this century the south face of the Escarpment, at least as far west as Oukloof was *Themeda* Veld. This is where the trekbokken came down from the Upper Plateau into the Great Karoo. Further to the east such veld still covers some of the rockier mountain sides to the west of Three Sisters. It can be contended that the present distribution of grasses is controlled more effectively by mismanaged domestic livestock than by rainfall.

It may be that this western *Themeda* Veld (with *Themeda-Tetrachne* Mountain Veld on the highest

points, where there is still Merxmuellera Mountain Veld today) was continuous with the main body of the original Dry Cymbopogon-Themeda Veld. The connection would have been in an irregular and hilly belt along the watershed between the Upper Plateau and the Great Karoo, i.e. between the catchment of the Ongers River to the north and the catchments of the Salt and Buffalo Rivers to the south. This watershed runs north, at a general altitude of 1 300-1 500 m, from the eastern part of the Nuweveld Range towards Melton Wold, east towards Victoria West, south-east to the Horseshoe Mountain and then east-northeast towards Richmond. The Themeda Veld would also have covered the high hills and plateaux scattered across the upper Salt River basin south-west from the Horseshoe Mountain to join that which survives to the west of Three Sisters and on to the Escarpment in the Nelspoort area.

It is thus possible that the mountain grassveld corridor across the country from the Drakensberg to Calvinia was not completely blocked by karoo at the gap in the Escarpment.

As in the Little Karoo, there is a good variety of karoo bushes and forbs in this far western and southern part of the Great Karoo, a fact which needs to be emphasized in country where ungrazed succulents tend to monopolize attention. The list of important species is almost the same as for the Little Karoo (p. 689), but a few have to be added, like Aloe claviflora, Asclepias buchenaviana, Cucumis africana, Helichrysum lucilioides, Hermannia grandiflora, Pentzia sphaerocephala, Pteronia scariosa and P. viscosa.

Although the gravelly and sandy flats of the Great Karoo 26.2 and 26.3 are often almost devoid of perennials now, the rocky flats and hills, even if they look nearly as bare, really have much more useful vegetation than meets the casual eye, in spite of the rainfall of less than 127 mm a year. They therefore indicate more of the original vegetation than the gravelly and sandy flats. One reason for this is that most species are palatable to livestock and so are kept short and inconspicuous, while the unpalatable species which tend to dominate other types of karoo are scarce here. A second reason is that the nature of the rock provides crevices to protect the crowns and roots of plants. A third reason may be that the crumbly shale surface soaks up small rains while the hilliness sheds any surplus from heavier rains into the many gravel-filled watercourses where it is stored and protected against evaporation. Most of it thus remains available to the vegetation to help it to hold out against cvergrazing.

Wherever such a surface and such a topography occur, more of the palatable species will survive than on plains with a silty or clayey soil where there is no protection and rain is likely to spread out on a puddled, impervious surface and quickly evaporate. On such plains, where the rainfall is below 127 mm, the result of overgrazing is likely to be either a "vloer" or a desert pavement of small stones, as in Bushmanland. Under somewhat higher rainfall, dominance by unpalatable bushes is the likely result.

East of the Gamka River, the shrubs of the central Karroid Broken Veld 26.3b (519 species, 854 m) remain the same, often very sparse except *Rhigozum obovatum*. Beyond a line from Beervlei to Aberdeen, in the eastern variation of the Karroid Broken Veld 26.3c (475 species, 701 m) they increase again, with the addition of *Schotia afra*, *Boscia*



FIG. 10.—Central Lower Karoo, 27 km north-east of Beervlei Dam.

oleoides and Pappea capensis. The grasses persist, with Sporobolus fimbriatus increasing eastwards and Ehrharta calycina and Digitaria eriantha coming in. Karoo bushes are much more plentiful, but today are mostly those that are unpalatable to domestic livestock.

The Central Lower Karoo 30 (538 species, 802 m) occupies the non-rocky parts. It lacks the shrubs, except sometimes on rocky outcrops and along drainage lines, and has much in common with the Arid Karoo. Karoo bushes and forbs that are likely to have been important include the following:

Aridaria noctiflora Felicia filifolia forma F. muricata F. ovata Drosanthemum lique Eriocephalus ericoides Euphorbia rhombifolia Euryops anthemoides Galenia fruticosa Hermannia cuneifolia H. grandiflora H. spinosa Kochia pubescens Lessertia pauciflora Limeum aethiopicum Osteospermum sinuatum Pentzia spinescens P. pinnatisecta Phymaspermum parvifolium Plinthus karooicus Polygala seminuda Salsola calluna S. tuberculata Senecio acutifolius Tetragonia arbuscula Trichodiadema barbatum T. violaceum Zygophyllum flexuosum Grasses of the Central Lower Karoo include:

Aristida diffusa var. burkei Digitaria argyrograpta Enneapogon desvauxii Eragrostis lehmanniana E. obtusa Fingerhuthia africana Stipagrostis anomala S. ciliata S. obtusa Tragus koelerioides

Riverine vegetation will be considered with that of the upper plateau under (g) on p. 696.

Most of the Great Karoo, particularly the central part, gives the impression of being inhospitable, even hostile, country, perhaps because of the scarcity of surface waters and the dull uniformity of topography and vegetation, rather than because of lack of feed for grazing and browsing animals. If these parts are regarded as gemsbok country, in the more favourable areas at the west and east ends and the belts joining them along the foot of the Escarpment with the Upper Plateau *via* the gap in the Escarpment, one might expect there to have been a more varied fauna.

Before leaving the Great Karoo basin, the central variation of the Spekboomveld 25.2 (503 species, 700 m) and the Noorsveld 24 (522 species, 457 m) at the far eastern end of it have still to be considered.



FIG. 11.—Eastern Spekboomveld reduced to False Karroid Broken Veld near Graaff-Reinet with Aloe ferox, Euphorbia enopla and Pappea capensis. Physiognomically similar, this central variation of the Spekboomveld shows considerable floristic difference from the western variation (p. 683), only partly because no river banks were included in the samples. One has to think of it as having been more open and grassy and less congested with thorny thickets than it is now.

The important grasses included the following:

Aristida diffusa var. burkei
Cenchrus ciliaris
Cymbopogon plurinodis
Cynodon dactylon
C. incompletus
Digitaria argyrograpta
D. eriantha
D. glauca
Ehrharta calycina
Enneapogon scoparius
Eragrostis curvula
E. lehmanniana

E. obtusa Heteropogon contortus Hyparrhenia hirta Merxmuellera stricta Panicum deustum P. maximum P. stapfianum Setaria lindenbergiana S. neglecta Sporobolus fimbriatus Themeda triandra

The trees and shrubs of the central Spekboomveld included:

Acacia karroo Allophylus decipiens Aloe ferox A. speciosa Asparagus racemosus etc. Azima tetracantha Boscia oleoides Brachylaena ilicifolia Buddleja glomerata B. saligna Cadaba aphylla Carissa haematocarpa Cussonia spicata Diospyros austro-africana D. lycioides D. scabrida var. cordata Dodonaea viscosa var. angustifolia Ehretia rigida Encephalartos lehmannii Euclea undulata Euphorbia coerulescens

Euphorbia enopla etc. Grewia robusta Lycium oxycarpum etc. Maytenus capitata M. undata Nymania capensis Olea africana Pappea capensis Polygala myrtifolia Portulacaria afra Putterlickia pyracantha Rhigozum obovatum Rhoicissus tridentata Rhus lancea R. longispina R. lucida Sarcostemma viminale Schotia afra S. latifolia Tarchonanthus camphoratus Zygophyllum foetidum

The bushes and forbs included:

Adromischus maculatus Aizoon glinoides Aloe comptonii etc. Antizoma capensis Barleria obtusa Bulbine frutescens Ceropegia ampliata Chascanum dehiscens Cyphostemma quinata Cotyledon ramosissima etc. Crassula ovata C. cultrata C. rupestris C. tetragona etc., etc. Dicoma spinosa Dioscorea elephantipes Euphorbia mauritanica E. rhombifolia etc. Felicia ovata Haemanthus albiflos Hermannia gracilis etc. Hibiscus aridus Indigofera denudata etc. Jatropha capensis Kedrostis capensis Lantana rugosa Lasiocorys capensis Limeum aethiopicum Monechma pseudopatulum Moquiniella rubra Pachypodium succulentum Passerina obtusifolia Pegolettia baccharidifolia Pelargonium peltatum P. tetragonum Polichia campestris Polygala seminuda Sansevieria hyacinthoides Schizobasis intricata Selago albida Senecio junceus S. longifolius S. vitalis etc. Stachys aethiopica Sutera halimifolia etc. Teucrium africanum Viscum obscurum V. rotundifolium

The Noorsveld 24 is of shorter stature and was probably more open and grassy than the Spekboomveld before the suckering noorsdoring (Euphorbia coerulescens) and other thorny shrubs thickened up. Spekboom is present but not so common, just as noorsdoring is present in the Spekboomveld but not so regularly. One thinks of it as a dense, grey thicket of Euphorbia coerulescens with a sprinkling of woody shrubs and small trees and a little grass growing through it, usually obscured by a haze of dust. The open, grassy condition can be found here and there, though it is only secondary as a result of better grazing management, while at the other extreme there are farms from which even the noorsdoring is disappearing. In recent wet seasons, however, the picture has changed in a remarkable manner: the obscuring haze is now a haze of grass seed.

Under a rainfall of only 175 to 200 mm, the nature and vigour of the grassiness would be surprising if one were not already aware of the part played by the goat and the donkey in controlling the distribution of grasses. It is the goat- and donkey-thwarting presence of the densely shrubby and thorny noorsdoring that has maintained the general presence of the grass in a vigorous state, so that plentiful seed is available to take advantage of any lightening of the grazing pressure in good seasons. The growth habit of the noorsdoring keeps the animal out but lets in enough sunlight to allow the grass and other plants, notably flourish. Indigofera costata subsp. macra, to Apparently the succulent noorsdoring does not compete with them. The density of the grassiness in the open spaces was one factor that controlled the suckering of the noorsdoring. Another was the habit of the kudu of nipping off the suckers as they appeared above ground.



FIG. 12.—Noorsveld north of Jansenville. Euphorbia coerulescens with Panicum maximum and Digitaria eriantha.

In species composition the Noorsveld is very similar to the Central Spekboomveld, although the frequency of occurrence of some species is different, some being more frequent, some less frequent. Of the species listed for the Spekboomveld, only the following have not been found in the Noorsveld samples:

Digitaria glauca
Hyparrhenia hirta
Allophylus decipiens
Buddleja glomerata
Dodonaea viscosa var.
angustifolia
Indigofera denudata

Merxmuellera stricta Setaria lindenbergiana Polygala myrtifolia Rhus lucida Passerina obtusifolia Senecio vitalis

There are a few species of importance in the Noorsveld that were not found in the Spekboomveld, such as Sporobolus nitens, Aloe striata, Asparagus striatus, Gasteria spp., Hydnora africana, Indigofera costata subsp. macra, Lotononis sp. (=A 23525) and Pentzia sphaerocephala.

If the noorsdoring preserved the grass, it has rather helped to destroy the gallery forest, which today consists of little besides *Acacia karroo* and the scrambling *Zygophyllum foetidum*. The noorsdoring can have this effect because if a farmer is prepared to go to the trouble of chopping it into small piecies to get rid of the latex, he can keep his animals alive in a drought, without having to trek away to give his veld some sort of rest.

(iv) Ceres-Tanqua Karoo.—The Ceres-Tanqua Karoo is today the most desert-like of the karoo basins. Like the Little Karoo, it is well watered by streams from the surrounding mountains, but is even more completely screened from rain by them. It lacks the hilliness of the western Little Karoo and the shaliness, except at the foot of the Escarpment, where it is a little less desert-like. Lacking the big shrubs (except in gallery forest) the vegetation where it survives at all, is Succulent Karoo 31.2 (381 species, 487 m) and the semi-succulent variation of the Western Mountain Karoo 28.2. It has been so far reduced that closer study than has hitherto been made will be necessary before one can attempt a reconstruction.

Whatever the vegetation may have been, there is easy access northwards to the less arid Western Mountain Karoo and the Mountain Renosterbosveld of Nieuwoudtville and Calvinia, and south-eastwards to the Mountain Renosterbosveld of the Klein Roggeveld and Matjiesfontein and the Karroid Broken Veld beyond. It is likely that the game would have fled from the snowy bleakness of the plateau in winter into the warm Karoo, just as the farmer does today.

(g) Upper plateau

Here the whole fauna survived until there were literate persons present to describe the animals, count them, paint pictures of them and make specimens of them. Some of the vegetation has suffered little change, and where it has suffered change, the main reason for attempting a reconstruction will be to find out how it could have carried the enormous numbers of animals which these observers reported.

If in this area, moreover, where relics of the original vegetation still survive, it is found possible to determine the kind and magnitude of the changes that have taken place, it will help one to visualize what is likely to have happened in other areas where no relics survive. This is particularly important in respect of stream-banks, vleis and floodplains that are so bare today and yet must have provided a large part of the original carrying capacity, particularly during winter and droughts. Rainfall has nothing to do with this bareness: there are wide valleys on the eastern edge of our area that are so eroded as to have hardly more vegetation than the "vloere" of Bushmanland. Fortunately, in that eastern part they are the exceptions.

The manner in which the previously dry rivers of the plateau have developed a steady flow once the remnants of soil in the remnants of vleis had become saturated during the past three years of heavy rainfall, gives us a clue to the enormous volume of water that was stored as a buffer against drought when the soil and vegetation of all the rivers and minor watercourses were still undisturbed.

The upper plateau is higher and cooler than the Karoo basins and most of it receives a higher rainfall. Whereas the whole of the Great Karoo receives less than 200 mm, the upper plateau receives more than 200 mm from about Carnarvon eastwards to 330 mm at Middelburg to about 500 mm at the eastern edge of the area under consideration. Only west, northwest and north of Carnarvon below the Kareeberg escarp-



FIG. 13.—The Tanqua Karoo, about 5 km north-northeast of Commando Drift.

ment does the rainfall drop below 200 mm, down to less than 127 mm in Bushmanland. Only there, too, is the run-off from the Great Escarpment mountains confined to a single river, the Sak River. Elsewhere there are many streams draining northwards either from the Escarpment or from hills receiving enough rain for them to feed streams. The gradient from south to north is very slight, so rivers are sluggish, floodplains are wide and pans occur, some of large extent and surrounded by wide flats.

For riverbanks, vleis and floodplains, we have two useful indicators: Fingerhuthia sesleriaeformis for the wetter ones that are not too excessively grazed out, and Eragrostis bicolor for the remainder. All through the eastern Free State and across the Orange River to the Seacow River, and the Camdeboo Mountains, and again on the Nuweveld Mountains at Beaufort West and westwards, Fingerhuthia is of regular enough occurrence to indicate that it was the dominant grass of the vleis. This is true at least as far as the western edge of the original grassveld, i.e. of what is now False Central Upper Karoo 36.1c (597 species, 1 341 m) and 36.2c (505 species, 1 372 m), to show what its nature was. Even along minor drainage lines, this vegetation was a half-metre deep mass of leaf of Fingerhuthia sesleriaeformis, Pennisetum sphacelatum, P. thunbergii, Koeleria cristata, Carex glomerata, etc. matted together with Trifolium angustifolium, T. burchellianum and possibly Indigofera stipularis, and with patches of $1-1\frac{1}{2}$ m Miscanthidium sorghum. At the drier edges was 30-40 cm deep Tetrachne dregei, Themeda triandra and Panicum stapfianum, merging into the general Themeda-Tetrachne-Digitaria eriantha-Sporobolus fimbriatus Veld

Add thickets of Phragmites australis, Juncus punctorius and Scirpus inanis on the riverbanks and Typha latifolia and Scirpus littoralis in the water, and it will become clear why the early settlers found the vegetation too luxuriant for their sheep and felt that they had to "tame" it, and why Nature needed to put hippos in the rivers and periodically needed to increase antelope numbers to stampeding levels.

West of the Seacow River, such luxuriance ceases to survive and it becomes difficult to visualize it. Eragrostis bicolor becomes the principal indicator. It covers the wide flats in the Philipstown, De Aar, Britstown and Hanover areas. One occurrence of Fingerhuthia is known in the middle of such a flat near De Aar and there are various occurrences of Themeda and a few of Tetrachne, which is why one supposed these flats to have been Themeda Veld. The big herds were here, so the luxuriance must have been here, too, to support them, but if this had not been known, it would have been difficult to appreciate it. The importance of even single relics of climax species becomes evident.

In the genuine karoo types, Central Upper Karoo 27 and False Arid Karoo 35 westwards, Fingerhuthia sesleriaeformis has been found at only three places below the Escarpment mountains, but the significant point is that these three occurrences are on streams arising in the karoo itself: two in the catchment of the Ongers River, at Hutchinson in the Brak River and at Pampoenpoort in the Groen River, and one in the catchment of the Sak River about 30 km south of Loxton. The last is in the Slangfontein River, one of whose tributaries rises a few km from the source of the Groen River. The Slangfontein River joins the Sak River some 80 km below where the latter leaves the mountains. With Fingerhuthia occurring all along the Escarpment (although very rarely today) to Calvinia, it will be seen that it was present to the upper reaches, at least, of all the rivers westwards to the Sak River and its tributaries right through to the Fish River, i.e. all through the Upper Karoo except Bushmanland. Eragrostis bicolor occurs along watercourses even into Bushmanland. In this same area there are a few records of *Tetrachne* dregei in catchments of streams arising in the karoo, as well as on the mountains at Beaufort West.

Burchell (1822-24) found Tetrachne on the bank of the Orange River near where Hopetown now stands, almost on the 1050 m contour. Today the only place where it is known to grow at so low an altitude is the Cypress Grove vlei between Middelburg and Cradock. If the vegetation implied by the presence of Tetrachne and Fingerhuthia grew on the extensive floodplains of the Ongers River and its tributaries down to this altitude, i.e. to just below the Smartt Syndicate Dam, it would provide a very different indication of the carrying capacity of this denuded and eroded part of the upper plateau and its ability to support large herds of antelopes.

Grasses which might have replaced *Tetrachne* and Fingerhuthia in the lower coarses of the rivers towards the Orange River are Hemarthria altissima and Sorghum verticilliflorum. Nothing has been found to indicate how far down the Sak River and its tributaries this sort of vegetation extended. The topography is, however, more broken and stony, without extensive floodplains, until one reaches country too hot and arid and perhaps too brackish for it, so it would have been confined to the river-banks.

Therefore in the Central Upper Karoo and the False Arid Karoo, i.e. west of the western boundary of the False Central Upper Karoo, to the Kareeberg and south to Fraserburg, the riverine vegetation can be reconstructed thus (in the wetter parts):

constructed thas (in the
Carex sp. "perdegras" (up-
stream)
Cyperus longus
C. marginatus
Diplachne fusca
Fingerhuthia sesleriaeformis
(upstream)
Gomphostigma virgatum
Hemarthria altissima
(downstream)
Hordeum capense
Juncellus laevigatus

Juncus maritimus Phragmites australis Polygonum lapathifolium subsp. maculatum Puccinellia spp. Rumex lanceolatus Scirpus inanis (upstream) Sorghum verticilliflorum (downstream) Typha latifolia subsp. capensis

In less wet parts at the margin, the following are present:

Anchusa riparia	Panicum stapfianum
Atriplex vestita	Pteronia glaucescens
Cynodon dactylon	Scirpus dioicus
Cynodon sp., cf. C. trans-	Sporobolus fimbriatus
vaalensis	S. ioclados
Helichrysum pentzioides	Stipagrostis namaquensis
Juncus arabicus	(sandy places)
Kochia pubescens	Suaeda fruticosa
Lycium prunus-spinosa	Tetrachne dregei
Melianthus comosus	(upstream)
Panicum lanipes (down- steam)	Themeda triandra

Restoration of any semblance of luxuriance would depend on the success of Phragmites australis and Stipagrostis namaquensis in trapping enough silt, sand and rubble to hold the moisture needed to enable the smaller grasses and sedges to re-establish themselves.

Considering that the rivers crossing the Great Karoo also rise in the mountains of the escarpment, or along the watershed in the gap, one might be justified in reconstructing the vegetation of their upper courses, at least, in the same way. It is in their upper courses

that the most extensive floodplains occur. Grasses and sedges that are still to be found include the following:

Cenchrus ciliaris	Panicum maximum
Cynodon dactylon	P. stapfianum
Cyperus longus	Paspalum paspalodes
C. marginatus	Phragmites australis
Digitaria eriantha	Puccinellia spp.
Diplachne fusca	Sporobolus fimbriatus
Eragrostis bicolor	S. ioclados
E. curvula var. conferta	S. tenellus
Hordeum capense	Stipagrostis namaquensis
Juncellus laevigatus	Typha latifolia subsp.
Juncus maritimus	capensis

Fingerhuthia and *Themeda* were probably important too, but not *Tetrachne*. Shrubs and trees of the gallery forest include the following:

Acacia karroo (with Viscum	L. salinicolum
continuum)	Maytenus heterophylla
Cadaba aphylla	Rhus lancea
Diospyros lycioides	R. pyroides
Lycium oxycarpum	R. undulata var. undulata

In the Arid Karoo, Phragmites australis and Stipagrostis namaquensis will themselves have to work their way downstream and upstream before they can start to restore the riparian vegetation. It seems unlikely that the great deposits of silt in the vloere and along the Sak River could have accumulated without a grass cover to prevent the silt from washing and, more particularly, blowing away as fast as the river brought it down. It must be remembered that much more water reached the lower course of the Sak River, and more regularly, before it was turned out into "saaidamme" all along the way. This meant also that the soil was less brackish than it is now. The presence of Acacia karroo on the river-banks in the neighbourhood of Onderstedoorns and the single big Olea africana (=Olea chrysophylla) at the south-west corner of Verneuk Pan, suggest that the Sak River may once have had a gallery forest, possibly with *Phragmites lanipes*, *Panicun stapfianum* and *Sporobolus ioclados* on the and floodplain Dichanthium papillosum ("D. annulatum"), Panicum lanipes. Cenchrus ciliaris and Stipagrostis namaquensis in sandy and gravelly tributaries. Eragrostis bicolor would be the pioneer. The same may have been true of the Carnarvon Leegte.

It is doubtful if enough water came down the Sak River regularly enough to maintain the great expanse of the Groot Vloer as a reedswamp and almost certain that the Carnarvon Leegte could not have supported reedswamp at Verneuk Pan. In such cases *Diplachne fusca* may have been the key species, just as it is in the Orange Free State in the pans. There, after a good flooding, it grows densely to the height of a metre. If it grew like that over the great expanse of the vloere it would have provided, even if only at times, for a very large population of grazing animals.

Until the Fish River was diverted into the "saaidamme" of the Sak River near Sak River Station, it did not join the Sak River, but turned west into what is now Swart se Kolk se Vloer to form a permanent lake. It had a depth of as much as 12 m on the west side, which is why, now that it is dry, it is said to be the only sloping vloer. To reach it, the river flowed through two vleis, now vloere, one of them still called Voëlvlei. With *Phragmites australis* still occurring in this river, *Fingerhuthia sesleriae-formis* on the Hantamberg where some of its tributaries rise and *Typha latifolia* subsp. *capensis* in the old river bed where it enters the vloer, some idea of the vegetation that existed can be formed.

Much attention has been given to the riverine vegetation. Even at the risk of repetition, one cannot overemphasize its importance to a large population of animals, because of its great extent and its value in holding the scanty rainfall and extending its usefulness into the dry season and the droughts that have always occurred. When there was the grassy cover on all the floodplains that is here visualized, the proportion of the rainfall lost in flash floods and by evaporation from bare soil was small. Instead, the bulk of it was used either by the plants through transpiration while making growth, or by seepage through the soil to maintain a steady flow in the main rivers and feed springs. These rivers were not the efficient stormwater drains that they are now, but were so obstructed by the reed-sedge-rush-bulrush vegetation as to call for the hippo to keep a channel open. What is more, the common plants were the ones which the animals could utilize rather than the ones that were too thorny, or resinous or waxy or in other ways so unpalatable as to be useless as feed to the generality of animals.

There is a world of difference between a temporary condition of "no grazing", because the vegetation has been grazed down, but is ready to



FIG. 14.—Driedoringveld of Arid Karoo, about 50 km westsouthwest of Brandvlei.

grow again when the drought breaks, and today's "no all-too-common permanent condition of grazing", because there is neither vegetation to grow again, nor seed, nor soil fit to support regeneration of vegetation. Considering that soil that is not under a permanent, continuous cover of grass (or similar vegetation) is washed away or blown away, the obvious corollary would appear to be that the presence of soil is proof of a formerly existing vegetation cover, which would usually have been grass.

Looked at in this way, this reconstruction of the vegetation of the arid and semi-arid regions appears reasonable.

As regards the original vegetation of the flats and hills, it appears that the grassveld which is now the False Central Upper Karoo 36.1 (1081 species, 1341 m) south of the Orange River consisted mainly of the following grasses:

Themeda triandra	Sporobolus fimbriatus
Tetrachne dregei	Eragrostis curvula var.
Digitaria eriantha	conferta
Panicum stapfianum	Cymbopogon plurinodis

Of these, Tetrachne and Panicum very rarely grew on the dolerite hills, while Enneapogon scoparius, Hyparrhenia hirta and Eustachys mutica regularly did so. Aristida diffusa var. burkei and Heteropogon contortus were relatively less important than they are now. Vlei vegetation was as described on p. 695.

The following forbs occurred in the grassveld, which is now False Central Upper Karoo, but it is difficult to be positive about it because of karoo invasion:

Albuca pachychlamys Cyperus usitatus Felicia ovata Helichrysum dregeanum Heliophila suavissima Lessertia paucifiora Limeum aethiopicum Nenax microphylla

Osteospermum scariosum Sutera pinnatifida Tetragonia arbuscula Thesium flexuosum Trachyandra saltii Trichodiadema pomeridianum

It can be reasonably presumed that a species which is palatable to domestic animals is likely to be a relic of the original flora, because it is unlikely to be an invader.

In addition, the dolerite hills have some bushes and forbs of their own, as follows:

Aloe broomii	Lightfootia albens
Anthospermum rigidum	Lotononis laxa
Argyrolobium collinum	Cheilanthes eckloniana
Asparagus capensis forma	Pelargonium ramosissimum
A. striatus	Pentzia punctata
Boöphane disticha	P. sphaerocephala
Ceterach cordatum	Phymaspermum aciculare
Chascanum incisum	Pollichia campestris
Dianthus micropetalus	Polygala seminuda
Hermannia cuneifolia	Selago albida
subsp. glabrescens	Sutera halimifolia
H. filifolia	Viscum capense
H. pulchella	

In addition there is a sparse to dense growth of shrubs such as:

Asparagus retrofractus	Maytenus heterophylla
Buddleja glomerata (rarely)	Rhigozum obovatum
Cussonia paniculata	Rhus erosa
Diospyros austro-africana	R. pyroides
D. lycioides	R. undulata var. tricrenata
Ehretia rigida	Tarchonanthus
Euclea crispa var. ovata	camphoratus

Olea africana and Celtis africana also appear to north and east.

North of the Orange River the grassveld, which is now False Central Upper Karoo 36.2 (848 species, 1 372 m), was essentially the same, but with *Eragrostis superba* replacing *Tetrachne dregei* westwards and with *Olea africana* and *Rhus ciliata* appearing more often on the hills, plus Ziziphus mucronata.

Desiccation of the vleis of the False Central Upper Karoo through erosion and the disappearance of an adequately dense and vigorous grass cover, probably explains why Acacia karroo, Rhus pyroides, Diospyros lycioides and Lycium spp. are invading the vleis and tending to form impenetrable thickets. True gallery forest is represented today by remnants of Salix capensis in the lower kloofs of the Escarpment mountains and along the more permanent rivers like the Seekoei River and of Acacia karroo and Rhus lancea along the lower courses of tributaries of the Orange River. The Orange River itself has a welldeveloped gallery forest consisting mainly of Salix capensis, Ziziphus mucronata, Acacia karroo, Rhus



FIG. 15.—View to west along southern edge of Orange River valley, 18 km north-northeast of Colesberg. *Era*grostis lehmanniana with Rhus ciliata, R. undulata var. tricrenata, R. erosa and Rhigozum obovatum.

lancea, Lycium hirsutum, Phragmites australis and, as far down as the Colesberg neighbourhood, Celtis africana.

The Pan Turf Veld 51 of the western Orange Free State has almost disappeared, but relics show it to have been a very dense Themeda Veld with a rich flora and it must have had a high carrying capacity, both on the flats and in and around the innumerable pans. The False Karoo 41 (493 species, 1 220 m), which has replaced it, still has almost five hundred species. It was the pans, with the springs and extensive seepages on the slopes around them, that had the greatest luxuriance of vegetation. Some, such as the biggest of them i.e. the nameless one near Koffiefontein, are remembered to have been reedswamps, while some still periodically become covered with a dense metre-deep growth of Diplachne fusca in seasons wet enough to flood them. Species still to be found include:

Anthephora pubescens Cymbopogon plurinodis Cyperus longus C. marginatus Digitaria eriantha Diplachne fusca Echinochloa holubii Eragrostis superba Hemarthria altissima Imperata cylindrica Lobelia thermalis

Mariscus capensis Panicum coloratum P. stapfianum Paspalum paspalodes Phragmites australis Platycarpha parvifolia Scirpus littoralis Setaria woodii Sporobolus fimbriatus Themeda triandra Trifolium burchellianum

Even the cover still provided on parts of the slopes and edges of pans by pioneer species, such as *Cynodon dactylon, Eragrostis bicolor, E. truncata, Sporobolus acinifolius, S. ioclados, S. ludwigii, S. tenellus, Tragus koelerioides* and the prostrate matforming *Salsola humifusa,* is of lawn-like density. Single trees and groups of *Rhus lancea* on slopes to some of the pans were probably much more plentiful formerly. *Acacia karroo, A. hebeclada* and *Acacia tortilis* var. *heteracantha* are likely to be invaders from the Kalahari Thornveld to the west.

Taking the Central Upper Karoo 27 (719 species, 1 310 m) and the False Arid Karoo 35 (740 species) together, the north-eastern part from Victoria West and Carnarvon north-eastwards, is topographically similar to the False Central Upper Karoo in having wide plains and scattered hills. The southern and western parts are more broken, to the south resembling the western part of the Great Karoo, so that the environment was not so favourable for the big herds. The Kareeberg region to the north-east of Carnarvon and west to the Williston neighbourhood is particularly hilly. What is regarded in "Veld Types of South Africa" (Acocks, 1975) as Variation 3 of the Arid Karoo is now regarded as Variation 1 of the False Arid Karoo, the original veld having been closer to the Central Upper Karoo than to the Arid Karoo. In the high country south of the western Kareeberg down to Saaifontein on the Sak River, it probably was Central Upper Karoo, only becoming transitional westwards.

On the northern foothills of the western Kareeberg are to be found outliers of the Orange River Broken Veld, with *Aloe dichotoma*.

The possibility that there might have been an extension to the Nuweveld of the original *Themeda* Veld on the hills and plateaux along the watershed at the southern edge of the Central Upper Karoo has been considered on p. 691.

In the Central Upper Karoo, in the north-eastern part of the False Arid Karoo 35.3 (443 species, 1 130 m) and in the high central part of the False Arid Karoo 35.2 (400 species, 1 310 m) there is no difficulty about reconstructing the vegetation of the hills. Its grassy constituent did not greatly differ from that of the grassland flats, excluding *Tetrachne dregei*, but its flora lacked *Rhus erosa* (which has the same distribution as *Tetrachne*) and had a great variety of karoo bushes, resulting in a rich flora.

The grasses of the hills included the following:

- Aristida diffusa var. burkei Cenchrus ciliaris Digitaria eriantha Ehrharta calycina Enneapogon scaber E. scoparius (central) Eragrostis curvula var. conferta (not in north-east) E. lehmanniana E. obtusa
- E. nindensis
- L. mindensi

Fingerhuthia africana Heteropogon contortus Panicum lanipes (not central) Schismus barbatus Sporobolus fimbriatus Stipagrostis namaquensis Themeda triandra Tricholaena capensis (central)



FIG. 16.—*Cenchrus ciliaris* on dolerite ridge, 64 km westnorthwest of Carnarvon.

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The shrubs of the hills of this part of the Central Upper Karoo and False Arid Karoo included the following:

Asparagus retrofractus	Melianthus comosus (not
Boscia albitrunca	north-eastern False Arid
Cadaba aphylla	Karoo)
Diospyros austro-africana	Phaeoptilum spinosum
(not north-eastern False	Rhigozum obovatum
Arid Karoo)	R. trichotomum (not cen-
D. lycioides	tral)
Lycium oxycarpum	Rhus lancea
	R. undulata var. tricrenata

Rhus lancea remains plentiful in some of the kloofs of the Kareeberg.

In addition to the bushes and forbs of the flats, the hills of this part of the Central Upper Karoo and False Arid Karoo have some of their own such as:

Aloe broomii (not in the	Cheilanthes
north-east)	in the no
A. claviflora (especially	Pachypodiu
north-eastern False Arid	(in the n
Karoo)	Selago albi
Antizoma capensis	Sericocoma
Asparagus striatus	Stachys spp
Ceterach cordatum (not in	cuneata)
the north-east)	Thesium lin
Dianthus sp.	

eckloniana (not orth-east) m succulentum orth-east) da avolans . (mainly S. neatum

The bushes and forbs of the Central Upper Karoo and False Arid Karoo in general include the following:

Aptosimum marlothii	E
A. spinescens	L
Aridaria noctiflora	L
Boöphane disticha (not in	N
north-east)	N
Dicoma capensis	C
Drosanthemum lique	C
Eriocephalus ericoides	P
E. pauperrimus	P
E. spinescens	P
Felicia filifolia forma	P
F. macrorrhiza (not in the	P
north-east)	P
F. muricata	P
Helichrysum lucilioides	R
Hermannia cuneifolia var.	S
cuneifolia (not in the	S
north-east)	S
H cuneifolia var	Ť
dabrescens	Ť
H grandiflara (not in the	÷
north east)	7
H animage	L
n. spinosa	

. zeyheri ightfootia rigida imeum aethiopicum felolobium candicans ficroloma massonii stesspermum sinuatum . pi escens egoiettia retrofracta entzia spinescens linthus karooicus olygala seminuda teronia adenocarpa glauca viscosa losenia glandulosa alsola tuberculata utera pinnatifida utherlandia frutescens etragonia arbuscula hesium hystrix richodiadema barbatum ygophyllum flexuosum

Of the shrubs, only Lycium spp., Rhigozum trichotomum (northwards) and Phaeoptilum spinosum are usual on the flats.

In the Central Upper Karoo and False Arid Karoo it is the grasses of the flats that are the problem. The only grasses that are important now (apart from Stipagrostis obtusa and S. ciliata which are presumably invaders from the Arid Karoo) are *Eragrostis* lehmanniana and *E. obtusa*, but they lack the permanence which one expects of a climax species. It may be that Digitaria eriantha, Sporobolus fimbriatus, Aristida diffusa var. burkei, Eragrostis curvula var. conferta, Fingerhuthia africana, Panicum stap-fianum (a twiggy form) and P. lanipes (northwards) were the dominants together with a number of lowgrowing grasses. Some of the latter were shortly rhizomatous or stoloniferous such as Eragrostis bergiana, E. truncata, E. nindensis, Tragus koelerioides, Sporobolus lampranthus, Ehrharta calycina (south and south-west) and E. capensis (south and south-west).

In the dwarf karoo of the extensive flats of sandy calcareous tufa known as the Ouvlak, the abundant annual Enneapogon desvauxii may also have been important by virtue of its ability to act like a perennial. Cleistogamous seeds which lie embedded in a small, dense tuft that remains firmly rooted when dead, enable it to do this. The Ouvlak type of vegetation which has developed on such flats in the former grassveld on the western side of Middelburg Division and the eastern side of adjacent Richmond Division, is known to be a favourite haunt of springbok. This sort of veld is also of importance to the brown locust.

The karoo of the far south-western, winter-rainfall part of the upper plateau is the Western Mountain Karoo 28.1 (1076 species, 1097 m) denser and taller than other karoo types and dominated in its present state by Eriocephalus spp., with grass inconspicuous and scarce. It is well watered by streams from the Escarpment mountains.

The grasses are largely the same as those of the Mountain Renosterbosveld:

Aristida diffusa var. burkei
A. vestita
Chaetobromus dregeanus
Digitaria eriantha
Ehrharta calycina
E. capensis
E. melicoides
Eragrostis curvula var. con-
ferta
Fingerhuthia africana

Hordeum capense Merxmuellera dura M. stricta Pentaschistis tomentella Schismus barbatus Secale africanum (probably) Stipagrostis ciliata S. namaquensis S. obtusa

Bushes and forbs that were probably important include the following:

Argyrolobium collinum Berkheya spinosa B. onobromoides Carex sp. "perdegras" Castalis tragus Chrysocoma oblongifolia Cyphia digitata Dianthus caespitosus Eriocephalus spp. Felicia filifolia forma F. lasiocarpa F. macrorrhiza F. ovata F. scabrida Fockea sinuata Galenia fruticosa Gomphostigma incomptum Hermannia grandiflora Hirpicium alienatum Indigofera heterotricha Lasiospermum poterioides Lessertia macrostachya Limeum aethiopicum

Monochlamys albicans Osteospermum scariosum O. sinuatum Pentzia sp., cf. P. quinquefida Pentzia sp. (=A 14409) Phymaspermum schroeteri Polygala pungens P. virgata Pteronia aspalatha P. membranacea P. oblanceolata Rosenia glandulosa Rosenia spinescens Salsola tuberculata Silene undulata Stachys aurea S. cuneata Sutera pinnatifida Tetragonia arbuscula T. robusta Trichodiadema barbatum Ursinia pilifera

Also present is a large geophyte and annual flora still persisting in places where the soil has not been eroded down to the rock. As in the Coastal Rhenosterbosveld, bulbs, corms, tubers and rhizomes appear to be more abundant in the top few centimetres than soil. Only a few Oxalis spp. have contractile roots strong enough to drag their bulbs along a zig-zag course through the crevices of the shale itself to a safe depth of 10 to 15 centimetres. So rich a flora as this, at its best in spring, may well have attracted the animals from the east on the many occasions when the spring rains failed there.

The drier phase of the Western Mountain Karoo 28.2 (685 species, 802 m), bordering on the Arid Karoo and the Succulent Karoo, is sparser and shorter with a higher proportion of succulents.

The last of the karoo types of the upper plateau are the Arid Karoo 29 (524 species, 976 m) and the False Succulent Karoo 39. The Arid Karoo shows considerable variation with soil type and amount



FIG. 17.—Marginal semi-succulent form of Western Mountain Karoo, about 20 km east-southeast of Nieuwoudtville.

and distribution of rainfall, but there are two main variations: Blomkoolgannaveld (*Salsola tuberculata*) on more or less sand-covered calcareous tufa, and Driedoringveld (*Rhigozum trichotomum*) on other soils. The former is mainly in the northern half on the granite and the latter in the south on Dwyka and Ecca shales and sandstones. The southern variation of the Arid Karoo of "Veld Types of South Africa" (Acocks, 1975) is now regarded as a variation of False Arid Karoo.

The main species, however, occur all through and it appears that the variations are chiefly varying reactions to overgrazing. A division into a western variation, west of the Sak and Hartebees Rivers, which is Bushmanland, and an eastern variation, east of the rivers, will be best for present purposes. The southern half of Bushmanland is a region of internal drainage, so level that its altitude varies perhaps as much as 20 m on either side of 914 m. The northern half is slightly higher, with ranges of low hills along the edge of the Orange River valley, and drains northwards. Rainfall is less than 127 mm per annum, the distribution of which is neatly summed up by the local saying that "there is plenty of rain in Bushmanland, only it takes five years to work round to one's farm". There used to be the permanent lake on the south side where the Fish River emptied into what is now Swart se Kolk se Vloer. One can imagine the bird life on this lake and the two vleis, one still known as Voëlvlei, both now vloere, through which the river flowed to reach it (see p. 696). There are permanent streams, or seepages, in the southwestern corner from the Kamiesberg, but no other water is received from outside, so permanent habitation is possible at few places.

The eastern part has an undulating topography, has a little more rainfall and is crossed by many drainage lines from the Kareeberge, which receive 175 to 200 mm of rain and perhaps more on the high western portion of the range. There are many extensive pans in Bushmanland and extensive pans and floodplains in the eastern part, all equally bare now and of the nature of vloere, a "vloer" being originally a threshing floor. The striking feature of the Arid Karoo was, and once more is, its grassiness, provided by the silvery plumose species of *Stipagrostis*—the Bushman grasses (*S. ciliata* and *S. obtusa*) twaagras or dgaagras (*S. brevifolia*), gemsbokgras (*S. uniplumis*), klipboesmangras (*S. anomala*, not plumose), as well as *S. fastigiata* and *S. hochstetterana* which are now very scarce. *S. brevifolia* and *S. fastigiata* are very permanent and, while the others may die in a prolonged drought they remain rooted and remain palatable for years. Seedlings grow rapidly and come into flower and seed in a matter of weeks. Seed may work itself vertically into the sand in such abundance as to silver the ground with its plumes when seen against the late afternoon or early morning sun.

Together with a variety of karoo bushes, some semi-succulent, and succulents, it appears that this veld, while always available to animals like gemsbok, would become an immediately available reserve of grazing for the others as soon as rain provided drinking water, without waiting for growth to take place.

The grasses included the following:

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enchrus ciliaris (east)	Oropetium capense
ichanthium papillosum	Panicum lanipes
("D. annulatum")	Sporobolus ioclados
iplachne fusca	S. lampranthus
regeochloa calviniensis	Stipagrostis anomala
(west)	S. brevifolia (west)
nneapogon desvauxii	S. ciliata
scaber	S. fastigiata (west)
agrostis bicolor	S. hochstetterana (west)
lehmanniana	S. namaquensi;
nindensis	S. obtusa
ngerhuthia africana	Tricholaena capensis

The shrub *Rhigozum trichotomum* (driedoring) is almost universal, ranging from 30 cm to 2 m in height and from rare to absent in the Blomkoolgannaveld to almost impenetrable in the Driedoringveld, being more common and often dominant in the latter, as the name implies. This condition of dominance is, however, certainly artificial, resulting from elimination of effective competition from the grasses. Lycium spp. and *Phaeoptilum spinosum* are fairly regularly present in smaller numbers, while *Xerocladia viridiramis* is of local occurrence.



FIG. 18.—Arid Karoo. Sheet erosion is indicated by the "stilts" of old bushes. Partial recovery is indicated by the number of young bushes not on "stilts", but *Rhigozum trichotomum* continues to invade in the background and the grass has not returned.



FIG. 19.—"Cushions" of *Psilocaulon ciliatum* replacing karoo bushes in marginal Western Mountain Karoo: the development of False Succulent Karoo, about 39 km east-northeast of Loeriesfontein



FIG. 20.—Orange River Broken Veld about 12 km south-east of Riemvasmaak Mission. The bushes of the Arid Karoo include:

Aizoon burchellii Aptosimum spinescens Aridaria noctiflora Eriocephalus pauperrimus E. spinescens Felicia filifolia forma F. macrorrhiza Hermannia grandiflora Hoodia gordonii Lebeckia linearifolia L. spinescens Lessertia pauciflora Limeum aethiopicum Monechma desertorum Osteospermum sinuatum O. spinescens Pentzia spinescens

P. pinnatisecta Plinthus karooicus Polygala seminuda Pteronia acuminata P. leucoclada P. mucronata Ruschia uncinella Salsola rabieana S. tuberculata Sericocoma avolans S. pungens Sphalmanthus geniculiflorus Sutera atropurpurea Tetragonia arbuscula Zygophyllum flexuosum Z. gilfillanii

Of these, *Salsola tuberculata* (blomkoolganna) was probably the most important.

The False Succulent Karoo 39, in its original condition probably did not differ greatly from the Arid Karoo. Bordering on the winter rainfall area, however, its minimal rainfall of less than 127 mm is likely to be dispersed through the year, a condition which favours the succulents rather than the nonsucculent karoo bushes. What little study has been made shows that the karoo bushes are present, as well as the grasses, even if scarce today.

The Namaqualand Broken Veld of the Veld Type Map (Acocks, 1975) which occupies the Orange River valley from the Kakamas neighbourhood down to Vioolsdrif is now regarded as being typical Orange River Broken Veld 32.1 (640 species, 802 m) while the Orange River Broken Veld 32.2 (363 species, 1 067 m) of Griqualand West is now regarded as being transitional to the Vryburg Shrub Bushveld. Below Kakamas it is all very arid, with a rainfall of under 127 mm, and (apart from the Orange River itself) it receives no run-off from wetter regions outside.

It is open country, sloping gently down towards the Orange River from the edge of the plateau on the south side, but in most parts dropping abruptly to the river on the north side. The soil is mostly coarse granite sand with dunes in places. The country becomes rocky near the river and very broken upstream towards Kakamas. Elsewhere, widely scattered rocky hills and short ranges of hills occur. It is on the hills and in the rocky parts that the distinctive broken veld is best developed, the open country resembling the Arid Karoo plus a sprinkling of small trees and big shrubs and other elements of the Namib and subtropical savanna floras. The grassiness of the Arid Karoo is retained; indeed, in sandier parts the efficient seed-dispersal mechanism of the *Stipagrostis* spp. and their speed of growth have resulted in a Desert False Grassveld 33c in places from which the bushes have disappeared. This is the only case in the drier regions where change in the vegetation has favoured the grazers at the expense of the browsers.

The Orange River has its gallery forest, the only luxuriant vegetation in this arid region. Species found between Vioolsdrif and Havenga Bridge near Luckhoff, and up the Vaal River to Warrenton, total 547 in the samples studied. The trees, shrubs and grasses where the rivers flow through the Orange River Broken Veld and False Orange River Broken Veld include:

Acacia erioloba A. karroo A. mellifera subsp. detinens A. tortilis subsp. heteracantha Boscia albitrunca Bothriochloa glabra Cadaba aphylla Cenchrus ciliaris Combretum erythrophyllum Dichanthium papillosum ("D. annulatum") Diospyros lycioides Echinochloa holubii Ehretia rigida Euclea pseudebenus Ficus cordata Grewia flava

Hemarthria altissima Lycium sp., cf. L. cinereum aggr. L. hirsutum Maerua gilgii M. schinzii Maytenus linearis Phragmites australis Rhus lancea R. undulata var. tricrenata R. viminalis Salix capensis Schotia afra Scirpus inanis Sisyndite spartea Sorghum verticilliflorum Stipagrostis namaquensis Tamarix usneoides Ziziphus mucronata

This is a richer flora than that of the frosty upper reaches of the rivers.

The widely scattered shrubs and small trees that mark the change from Arid Karoo to Orange River Broken Veld 32.3a (434 species, 976 m), which extends as far as Prieska Division, are Acacia erioloba (watercourses), A. mellifera subsp. detinens, Boscia albitrunca, B. foetida, Cadaba aphylla (watercourses), Lycium oxycarpum, and Parkinsonia africana.



FIG. 21.—The normally dry Hartebees River in spate, with gallery forest of *Tamarix usneoides*, Acacia karroo and A. erioloba near Kakamas.

To the bushes and forbs of the Arid Karoo (p. 702) can be added the following species:

Aloe claviflora Aptosimum albomarginatum Barleria rigida Cucumis hookeri Hermannia abrotanoides Monechma incanum Pteronia unguiculata Senecio longiflorus Sylitra biflora Talinum caffrum

Hoodia gordonii

Kissenia capensis

*Leucosphaera bainesii

Limeum aethiopicum

Lycium oxycarpum

*Microloma incanum

Nymania capensis

*Pappea capensis

*Pentzia argentea

*P. pinnatisecta

Monechma incanum

Parkinsonia africana

Phaeoptilum spinosum

*Rhigozum trichotomum

*Rhynchosia longiflora

Sarcostemma viminale

Salsola glabrescens

*Schotia afra Senecio longiflorus

*Sisyndite spartea *Sutera maxii Sylitra biflora

Sericocoma avolans

Tetragonia arbuscula

Thamnosma africanum

*Polygala leptophylla

*Montinia caryophyllacea

*Pachypodium namaquanum

Grasses were the same as in the Arid Karoo.

The distinctive plant of the rocky parts is Aloe dichotoma even if it is not always present. Although it rarely occurs in non-rocky places, there are two extensive groves of it to the north and north-east of Pofadder in sandy valleys. Sandy valleys are more usually dotted with Acacia erioloba. The species of the typical Orange River Broken Veld probably included the following:

Acacia mellifera subsp. detinens *Adenolobus gariepensis Aizoon burchellii Aloe dichotoma *Antherothamnus rigida *Antizoma sp. = Pearson 8274 *Aridaria sp. Barleria rigida Boscia albitrunca *B. foetida Cadaba aphylla Calicorema capitata *Ceraria namaquensis Codon royenii *Commiphora gracilifrondosa *Crocyllis anthospermoides *Cucumis sagittatus *Curroria decidua Dyerophytum africanum Ehretia rigida Euphorbia gariepina *E. gummifera *Galenia fruticosa *Hermannia stricta *Hermbstaedtia glauca Hibiscus elliotiae *Hoffmanseggia lactea Orange River Broken Veld probably included: *Anthephora ramosa

Aristida engleri

Cenchrus ciliaris

Digitaria eriantha

Enneapogon scaber

Eragrostis nindensis

Fingerhuthia africana

Heteropogon contortus

Leucophrys mesocoma Odyssea paucinervis

Danthoniopsis ramosa

("D. annulatum")

*Dichanthium papillosum

Thesium lineatum Ziziphus mucronata The grasses of the rocky parts of the typical Panicum lanipes *P. scopelophilum *Setaria appendiculata *Sporobolus lampranthus Stipagrostis ciliata *S. fastigiata *S. hochstetterana S. namaquensis S. obtusa S. uniplumis Tricholaena capensis *Triraphis ramosissima

So it seems that these arid regions, receiving less than 127 mm of rain a year, have the same richness of flora as the equally arid Little Karoo and Great Karoo.

The Griqualand West form of the Orange River Broken Veld 32.2 all occurs on rocky hills. Rainfall is somewhat higher and, although there is no physiognomic difference, there is considerable floristic difference. Species marked with an asterisk in the list for the typical form, mostly belonging to the Namib flora, are either absent or become scarce, while others come in, so that the list of important species in the Griqualand West Orange River Broken Veld become as follows:

Acacia karroo A. mellifera subsp. detinens Aizoon burchellii Aloe dichotoma

A. hereroensis Aptosimum albomarginatum Barleria rigida

B. lancifolia Boscia albitrunca Cadaba aphylla Chascanum pinnatifidum Codon royenii Dianthus scaber Dyerophytum africanum Ehretia rigida Euclea undulata Euphorbia avasmontana E. gariepina Ficus cordata Garuleum schinzii Grewia flava Hermannia abrotanoides Hibiscus elliotiae Hoodia gordonii Indigofera sessilifolia Justicia thymifolia Kissenia capensis Lantana rugosa Lasiocorys capensis Limeum aethiopicum Lycium oxycarpum Maytenus ilicina Monechma divaricatum

M. incanum Nymania capensis Parkinsonia africana Phaeoptilum spinosum Plinthus karooicus Pollichia campestris Pupalia lappacea Rhigozum obovatum R. trichotomum Rhus dregeana R. undulata var. tricrenata Rhynchosia totta Salsola glabrescens Sansevieria aethiopica Sarcostemma viminale Senecio longiflorus Sericocoma avolans Stachys burchelliana Sylitra biflora Tarchonanthus camphoratus Tetragonia arbuscula Thesium hystrix Thesium lineatum Ziziphus mucronata

Of the grasses, those in the typical Orange River Broken Veld list that are marked with an asterisk appear to be absent while others come in, so that the list for Griqualand West becomes:

Anthephora pubescens	
Aristida diffusa var. burkei	
A. engleri	
Cenchrus ciliaris	
Digitaria eriantha	
Enneapogon scaber	
E. scoparius	
Eragrostis curvula	
E. nindensis	
E. lehmanniana	
Eustachys mutica	

Fingerhuthia africana Heteropogon contortus Panicum lanipes P. stapfianum Sporobolus fimbriatus S. ioclados Stipagrostis ciliata S. namaquensis S. obtusa S. uniplumis Tricholaena capensis

In Griqualand West on the right bank of the Orange River from Buchuberg to Prieska and in Prieska Division on the left bank from near Koegas towards Prieska and along the Doornberg, this is steep, rugged country.

The fourth variation of the Orange River Broken Veld 32.3b (413 species, 1037 m) is the Swarthaakveld, mainly between Prieska and Douglas, and not so arid as 32.3a. It occurs on stony flats between the Asbestos Hills and the river, mostly calcareous tufa, and was probably an open, grassy broken veld, transitional from the third variation of Orange River Broken Veld of the plains to the Central Upper Karoo and the Vryburg Shrub Bushveld, with the following species:

Acacia mellifera subsp.	Rhigozum obovatum
detinens	R. trichotomum
Boscia albitrunca	Rhus ciliata
Cadaba aphylla	R. lancea
Ehretia rigida	Rhus sp.
Grewia flava	R. undulata var. tricrenata
Maytenus heterophylla	Tarchonanthus campho-
Olea africana	ratus
Phaeoptilum spinosum	Ziziphus mucronata

The above species are scattered less thinly than in 32.3a, or possibly group into thickets in depressions around pans and in kloofs leading down to the Orange River. Grasses like Themeda and Cymbogogon appear again and we are once more in kudu country. Whether part of the original fauna, or introduced from elsewhere, forty years ago the kudu was certainly present in these wooded kloofs.

Acacia mellifera subsp. detinens (swarthaak) and Rhigozum trichotomum have assumed dominance and have advanced upstream into what was Themeda-Tarchonanthus-Olea Veld and, south of the river, into what was open karoo, to form the False Orange River Broken Veld 40a (540 species, 1 130 m).

The Orange River Broken Veld and False Orange River Broken Veld are the last of the genuine karroid types. Eastwards and northwards, any karoo bushes were subordinate to the grasses, while their present abundance or even dominance, is the result of invasion of grassveld and savanna weakened by overgrazing.

In the half of the Republic being studied, the remaining veld types are variations of the Kalahari Thornveld 16, now being invaded by karoo (Veld Type 17) to form new kinds of Karroid Broken Veld. The original grassiness is, however, easily discernible, though the potential luxuriance that one occasionally glimpses is rather startling. Still, it was what was necessary to provide the dense cover and the hot fires needed to hold the balance between grass and trees and shrubs and prevent the delopment of thickets, thereby maintaining the ability of the veld to support the whole fauna.

The first division to be made is into Kalahari Thornveld proper and Vryburg Shrub Bushveld of which 16.1 and 17.1 occur on sand and 16.2 and 17.2 occur in rocky places. Today there are extensive areas of grassland on firmer soils northwards, viz. 16.2d (i) (292 species, 1 280 m), but this may be artificial. In the drier south and west, the Kalahari Thornveld becomes so open as to be virtually grassveld. Acacia tortilis subsp. heteracantha did not extend west of the escarpment of the Kaap Plateau nor south of the Orange River, while Acacia mellifera subsp. detinens was probably not present at all.

The Kalahari Thornveld or Kameeldoringveld is normally an open woodland of Acacia erioloba (=A. giraffae) locally accompanied by, or replaced by Acacia haematoxylon, especially in the drier southern part. It varies from almost closed, as in the Kathu Forest, to almost grassveld. In the less arid eastern part, the grassveld constituent is transitional to the Dry Cymbopogon-Themeda Veld and, northwards, to the Bankenveld. There were few karoo bushes to provide winter feed for the browsers, their place being taken by forbs, which mostly die down in winter, and evergreen shrubs were few. On the other hand, surface waters were more plentiful in pans that held their water longer than they have done during the last seventy years or more. How long they will hold their water after the excessive rains of the last three years remains to be seen.

Most of the trees and shrubs of the less arid eastern part, viz. 16.1, were possibly associated with *Acacia erioloba* in small bush clumps rather than scattered, such as:

Accesia avialaba	Crowie flave
Acacia erioloba	Grewia liava
A. hebeclada	Maytenus heterophylla
A. karroo	(northwards)
A. tortilis subsp. hetera-	Lycium hirsutum
cantha (mainly south-	Rhus ciliata
wards)	R. lancea (northwards)
Asparagus africanus	R. pyroides (northwards)
Boscia albitrunca	Tarchonanthus camphora-
Dichrostachys cinerea	tus
subsp. africana (north- wards)	Terminalia sericea (north- wards)
Diospyros lycioides	Ziziphus mucronata
Ehretia rigida	
In the eastern part, the Thornveld included:	grasses of the Kalahari

Anthephora argentea A. pubescens Aristida meridionalis Brachiaria nigropedata (northwards) Cenchrus ciliaris Cymbopogon plurinodis Cynodon dactylon Digitaria polevansii Elionurus muticus (northwards) Eragrostis lehmanniana E. pallens E. superba E. trichophora Eustachys mutica Heteropogon contortus (northwards) Panicum kalaharense (northwards) P. maximum Schmidtia pappophoroides Sporobolus fimbriatus Stipagrostis amabilis S. uniplumis Themeda triandra (north wards) Tricholaena monachne Triraphis andropogonoides

Excluding the karoo species that occur today, the forms of the Kalahari Thornveld included:

Acanthosicyos naudinianus Anthospermum rigidum Antizoma angustifolia Bolusia capensis Boöphane disticha Cassia biensis C. italica subsp. arachoides Chascanum pinnatifidum Coccinia sessilifolia Commelina africana etc. Convolvulus ocellatus var. Dicoma schinzii Elephantorrhiza elephantina Geigeria brevifolia Harpagophytum procumbens Heliotropium ciliatum Hypoxis rooperi Indigofera daleoides I. velutina Ipomoea ommaneyi Lantana rugosa

Listia heterophylla Lithospermum cinereum Melhania didyma "var. linearifolia' Neorautanenia ficifolia (northwards) Nolletia ciliaris Orthanthera jasminiflora Osteospermum scariosum Otoptera burchellii (northwards) Oxygonum alatum Pavonia patens Plinthus sericeus Pollichia campestris Polygala hottentotta Rhynchosia confusa Solanum supinum Talinum arnotii T. caffrum Tephrosia lupinifolia Tylosema esculentum

(northwards)

The drier western part of the Kalahari Thornveld 17.1 (562 species, 1 172 m) that has been studied by the author, is only the eastern fringe of the Kalahari, but it is clearly similar to the remainder of the southern part of the Kalahari Thornveld described by Leistner (1967) and by Leistner & Werger (1973). Both parts include the karoo on limestone outcrops, but this is excluded here as being False Arid Karoo. If it existed formerly, it would, although small in area, have locally affected the fauna.

Except near the Langeberg and other ranges and along rivers, trees were few and far between. Acacia tortilis subsp. heteracantha was absent, whereas A. haematoxylon was of more regular occurrence than farther east. The trees and shrubs were:

Acacia erioloba	Ehretia rigida
A. haematoxylon	Grewia flava
Asparagus africanus	Lycium hirsutum
Boscia albitrunca	Rhigozum trichotomum
Crotalaria virgultalis	Ziziphus mucronata

The grasses of the drier western part of the Kalahari Thornveld included:

Anthephora argentea A. pubescens Aristida meridionalis Asthenantherum glaucum Brachiaria dura var. pilosa Digitaria sp. Eragrostis lehmanniana E. pallens

Eragrostis trichophora Schmidtia pappophoroides Stipagrostis amabilis S. ciliata S. namaquensis S. obtusa S. uniplumis Tricholaena monachne

The forbs of this drier western phase of the Kalahari Thornveld included:

Acanthosicyos naudianus Adenia repanda Antizoma angustifolia Boöphane disticha Cassia italica subsp. arachoides Convolvulus ocellatus var. ornatus Dicoma schinzii Euphorbia mauritanica Geigeria brevifolia Harpagophytum procumbens Heliotropium ciliatum Hermannia brachypetala Hoffmanseggia burchellii Jatropha erythropoda Monechma incanum Pergularia daemia Plinthus cryptocarpus P. sericeus Pollichia campestris Polygala hottentotta Requienia sphaerosperma Solanum supinum Trochomeria debilis

The Vryburg Shrub Bushveld 16.2 (888 species) and 17.2 (788 species) has many variations, of which the typical one is taken to be the *Tarchonanthus* Veld



FIG. 22.—Regeneration of *Themeda triandra, Miscanthidium sorghum* and sedges in a vlei at Palmietfontein, Hay Division.

16.2a (i) (560 species, 1 341 m) and 17.2a (i) (273 species, 1 372 m) of the calcareous tufa flats of the Kaap Plateau in Griqualand West and in Vryburg 16.2a (iii) (323 species, 1 250 m) with outliers 17.2a (ii) (359 species, 1 160 m) below the Plateau. In pre-Kimberley days these outliers were more extensive. Veld Type 17.2 is the Vryburg Shrub Bushveld invaded by karoo, so for present purposes it has to be combined with 16.2 with elimination of the invading karoo species.

The calcareous tufa parts of the Kaap Plateau are very flat with many small shallow pans and wide shallow valleys, all normally dry and bare now, but with rare traces of a formerly luxuriant vegetation. It was here, when the author was going from farm to farm collecting information about the vermeerbos problem, that he repeatedly heard the expression "maktrap", meaning that the early settlers had considered that they had to trample down and "tame" the too-luxuriant vegetation to make it suitable for their sheep. That was forty years ago and by then success was already complete except on certain farms that could not be permanently occupied because of lack of water.

That the plateau was generally well watered, presumably with a fauna to match, is confirmed by the ubiquity of Bushman implements and the traces of their "factories" at so many places that look as though they were formerly springs. The excessive rains of the past three years have more than restored this well-watered condition, but the absence of the former soil and vegetation, of pans and streams in particular, will shorten the duration of this recovery. There are traces of a black humus soil on the limestone, just as in the Duineveld of the south coast.

The characteristic plants now are the shrubs of *Tarchonanthus camphoratus* "var. *litakunensis*" and "*Tarchonanthus minor*", sometimes growing fairly densely, sometimes sparsely, with a sprinkling of *Olea africana* and *Rhus lancea* in what was a *Themeda* Veld. It is likely that *Tarchonanthus* "spp." (and *Rhus ciliata* which forms thickets today) were less common, so that the veld was an open woodland of *Olea africana* and *Rhus lancea*. These two species also grow more closely along the "are", low limestone ridges along "water veins", and may have formed

small bush clumps with the *Tarchonanthus* "spp." *Maytenus heterophylla*, *Cadaba aphylla*, a tall form of *Rhus dregeana* and others. The names *Tarchonanthus camphoratus* var. *likakunensis* and *T. minor* continue to used because the cattle do not agree with the taxonomists that the plants are indistinguishable, ignoring the former and eating the latter to the verge of extinction.

The rainfall is lower at the south end of the plateau, but not sufficiently so as to alter the nature of the veld.

In this typical form of the Vryburg Shrub Bushveld 16.2a (i) and 17.2a (i), the principal trees and shrubs are likely to have been the following:

Acacia karroo	Lycium hirsutum
A. tortilis subsp. hetera-	Maytenus heterophylla
cantha	Olea africana
Asparagus africanus	Rhus dregeana ($=$ R. tridac-
A. laricinus	tyla) (in the south)
A. retrofractus	R. lancea
Boscia albitrunca	R. pyroides
Diospyros austro-africana	Tarchonanthus camphora-
D. lycioides	tus "var. litakunensis"
Ehretia rigida	"Tarchonanthus minor"
Euclea crispa var. ovata	Ziziphus mucronata
Grewia flava	-

Bushes and forbs of would have included:

Achyranthes aspera Aerva leucura *Aptosimum albomarginatum *Barleria bechuanensis "var. espinulosa Chascanum pinnatifidum Coccinia sessilifolia Commelina africana Dianthus sp. Geigeria filifolia Hermannia comosa H. linnaeoides pulverata Hibiscus marlothianus Kalanchoe pyramidalis Lantana rugosa Lasiocorys capensis Lessertia pauciflora Limeum aethiopicum Lippia scaberrima (northwards) Melhania rupestris

*Menodora africana

Bushes and forbs of the Tarchonanthus Veld

Monechma divaricatum Ornithoglossum viride Pavonia patens Pentarrhinum insipidum Phyllanthus maderaspatensis Pollichia campestris Polygala asbestina Pupalia lappacea Rhynchosia totta (northwards) Ruschia canonotata R. griquensis Salvia stenophylla Sansevieria aethiopica Senecio intricatus S. longiflorus Solanum supinum Stachys spathulata Sutera atropurpurea Talinum caffrum Viscum rotundifolium Zygophyllum pubescens



The grasses of the Tarchonanthus Veld included:

Chrysopogon serrulatus Cymbopogon plurinodis Cynodon dactylon Digitaria argyrograpta D. eriantha D. polyphylla Elionurus muticus Enneapogon scoparius Eragrostis lehmanniana E. superba Eustachys mutica Fingerhuthia africana Heteropogon contortus Miscanthidium sorghum Panicum coloratum Sporobolus fimbriatus S. ioclados Stipagrostis uniplumis Themeda triandra Tragus koelerioides

Where the dolomite is not covered with calcareous tufa or sand, the surface is rugged, especially along the escarpment of the Kaap Plateau 16.2c (423 species, 1 310 m) and 17.2c (349 species, 1 310 m). The following species may be added to the flora of the limestone flats:

Anthephora pubescens	Ficus cordata
Cadaba aphylla	Kalanchoe rotundifolia
Cenchrus ciliaris (mainly	Lebeckia macrantha
southern)	Maytennus undata $(=M.$
Ceterach cordatum	ilicina)
Celtis africana (mainly	Rhigozum obovatum
southern)	Salvia namaensis
Corallocarpus welwitschii	Stachys burchellii
Cypholepis yemenica	Vangueria infausta

Only Aptosimum albomarginatum and Hermannia pulverata need to be removed from the above to give a list of the main species of the dolomite.

On the red sandy loam flats in the northern par^t of the Kaap Plateau 16.2d (i) (292 species, 1 280 m) the woodland is very open, the only thorn tree found in as many as half the samples, for instance, being *Acacia karroo*. Rainfall increases northwards, so that source grasses come in, or become more plentiful than they were southwards, such as:

Andropogon amplectens	
A. schirensis	
Brachiaria nigropedata	
B. serrata	
Cymbopogon excavatus	
Elionurus muticus	

Eragrostis curvula (=E. robusta) Schizachyrium sanguineum Schmidtia pappophoroides Setaria flabellata Triraphis andropogonoides

Forbs belonging to the Transvaal Bushveld begin to appear, while others, particularly those of the limestone, become scarce to absent, so that the list of the bushes and forbs of the northern sandy loam flats 16.2d (i) would have been as follows:

Achyranthes aspera Aerva leucura Anthospermum rigidum Barleria macrostegia Bulbostylis burchellii Cassia biensis C. italica subsp. arachoides Chascanum hederaceum Crabbea angustifolia Dicoma macrocephala Elephantorrhiza elephan-

tina Hibiscus marlothianum Lantana rugosa Lippia scaberrima Menodora africana Orthanthera jasminiflora Osteospermum scariosum Oxygonum alatum FIG. 23.—Kimberley Hardeveld 24 km north-west of Christiana with Acacia erioloba, A. tortilis subsp. heteracantha, A. hebeclada and A. karroo.

> Pavonia patens Phyllanthus maderaspatensis Pollichia campestris Rhynchosia adenodes Ruschia griquensis Sida cordifolia S. dregei Solanum supinum Vernonia oligocephala Zornia tetraphylla

Further south, on hard red sandy loam around Warrenton, Barkly West and Kimberley is a mixed Thornveld, the Kimberley Hardeveld 16.2b (301 species, 1 130 m) and 17.2b (417 species, 1 220 m) ranging from dense to open, and including all the local *Acacia* species except *A. haematoxylon*. It is, however, almost certainly the result of invasion of grassveld by the bushveld species and in the case of 17.2b, of karoo species as well. This veld must thus be considered to have been *Themeda* Veld.

There are three more major variations of the Vryburg Shrub Bushveld: (a) on the Asbestos Hills 16.2d (ii) (541 species, 1 500 m) and on the drier southern and western parts of these hills that are invaded by karoo 17.2d (ii) (383 species, 1 372 m); (b) on the Langeberg and its foothills 16.2e (462 species, 1 310 m); and (c) on the koppies around Windsorton 16.2f (309 species, 1 160 m), and around Kimberley, where karoo invasion has taken place 17.2f (394 species, 1 160 m). For present purposes, as already pointed out, the invading karoo species have to be ignored.

The Asbestos Hills are stony rather than rocky and generally not steep, so that they are more easily accessible to the hoofed animal than the rocky koppies and the excessively rocky and steep Langeberg. If the stoniness ever was covered by soil, no trace of it has been found. The acid nature of the banded ironstone favours the sour grasses, mainly northwards where the rainfall is higher, so that the list of grasses would have been as follows:

Andropogon schirensis (northwards) A. schinzii (northwards) Anthephora pubescens Aristida diffusa var. burkei A. meridionalis (northwards) Brachiaria nigropedata

B. serrata (northwards)
Cymbopogon excavatus (northwards)
C. plurinodis
Cypholepis yemenica (northwards)
Digitaria eriantha
D. polyphylla Diheteropogon amplectens Elionurus muticus Enneapogon scoparius Eragrostis curvula E. nindensis Eustachys mutica Fingerhuthia africana Heteropogon contortus Hyparrhenia hirta Panicum coloratum . stapfianum Rhynchelytrum setifolium

Schizachyrium sanguineum (northwards) Schmidtia pappophoroides Sporobolus fimbriatus Stipagrostis uniplumis Themeda triandra Tragus koelerioides Trichoneura grandiglumis Triraphis andropogonoides (northwards) Urelytrum squarrosum (northwards)

Of these trees and shrubs of the Kaap Plateau Tarchonanthus Veld (p. 702) all except Acacia tortilis subsp. heteracantha occur on the Asbestos Hills, with Acacia erioloba (sandy valleys), Cadaba aphylla, Euclea undulata, Lebeckia macrantha, Nymania capensis, Rhigozum obovatum, and Rhus undulata var. tricrenata becoming sparse towards the south. Of the widespread bushes and forbs of the Tarchonanthus Veld, only Aerva leucura, Hermannia linnaeoides and Lippia scaberrima fail to appear on the Asbestos Hills, while 21 have to be added, although a few of them do occur, but as rarities, on the Kaap Plateau. These are the following:

Anthospermum rigidum Boöphane disticha Ceterach cordatum Dimorphotheca cuneata *Euphorbia gariepina E. rhombifolia Garuleum schinzii *Glossochilus burchellii *Helinus spartioides (rare to the north) *Hermannia abrotanoides Justicia thymifolia

Osteospermum microphyllum *O. scariosum Pachypodium succulentum Pellaea hastata Sida dregei Stachys burchellii Sutera halimifolia Sutherlandia frutescens Thesium lineatum *Triaspis hypericoides

In the southern half of the Langeberg 16.2e that has been studied, few of the sour grasses occur, but it is along this range and the Asbestos Hills that the sour grasses make their deepest penetration into the arid regions. The list of grasses becomes as follows:

Anthephora pubescens
Aristida diffusa var. burkei
Brachiaria nigropedata
Cenchrus ciliaris
Cymbopogon plurinodis
Digitaria eriantha
D. polyphylla
Elionurus muticus
Enneapogon scaber
E. scoparius
Eragrostis curvula
E. lehmanniana

E. nindensis Eustachys mutica Fingerhuthia africana Heteropogon contortus Panicum stapfianum (="P minus var. planifolium") Rhynchelytrum setifolium Schmidtia pappophoroides Sporobolus fimbriatus Themeda triandra Tragus koelerioides

Running almost north and south, the Langeberg has a marked aspect difference. The west side is covered with Croton gratissimus with Euphorbia avasmontana scattered through it. In rocky kloofs on the east side there is much Buddleja saligna, while Acacia erioloba is regularly found in sandy kloofs below. Although Acacia mellifera subsp. detinens is present all through today, it is not regarded as a member of the original flora of any of these Kalahari types. Otherwise the tree and shrub flora of the Langeberg is similar to that of the Asbestos Hills, but with Diospyros austroafricana, Lebeckia macrantha, Maytenus heterophylla and Rhus pyroides failing to appear. Tarchonanthus camphoratus "var. litakunensis" is almost entirely replaced by Tarchonanthus "minor" and Ficus cordata, Maytenus undata (=M. ilicina), Nymania capensis, Phaeoptilum spinosum and Putterlickia pyracantha coming in or becoming more frequent, in addition to Acacia erioloba, Croton gratissimus, Euphorbia avasmontana and Buddleja saligna.

The bush and forb flora of the Langeberg shows considerable difference from that of the Asbestos Hills, with a number of species failing to appear. (those marked with an asterisk in the list on pp. 705 and 706), and a number, some of them from the Orange River Broken Veld, coming in as regular constituents:

Acanthosicyos naudinianus Adenia repanda Aloe hereroensis Corallocarpus welwitschii Cotyledon decussata Dipcadi glaucum Hibiscus elliotiae

H. fleckii Lopholaena cneorifolia Psiadia punctulata Sarcostemma viminale Sutera crassicaulis Sylitra biflora

With permanent water at Witsand a few kilometres to the west and springs in the kloofs, one might regard this rugged mountain as a stronghold of such animals as the klipspringer and vaal rhebok, and as a reserve of grazing for others when the need arose to climb.

The Kimberley Koppies 16.2f (309 species, 1 160 m) and 17.2f (394 species, 1160 m) look similar to those of the False Karoo, but their vegetation shows considerable differences. Their grasses included:

Fingerhuthia africana
Heteropogon contortu
Hyparrhenia hirta (noi
wards)
Panicum coloratum
P. maximum
Rhynchelytrum sp., c
villosum
Schmidtia pappophor
Sporobolus fimbriatus
Themeda triandra
Tragus koelerioides
Trichoneura grandiglu
0

gon contortus nia hirta (northcoloratum um ytrum sp., cf. R. pappophoroides us fimbriatus triandra oelerioides ura grandiglumis

The shrubs and trees of the Kimberley koppies included the following:

Acacia tortilis subsp. hetera-
cantha
Boscia albitrunca
Cadaba aphylla
Diospyros lycioides
Ehretia rigida
Euclea crispa var. ovata
Grewia flava

Maytenus heterophylla (northwards) Olea africana (southwards) Rhigozum obovatum Rhus ciliata R. lancea (northwards) Tarchonanthus camphora-tus "var. litakunensis" Ziziphus mucronata

The bushes and forbs of the Kimberley koppies included:

Abutilon austro-africana Achyranthes aspera Antizoma angustifolia Argyrolobium rupestre Asclepias burchellii Barleria rigida Boöphane disticha Caralluma lutea Cassia italica subsp. arachoides Ceterach cordatum Chascanum pinnatifidum Coccinia rehmannii Commelina africana Corallocarpus welwitschii Corbichonia decumbens Crotalaria griquensis Dicoma capensis Dipcadi viride Euphorbia sp., cf. E. rectirama Fockea angustifolia Heliotropium nelsonii Hermannia bryoniaefolia

Hibiscus atromarginatus H. marlothianus Kalanchoe paniculata Lantana rugosa Lasiocorys capensis Limeum aethiopicum Melhania prostrata Osteospermum scariosum Pachypodium succulentum Pavonia patens Pellaea hastata Phyllanthus maderaspatensis Pollichia campestris Pupalia lappacea Rhynchosia totta Schizobasis intricata Senecio longiflorus Solanum supinum Sutera crassicaulis S. halimifolia Talinum caffrum Viscum rotundifolium



FIG. 24.—Sea of pioneer grass seen from a point nearly 6 km west of Conway Station. Grassy False Karoo with *Eragrostis lehmanniana*.

It is evident that if this reconstruction of the vegetation is correct, the colouring of the landscape would have been different from what it is now. On the whole, the landscape would have been lighter in colour and smoother in contour and texture. The exception, temporarily, is the False Central Upper Karoo, now submerged in a winter-white sea of pioneer *Eragrostis lehmanniana*.

The invading and encroaching bushes, shrubs and trees such as Chrysocoma tenuifolia, Felicia filifolia, Dimorphotheca cuneata, Elytropappus rhinocerotis, Pteronia tricephala, Eriocephalus spp., Euryops spp., Rhigozum trichotomum, Acacia karroo, A. mellifera subsp. detinens, etc., are nearly all dark green or grey. Shadows in their uneven surface help to cause them to show up black at a distance, so their elimination would lighten the colour and smooth the texture of the vegetation.

Because Themeda's red-brown or orange-brown colour when flowering, or just after the first frosts, closely matches the colour of red soil, restoration of a Themeda Veld would sometimes, in denuded and eroded false karoo, make little difference to the colour of the landscape. Young growth, on the other hand, especially if fire or grazing has removed the pale, purple-pink old growth, is pale blue-green; so here and in the Mountain Renosterbosveld and Karroid Merxmuellera Mountain Veld, whether coloured light yellow-green by Merxmuellera or black by shrubs, restoration of Themeda Veld would make a conspicuous difference. Only where the brown dolerite boulders have recently been eroded out of the soil would the change be inconspicuous. While the pale green of Merxmuellera is spreading as better management reduces the area under the shrubs, the restoration of the red of Themeda is still in the future. Fortunately there is a scattering of relics all through the mountains to give us an idea of what they looked like and how brilliant their colouring must have been. In the parts of the winter-rainfall area outside the range of Themeda, the winter colouring was green, the summer colouring white.

Where grasses like *Digitaria*, *Sporobolus*, *Eragrostis*, *Fingerhuthia* and *Tetrachne* were dominant, the green of young growth was less bluish, while the flowering

colour was a film of dark grey over the green, and the winter colouring white to cream to light grey. If *Panicum* were dominant, the flowering colour would be purplish. In the arid regions, the flowering colour of the *Stipagrostis* spp. was silvery white, changing to pale blue as the grasses dried off and became matted down into the condition known to the farmer as "bloudak".

The distinctive yellow-green colour of the spekboom is retained winter and summer and is recognizable at a distance; the only plant that can occasionally cause a little doubt is Zygophyllum foetidum. It is not a grass colour, but there is a plant that can perfectly mimic over large areas the pale blue-green colouring of a young Themeda Veld; this is the creeping succulent Hymenocyclus luteolus in the south-eastern Cape in places that used to be spekboomveld. In such cases and where forest has been replaced by grassveld or fynbos, the original colouring was darker than it is now. Where thicket was more open and grassy than it is now that it has closed up and lost its grassiness, its colouring was lighter.

In the karoo, the mixture of grass and small bushes would have produced the same pepper-and-salt effect that it still does, varying with the wetness of the season, the time of year and the degree to which the grasses were grazed down. The difference was that the all-too-common condition of today, which, to amplify the well-known quotation, can be described as "little bushes standing each on its own little mound in its own little desert", was never reached.

Restoration of the soil would smooth the contour by covering the ledges of hard sandstone that break up the outlines of the shaly slopes and by covering the boulders of igneous koppies and other rocky hills and mountains, besides filling the dongas. More vigorous growth of grass would increase this effect.

To avoid any misunderstanding, it must be emphasized that the present uniform winter-white grassiness of so much of the upper plateau is the effect of three years of excessive rainfall on a vegetation from which practically all the climax grass had disappeared. It is an artificial product which bears little or no resemblance to the original vegetation which this paper has tried to reconstruct and describe.

UITTREKSEL

Daar word gepoog om die oorspronklike plantegroei van die vlaktes, plato's, berge en riviere van die halfdorre tot dorre westelike helfte van die Republiek van Suid-Afrika voor te stel, alvorens dit onder enige menslike invloed, behalwe dié van die Boesmans en Hottentotte, gekom het. Lyste van plantsoorte wat voorheen waarskynlik belangrik was, al is hulle vandag seldsaam, word gegee. Besondere ag word geslaan op die rivieroewerplantegroei. Aandag word ook gegee aan eienskappe van die plantegroei en topografie wat moontlik die dierelewe kon beïnvloed het.

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