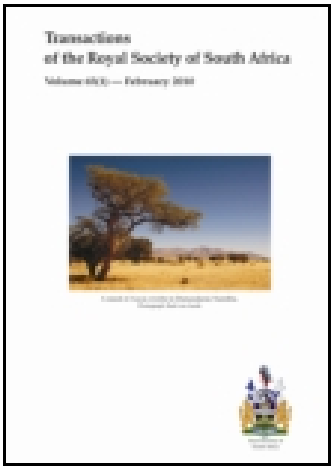

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SOME OBSERVATIONS ON THE EFFECTS OF A BUSH FIRE ON THE VEGETATION OF SIGNAL HILL

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SOME OBSERVATIONS ON THE EFFECTS OF A BUSH FIRE ON THE VEGETATION OF SIGNAL HILL.

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(With Plates X to XII and one Text-figure.)

The practice of burning the veld in South Africa is probably an ancient one. According to Dr. Marloth (3), the early Portuguese navigators saw bush fires while sailing along the coast of the Cape Province, thus indicating that the custom was not one introduced by the early white settlers.

At the present time there is no exact information as to the effects that this periodic burning has on the vegetation, though certain experiments in connection with this problem are being conducted at Pretoria by Dr. E. P. Phillips of the Division of Botany (5, 6). In South Africa, however, the problem is not a uniform one, as the types of vegetation to be found in different parts of the Union show fundamental differences. Thus the area which Dr. Phillips has under observation is typical grassland, such as covers large tracts of country in the Transvaal and Orange Free State, while the area with which the present paper is concerned is normally covered with sclerophyllous bush, the characteristic vegetation of the south-western region. In regions of grassland, as a rule, burning is carried out systematically, year by year, whereas in the south-western districts this is not the case, fires occurring at irregular intervals. These latter fires may be due to natural causes, but more often they are started deliberately either by the farmer who wants young shoots on which to graze his cattle, or by the poorer members of the population who, after some time has elapsed, collect the dead branches for firewood. It follows from the nature of the vegetation that in grassland the fires are more readily controlled than in the bush-covered country of the south-west.

Signal Hill, or Lion Mountain, on a portion of whose slopes the following investigation was carried out, separates Cape Town from the sea on its western side. As will be seen from the accompanying map (fig. 1), the hill runs in a north-north-easterly direction, the highest point (about 2200 feet),

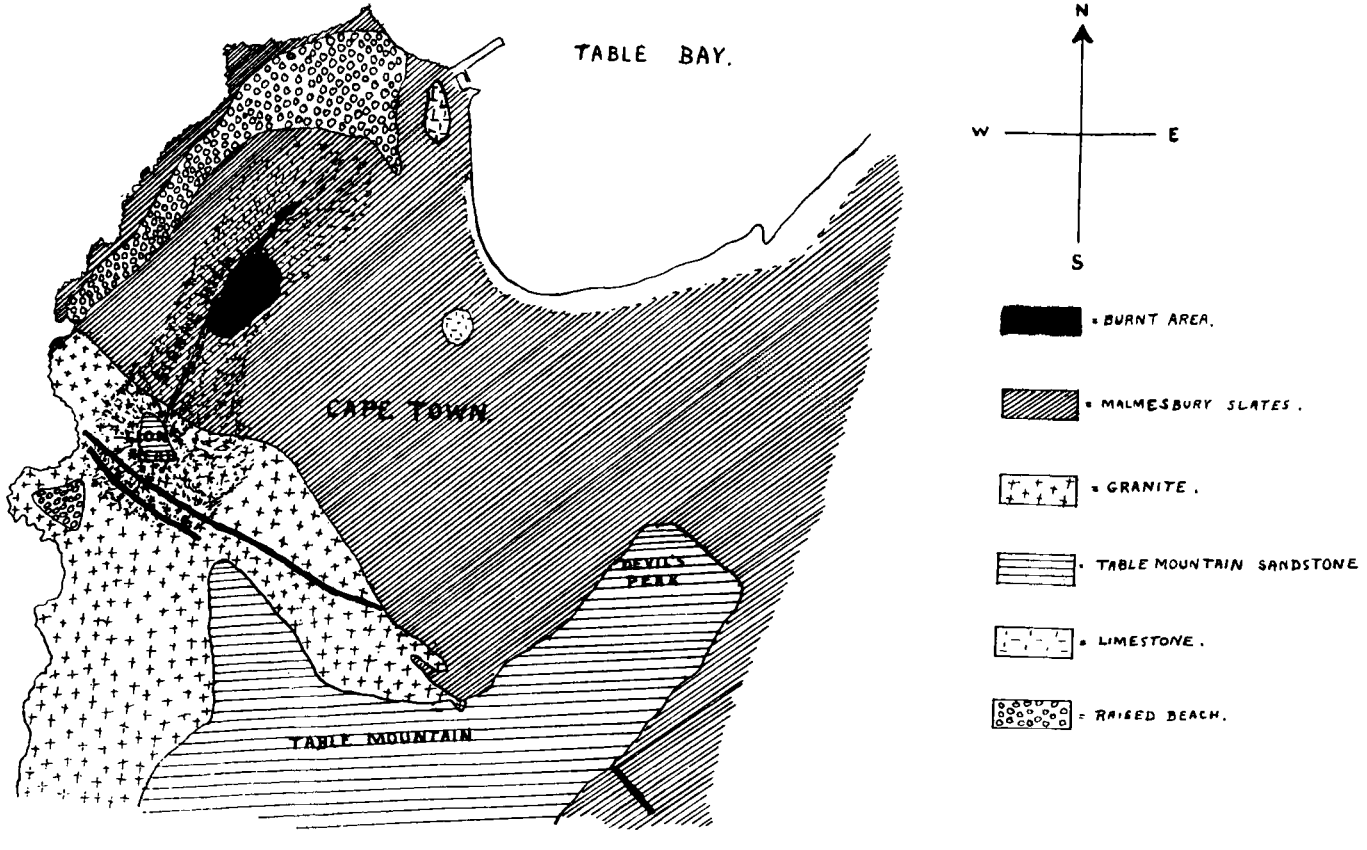

FIG. 1.—Geological map of the northern part of the Cape Peninsula, showing Signal Hill and the burnt area. Adapted from the Geological map of the Cape Division, 1899. Scale $1\frac{1}{16}$ inch to a mile.

known as Lion's Head, being situated at the southern end of the hill. The rest of the hill consists of a ridge about a mile and a half long and of considerably lower altitude than the head, the average height being about 1100 feet.

The soil of that part of Signal Hill with which this paper is directly concerned is clay, derived from the Malmesbury slates, of which the northern end of the hill is composed. The burnt area is by no means uniform in character. Several valleys (fig. 2) of more or less equal depth cut up the hillside, and these have a vegetation which in its constituents shows certain marked differences from that of the ridges in between the valleys.

The bush fire, the effects of which are recorded in this paper, broke out on the 5th February 1919, and owing to a strong south-east wind it was not extinguished till late on the following day. The approximate extent of the burnt area is shown in fig. 1. Owing to the somewhat sheltered position of the water-course in each valley, the vegetation there was not badly burnt, while elsewhere the fire killed the aerial parts of every plant with the exception of a few isolated pines and one eucalyptus tree. These trees were the only ones on the burnt slope, and they were odd specimens which had invaded the area from neighbouring plantations.

At one spot at the southern end of the area the ground is fenced off, and this protected area was valuable in affording a means of judging the effects of cattle and man on the regenerative processes after the fire.

In our * investigations valley A (fig. 2) and its immediate slopes provided us with a suitably restricted field for more detailed observations. The other parts of the burnt area were visited from time to time, but an intensive study was made of valley A alone.

Detailed observations on the vegetation of this part of Signal Hill were not made prior to the bush fire, and consequently it was necessary to rely upon the evidence of charred bushes, and the character of a few small patches which had escaped the fire, in estimating the original composition of the flora. The plant which dominated these slopes as seen from the town was *Rhus lucida*, bushes of which were dotted at frequent intervals over this part of the hill. The green colour of these bushes was in marked contrast with the prevailing grey-green colour of the smaller shrubs growing in between the *Rhus* bushes.

The first visit to the burnt area was made eighteen days after the fire, and during that interval there had been some rainy days interspersed with fine, hot days.

* During the year 1919 this work was carried out in conjunction with three students—Miss S. Garabedian, Miss E. G. Torrance, and Miss W. Wilson. The investigation formed part of the work of the M.A. course in botany for that year.

The following shrubs were noted on a small unburnt area at the foot of valley A :—

Rhus lucida (a).†
Elytropappus Rhinocerotis (a).
Cliffortia ruscifolia (f).
Passerina sp. (f).
Athanasia trifurcata (f).
Leyssera gnaphaloides (f).
Asparagus capensis (f).
Psoralea hirta (f).
Noltea africana (l, f).
Rhus glauca (o).
Rhus angustifolia (o).
Passerina filiformis (o).
Anthospermum ciliare (o).
Borbonia cordata (o).
Solanum sodomaeum (o).
Berkheya rigida (o).
Aster fruticosa (o).
Cliffortia polygonifolia (o).
Euclea racemosa (o).
Gymnosporia buxifolia (o). In water-course only.
Leonotis Leonurus (o). ,, ,,
Conyza ivifolia (r). ,, ,,

In addition the following undershrubs or herbs were found :—

Cynodon Dactylon (l, a).
* Lobelia Erinus (l, a).
Selago adpressa (l, f).
Chironia baccata (o).
Pelargonium grossularioides (o).
Rumex acetosella (o).
* Erodium malachoides (o).
Andropogon hirtus (o).
Briza maxima (o).
Helichrysum crispum (o).
Helichrysum cymosum (o).
Scabiosa columbaria (o).
Oenanthe filiformis (o).

† The usual abbreviations have been used. a = abundant, f = frequent, o = occasional, r = rare, l = locally.

Gorteria personata (o).
Pellaea auriculata (o).
* Lobelia lutea (r).

(* indicates that the plants were in flower.)

In one spot an outcrop of slate was seen, and this was covered with crustaceous lichens. Associated with this rock were *Mesembryanthemum asperum* and *Crassula muricata*, both succulents, and it may be noted here that apart from these rock exposures succulents were rare.

The outstanding feature of this first visit was the vigorous growth of aerial shoots in *Asparagus capensis* and *Andropogon hirtus*. Both these species had been burnt down to the ground; but in spite of the fact that less than three weeks had elapsed since the fire, the whole hillside was dotted with these plants, their green colour being in vivid contrast with the prevailing blackness of the scene. In the case of *Asparagus capensis* many bushes were a foot and a half high. Both these species were more abundant on the southern slopes of each valley than elsewhere, and it was noted later that these slopes which are more exposed to sunlight than the northern slopes bear a more open type of vegetation. Another plant which was growing actively on the burnt area was *Hibiscus aethiopicus*, but owing to its small size it did not strike a conspicuous note, as was the case with the two other species.

The next visit was paid about a month later, on the 20th March. The condition of the area was little changed. One plant of *Asparagus capensis* was in full flower, and it is of interest to note that the usual flowering period of this species (May to June) had been anticipated. *Hibiscus aethiopicus* was in flower all over the area. Besides these, *Gladiolus brevifolius* and *Haemanthus coccineus* were flowering, the latter being very conspicuous. In the following years (1920 and 1921) flowers of this plant were rarely found, and it seems safe to conclude that the fire must have induced the burst of activity in 1919.

All over the hillside young shoots were being given off in profusion from the bases of the charred stems in the various species of *Rhus* which characterise these slopes. The following species were noted :—

Rhus lucida (a).
R. angustifolia (l, f).
R. glauca (o).
R. tomentosa (o).
R. mucronata (o).
R. rosmarinifolia (r).

Other plants here and there were seen to be behaving in a similar fashion,

but the phenomenon was not as general in these as amongst the species of *Rhus*. The following list of such plants was made :—

Montinia acris (l, f).
Zantedeschia aethiopica (o).
Sonchus Ecklonianus (o).
Cliffortia polygonifolia (o).
Salvia africana (o).
Anthospermum ciliare (o).
Athanasia trifurcata (o).
Mohria caffrorum (o).
Leonotis Leonurus (r).
Bobartia spathacea (r).
Peucedanum galbanum (r).

Gymnosporia buxifolia was giving off new shoots, but as the plants were confined to the water-courses they had been somewhat protected and the aerial shoots had not been killed. A common plant in the water-course at the foot of valley B was *Clutyia pulchella*, and although the old stems appeared badly charred, they were giving off new shoots over the whole surface. This was an unusual method of regeneration, the only other plant behaving in a similar way being a young Eucalyptus tree which was growing on the slopes above valley C.

A week later another visit was paid, and the only change noted was that certain plants were now in flower, viz. *Curculigo plicata*, *Oenanthe filiformis*, *Andropogon hirtus*, and *Oxalis livida*. The two first-mentioned species belong to the same class of plant as *Haemanthus coccineus*, the flowers in all cases appearing some considerable time before the leaves.

In the Cape Peninsula there are two marked periods of flowering activity. The first begins about the end of March and attains its maximum with the first winter rains. Numerous species of Oxalis are characteristic plants of this period. The second and major period is in the spring, towards the end of the rainy season. These two flowering periods are well marked on the area under discussion, and it is noteworthy that in general there was no obvious forestalling of the periods in 1919. However, though the times of flowering remained as in normal years, the same cannot be said of the quantity and quality of the flowers produced. In both these respects the flowers on the burnt area were far above the average, and this in a year when elsewhere the flowers were not particularly fine.

During April the following plants came into flower :—

Oxalis tomentosa (a). On the lower slopes only.
Oxalis variabilis (a). Slightly later than *O. tomentosa*.

Oxalis hirta (f).
Oxalis sericea (o).
Melica racemosa (o).
Polygonum atraphaxoides (o).

All the species of Oxalis which were found on the burnt area have deeply situated bulbs, and several new bulbs are formed each year, vegetative reproduction seeming to be the rule. As a result, the ground is covered with Oxalis plants and the whole hillside presents an extremely gay appearance. In 1919 the brilliant display of Oxalis was noteworthy.

In April the following additions were made to the March list of plants which were producing new shoots from the uninjured parts below :—

Adiantopsis capensis (a). Under bushes and on northern slopes of valleys.
Pellaea auriculata (f). ,, ,, ,,
Cliffortia ruscifolia (o).
Royena glabra (o).
Bulbine favosa (o). Valley only.
Kiggelaria africana (r). ,, ,,
Lycium afrum (r).

It was noted at this time that certain plants showed no signs of recovery after the fire, notably *Elytropappus Rhinocerotis*, and *Protea mellifera*, which was represented by a single specimen.

The winter rains began to fall in May, and on the next visit on the 13th June many changes were noted.

In the winter the northern side of each valley gets very little sun, and the differences in vegetation between the two sides of each valley were very marked. Valley A bore evidences of a great rush of water during the rains which had fallen shortly before this visit, and the stream bed was characterised by a large number of young shoots of *Ranunculus*. Later in the year two species were identified, *R. pubescens* and *R. muricatus*. On the banks at the side of the water-course and also on the northern slopes of the valley an abundance of small ferns, mosses, liverworts, and lichens were noted. The most abundant fern was *Adiantopsis capensis*, which here and there formed close sward-like patches. *Pellaea auriculata* and *Mohria caffrorum* were plentiful. The following genera of liverworts were noted : *Fossombronia*, *Fimbriaria*, *Lunularia*, and *Riccia*. The mosses and lichens were not identified. The latter were confined to the exposed rock surfaces and branches of various shrubs. The following herbaceous plants, all of which possess underground organs of perennation, were noted on the northern slope :—

* Crassula septas (a).
* Rumex cordatus (f).

Scabiosa columbaria (f).
Cyphia Phyteuma (f).
* Oxalis variabilis (f).
* Oxalis glabra (f).
* Oxalis lanata (f).
Oxalis tomentosa (f). Flowers dead.
* Oxalis cernua (o).
* Oxalis compressa (o).
* Oxalis sericea (o).
* Curculigo plicata (o).
Rumex sp. (o).
* Crassula saxifraga (o).

These plants covered the ground, and gave an air of luxuriant growth which was entirely lacking in the case of the southern slope. On the latter the cryptogamic element was poorly represented, and *Crassula septas*, which owing to its beautiful clusters of white flowers was most conspicuous on the northern side, was entirely absent. *Rumex cordata* and *Scabiosa columbaria* were also lacking on this side. The various species of Oxalis, however, were well represented, and in addition *Curculigo plicata*, which was at this time in leaf, though in many cases the flowers were still persisting. *Asparagus capensis* was flowering freely.

On both slopes of the valley, and also on the ridge between valleys A and B, the leaves of a large number of Monocotyledons were seen.

On the ridge seedlings of *Borbonia cordata* were common, and were localised in a number of " schools." This was the first example of a plant coming up from seed after the fire. The normal fruiting period of this species coincided with the time of the fire, and it seems safe to conclude that the seeds, which are fairly large and heavy and thus not wind distributed, are able to withstand a high degree of heat.

Several plants of *Antholyza revoluta* were seen in flower on the ridge. Plants of *Arctopus echinatus* were also fairly common.

Valley B was visited on this occasion, and was found to agree fairly closely with A, both in the composition of the flora and the distribution of species.

The whole area, with the exception of the portion enclosed by the fence already mentioned, was used as a grazing-ground for cattle. The result of this was twofold. Certain plants, notably *Andropogon hirtus*, were almost entirely eaten down. Inside the fence, on the other hand, the tall inflorescences of this grass were quite a feature of the vegetation (fig. 3). A second result of the cattle grazing was the formation of a number of tracks all over the hillside and the consequent loosening of soil. This was very

conspicuous on the ridge at the northern boundary of the burnt area. Here several new water-courses were formed as a result of the washing away of the loosened soil.

Man was also instrumental in loosening the soil. Wood-gatherers were constantly seen, as is always the case after a bush fire, and the tracks caused by dragging large bundles of burnt brushwood down the hill were very noticeable.

The outstanding feature of the next period of activity, which began towards the end of August, was the predominance of Monocotyledons amongst the herbaceous plants in flower. The following were noted :—

MONOCOTYLEDONS.

Water-course of valley A.

Moraea tristis (f).
Moraea papilionacea (o).

Valley slopes and ridge.

Sparaxis grandiflora (a).
Geissorhiza secunda (a).
Geissorhiza sp. (a).
Pterygodium catholicum (a).
Homeria collina (f).
Moraea tripetala (f).
Lachenalia orchioides (f). Not in full flower.
Pterygodium alatum (f).
Disperis villosa (l, f).
Hesperantha sp. (o).
Babiana plicata (o). End of flowering period.
Satyrium bicorne (o).
Hypoxis serrata (o).
Romulea chloroleuca (o).
Lachenalia unifolia (r).
Gladiolus gracilis (r).
Disperis circumflexa (r).

Ridge only.

Romulea hirsuta (a).
Baeometra collumellaris (f).
Galaxia ovata (o).
Ornithogalum tenellum (o).
Aristea cyanea (o).
Galaxia graminea (r).

Northern slopes of valley A.

Hypoxis stellata (f).

Southern slopes of valley A.

Babiana stricta (f).

DICOTYLEDONS.

Valley slopes and ridge.

Dimorphotheca pluvialis (f).
Drosera cistiflora (f).
Diascia sp. (f).
Cenia turbinata (o).
Oxalis cernua (o).
Tripteris clandestina (o).
Zantedeschia aethiopica (o).
Oxalis variabilis (o).
Anagallis arvensis (o).
Nemesia barbata (o).
Nemesia parviflora (o).
Zaluzianskya divaricata (o).
Oxalis sericea (o).
Oxalis compressa (o).
Silene Burchellii (o).
Cerastium capense (o).
Heliophila diffusa (o).
Adenogramma galioides (o).
Cyphia volubilis (r).
Microloma lineare (r).

Northern slopes of valley A.

Scabiosa columbaria (f).

Southern slopes of valley A.

Ursinia anthemoides (f). This plant was also found in small numbers on other parts of the area.

Gazania pinnata (o).

With regard to the vertical range of these plants, the majority gradua diminished in numbers towards the top of the area. There were a f exceptions to this general rule. *Hypoxis serrata* was present on the hig slopes only. *Oxalis cernua*, which was present on the lower slo of the area, was replaced towards the top by the closely related spec *Oxalis sericea*. The orchids, with the exception of *Pterygodium catholicu* were all confined to the lower slopes.

Towards the end of October a further visit was paid, and most of the plants that had been noted in September were found to have finished flowering. Other plants had taken their place, the most conspicuous of these being *Moraea pavonia* var. *lutea*. This plant was abundant on the lower slopes of the burnt area, and the tall stems tipped with comparatively small yellow flowers provided the dominant note in the vegetation. On a more detailed survey of the area it was found that a large number of grasses were in flower, and these together with *Moraea pavonia* may be said to characterise the late spring period. The following list of grasses was made :—

Vulpia bromoides (a).
Lasiochloa ciliaris (a).
Aira caryophyllea (o).
Briza major (a).
Melica racemosa (f).
Ehrharta calycina (f).
Festuca scabra (f).
Andropogon hirtus (f).
Bromus molliformis (l, f).
Briza minor (o).
Ehrharta erecta (o).
Lolium rigidum (o).
Avena barbata (o).
Brizopyrum capense (o).
Bromus unioloides (o).
Hordeum murinum (o).
Aristida angustata (r).

These grasses were widely distributed over the lower slopes of the whole area.

In addition to the grasses, the following plants were noted as being in flower :—

Water-course of valley A.

Lobelia Erinus (f).
Ranunculus pubescens (f).
Ranunculus muricatus (f).
Caucalis africana (f).

Valley slopes and ridge.

Moraea pavonia var. lutea (a).
Trifolium angustifolium (a).
Rhus lucida (a).

Passerina sp. (f).
Psoralea decumbens (f).
Leyssera gnaphaloides (f).
Felicia tenella (f).
Sebaea aurea (white variety) (f).
Pelargonium tabulare (f).
Medicago denticulata (l, f).
Trifolium agrarium (l, f).
Trifolium procumbens (l, f).
Trifolium glomeratum (l, f).
Geranium dissectum (o).
Chrysocoma coma-aurea (o).
Sebaea exacoides (o).
Pelargonium grossularoides (o).
Pelargonium myrrhifolium (o).
Wahlenbergia capensis (o).
Prismatocarpus sessilis (o).
Lessertia tomentosa (o).
Hibiscus aethiopicus (o).
Gorteria personata (o).
Euphorbia genistoides (o).
Fumaria muralis (r).
Pelargonium lobatum (r).
Disa micrantha (r).

Northern slopes of valley A.

Cyphia Phyteuma (f).

Southern slopes of valley A.

Aster fruticosa (l, a).
Solanum sodomaeum (o).

The following were seen coming into flower, but were not fully out :—

Micranthus plantagineus (f).
Cyanella capensis (f).
Psoralea hirta (l, f).
Micranthus fistulosus (o).

As the above list indicates, there were a large number of plants in flower at this time, but the general effect was not as showy as that of the previous month. The differences between the northern and southern slopes of the valleys were less marked than before, and it is noteworthy that at this time

of year the sun's rays fall much more uniformly on the two slopes than during the winter months.

The whole area showed a deficiency in annuals, and certain of these had clearly been introduced by cattle since the fire. Amongst these were noted *Trifolium agrarium*, *Trifolium procumbens*, *Trifolium glomeratum*, and *Medicago denticulata*, which were found associated with animal manure.

The foregoing concludes the observations made during the year immediately following the fire. In 1920 the first visit took place on the 4th April. The earlier months of this year had been very dry, and the hillside presented a very barren appearance. On this occasion the characteristic feature was the bright green of the bushes of *Rhus lucida*, this shrub having grown very actively during the winter months of the previous year. The average height of the bushes was about three feet. The ground in between the bushes was occupied by a large number of smaller plants of a grey-green colour. A careful examination was made, and a large number of them were found to be seedlings. The following list of seedlings was made :—

Elytropappus Rhinocerotis (a).
† Athanasia trifurcata (l, a).
Psoralea hirta (l, a).
Borbonia cordata (l, a).
Arthrosolen laxus (f).
† Anthospermum ciliare (f).
Psoralea uncinata (l, f).
† Peucedanum galbanum (l, f).
Erica viridi-purpurea (l, f).
Mesembryanthemum scabrum (o).
Cliffortia ruscifolia (o).
† Cliffortia polygonifolia (o).
Conyza ambigua (o). Chiefly growing in bushes of *Rhus lucida*.
† Aster fruticosa (o).
Aspalathus spinosa (o).
Aspalathus sp. (possibly A. thymifolia), (o).
Senecio rigida (o). Mostly confined to the damper parts of the area.
Senecio pubigerus (o). Chiefly growing in bushes of *Rhus lucida*.
Senecio Burchellii (o). ,, ,, ,,
Euryops abrotanifolius (o).
Passerina sp. (o).
Osteospermum moniliferum (o).

Stoebe alopecuroides (o).
† Salvia africana (r).
† Olea verrucosa (r).
Hakea suavolens (o). Very local.

The outstanding feature is the large number of representatives of the families Compositae and Leguminosae (fig. 4). It is illuminating to compare this list with the following, which contains the names of all the shrubs which had rejuvenated from underground stocks :—

Rhus lucida (a).
Asparagus capensis (f).
Rhus angustifolia (l, f).
Myrsine africana (l, f).
Montinia acris (l, f).
Rhus glauca (o).
Rhus mucronata (o).
Rhus tomentosa (o).
Euclea racemosa (o).
Royena glabra (o).
† Olea verrucosa (o).
Hermannia cuneifolia (o).
† Salvia africana (o).
Polygonum atraphaxoides (o)
† Athanasia trifurcata (o).
Leucadendron adscendens (o
† Cliffortia polygonifolia (o).
† Anthospermum ciliare (o).
Leonotis Leonurus (o).
Rhus rosmarinifolia (r).
Euclea tomentosa (r).
† Aster fruticosa (r).
† Peucedanum galbanum (r).
Cluytia pulchella (r).

(† Common to both lists.)

It will be noted that only seven plants are common to both lists, and, with the exception of a few specimens of *Athanasia trifurcata*, the two families so conspicuous in the seedling list are absent. On the other hand, two families which did not appear in the seedling list are an outstanding feature of this list, viz., Anacardiaceae and Ebenaceae.

The distribution of the seedlings is of interest. Certain of the Leguminosae, viz. *Borbonia cordata*, *Psoralea hirta*, and *Psoralea uncinata*, were

very local in their distribution and formed more or less isolated patches all over the area. It was obvious that these seedlings were all growing close to the spot that had borne the parent plant (or plants), (fig. 5). Another example of this localised distribution of seedlings was found in *Hakea suavolens*. In this case a single, large shrub near the top of the area had been burnt, but owing to its very woody nature it could be recognised. All round the burnt plant was a host of seedlings, and it called to mind a note made by Dr. Harvey in Australia (2) that certain of the Proteaceae native to that country only shed their seeds after prolonged basking in the sun, or after bush fires. *Hakea* is one of the genera mentioned in this connection. The seeds of members of the Compositae on the area (with the exception of *Osteospermum moniliferum*) are all wind scattered, and consequently their distribution was much more general. In point of numbers the plants of *Elytropappus Rhinocerotis* were far in advance of any others, and, with the exception of the northern slopes of the valleys, they were evenly distributed all over the area. This suggests that, as in the case of the Leguminosae, the seeds had withstood the fire and had not been introduced from plants growing in the adjoining unburnt part. Had this been the case, one would have expected to find the numbers of plants at the margin in excess of those near the centre.

The northern and southern slopes of the valleys showed a somewhat striking difference in the bushes which grew on them. The southern slopes were the more sparsely populated, and the chief bushes were *Rhus lucida*, *Elytropappus Rhinocerotis*, *Athanasia trifurcata*, and *Borbonia cordata*. The northern slopes differed from the southern in the diminution in numbers of *Elytropappus Rhinocerotis* and *Athanasia trifurcata*, and the presence of *Myrsine africana*, *Anthospermum ciliare*, *Rhus angustifolia*, *Stoebe alopecuroides*, and *Royena glabra*.

Asparagus capensis, the young shoots of which in the previous year had been such a feature of the landscape, was most inconspicuous. After a careful survey of the area it was clear that the number of plants was about the same as in 1919, but this year no young shoots had appeared before the winter rains, and the old dull-green shoots were easily overlooked. Another noteworthy feature was the absence of flowers in *Haemanthus coccineus*. On the other hand, *Andropogon hirtus* and *Hibiscus aethiopicus* were in full flower, as in the previous year. A plant that had either been absent or overlooked in 1919 was *Linum thesioides*, which was rather sparsely distributed on the southern slopes of valley A.

The area was visited once more in June, but there was little to record. The early months of 1920 were remarkably dry, and the whole vegetative period was somewhat later than usual over the whole Peninsula. The same plants were found as in 1919 (with the exception of the

seedlings already mentioned), and the only additions to the previous lists were :—

Eriospermum lanceifolium (o).
Lobostemon fruticosus (o).
* Eragrostis brizoides (r).
* Disa tenuis (r).
* Chenopodium ambrosioides (r).
Watsonia rosea (r).
Cotyledon grandiflora (r).

The winter rains this year were exceptionally heavy, and at one point on the southern slope of valley A there was a small landslide (fig. 6) which caused a large amount of debris to be washed down the water-course, altering this considerably (fig. 7). In several places a deep channel was cut by the rush of mud and stones.

The spring flora, though in composition the same, was by no means as rich as in the previous year, and as elsewhere on the Peninsula the season was considered a good one, one is forced to conclude that the previous year's display was an effect of the fire.

In October records were made of a few plants that had not been noted the previous year, viz. :—

Indigofera incana (f).
Gnaphalium parvulum (f).
Lessertia pulchella (o).
Silene anglica (o).
Lessertia excisa (o).
Hypochoeris glabra (o).
Carduus pycnocephalus (o).
Avenastrum sp. (o).
Aizoon sarmentosum (o).
Hermannia prismatocarpus (o).
Polygala bracteolata (r).
Urospermum picroides (r).
Pelargonium hirsutum (r).

During the winter months several water-holes for cattle were dug on the ridge between valleys A and B. In October these holes were nearly dry, and the plants growing in them were interesting in that they were totally distinct from any growing elsewhere on the area. The following were seen :—

Cyperus tenellus.
Crassula brevifolia.

Juncus bufonius.
Small grass. Not in flower; possibly
Agrostis lachnantha.

This year a visit was paid in November. The only record of note was the abundance of *Ornithogalum pilosum*, a plant which until recently had been considered rare on the Peninsula.

In March 1921, a little over two years after the fire, a few plants of *Antholyza lucidor* were in flower at the top of the patch, but as the particular region in which the plants were found had not been visited in any previous March, there were no records of the behaviour of this species. *Senecio pubigerus*, which in 1920 had been confined to the shelter of the bushes, had spread widely over the slope of valley A and elsewhere was quite a common plant apart from the larger bushes. One young silver tree (*Leucadendron argenteum*) was seen near the top of the patch.

During the late winter and spring months rapid growth took place over the whole area, and on the northern slopes of the valleys a number of seedlings of *Erica viridi-purpurea* were noted coming into flower for the first time. On the slopes between valleys B and C a single plant of *Protea grandiflora* was noted. The shoots of this had obviously come up from the underground stock. On the ridge between valleys A and B a group of young plants of *Relhania ericoides* and several young plants of *Selago ramosissima* were seen.

The spring flowers of this year showed a still further reduction in number and quality, with the exception of *Babiana stricta*. This species was exceptional in that no obvious effects of the fire manifested themselves in this or in previous years. This may be due to the fact that the corms are unusually deeply seated.

General Conclusions.

It is clear that in certain plants rapid growth was induced after the fire, while in others the vegetative parts were wholly killed and the plants had to rely upon their seeds for the continuance of life.

The exact way in which fire influences the plant is not clear. Several factors may be at work. Possibly the heat during the fire acts directly on the underground organs, mobilising all the forces of the plant. It is a well-known fact that by employing high temperatures the normal time of flowering in certain plants may be anticipated (4). In the case of those plants, notably *Asparagus capensis*, in which the flowering period was obviously induced at a somewhat earlier time than usual, it is probable that the heat acted directly on the underground organs. It is also likely that the direct action of heat was responsible for the production of the large number of

flowers of *Haemanthus coccineus*, though in this case the actual time of flowering was the normal one.

In those cases, however, in which the time of flowering was normal, but the number and size of the flowering shoots were greater than usual, it is probable that additional factors were involved. As an example of this type of behaviour we may take the spring Monocotyledons, which have underground storage organs, and whose leaves appear soon after the early winter rains. Owing to the removal of all the bushes their leaves were well supplied with light, and hence we may suppose that their photosynthetic activity was greater than would have been the case had they been overshadowed by bushes. Another factor which may have operated to some extent was the increased warmth of the soil, due to the exposure of the ground to the direct rays of the sun. The winter, however, in the Cape Peninsula is very mild, and it seems likely that light rather than heat is the predominating factor.

The following suggestions are put forward as to the ways in which fire may influence the soil and thus benefit the plants :—

1. The physical effects of fire on the upper layers of soil may be such that increased aeration is brought about.
2. Soil protozoa, which are known to have a retarding influence on the growth of plants, are very sensitive to high temperatures (1), and the number of these organisms may be considerably reduced.
3. The ash from the burnt plants may have a certain manurial value, thus enriching the soil chemically.

No definite example was met with of a species which had been eradicated by burning, though there is no direct evidence to show that such a species did not exist, since the area had not been surveyed before the fire. The evidence that one relies upon in drawing the conclusion is the composition of the unburnt surroundings. This, however, is far from satisfactory, owing to various factors such as cultivation, etc.

One fact is clear, and that is that burning favours the spread of the " Rhenoster Bush " (*Elytropappus Rhinocerotis*). The type of vegetation now established on the site of the fire is similar to that termed by Marloth " Rhenosterveld " (fig. 6), and the foregoing lends support to his view that this formation is an artificial one (3).

Another result of a bush fire on a slope such as this is obvious. The soil is laid bare, and cases of erosion—some slight, some marked—were common all over the area.

While making the observations just recorded, several interesting facts were noted, which, though they have no direct relation to the subject under discussion, are nevertheless striking and may be mentioned here.

The Peninsula flora is characterised by the presence of certain families which are typical of the south-western districts, but are either lacking or scarce in South Africa beyond these limits. The area under discussion is singularly deficient in a number of these families. Bruniaceae and Penaeaceae are entirely absent, the family Restiaceae is represented by a single specimen, and members of Proteaceae, Rutaceae, and Ericaceae are only occasionally seen.

It has been suggested, especially in the case of the Proteaceae, that bush fires have been largely instrumental in eradicating large numbers of species from these slopes. This suggestion, however, does not explain why it is that most of the families mentioned above are well represented on the slopes below Lion's Head, which slopes in their vegetation incline to the true " Macchia " type. It is significant that the soil here is derived from granite (fig. 1), and as bush fires have occurred in plenty, it seems reasonable to conclude that the soil may be the determining factor in the case.

The problem needs further investigation, but certain facts such as the dominance of *Blaeria ericoides* at certain spots on the granite soil, and the scarcity of the family Ericaceae on similar positions on the slate, lead one to the conclusion that the soil in this particular instance has a profound influence on the vegetation.

My thanks are due to Professor Thoday for his kindness in taking the photographs which illustrate this paper, and for the many helpful criticisms which he has offered from time to time during the progress of the work.

Summary.

1. The bush fire, the effects of which are recorded, broke out on the 5th February 1919 and burned for two days, killing all the aerial parts of plants on the slope.

2. About three weeks later considerable growth had taken place in *Asparagus capensis* and *Andropogon hirtus*. Shortly afterwards *Haemanthus coccineus* and a few other less notable plants were in flower. Various species of *Rhus* were putting up shoots.

3. The early winter and spring flowering periods were characterised by an abundance of vigorous flowering shoots. These appeared at the usual time. In the majority of cases these plants possess underground storage organs. Progressive decrease in numbers and vigour of plants flowering during these periods was noted in 1920 and 1921. Suggestions are made to account for the phenomenon.

4. Numerous seedlings came up during the winter of 1919, but in general these were not identified till the next year.

5. The northern, shaded slopes of the valleys showed a conspicuously different plant population from the southern exposed slopes during the winter months. In the summer months the contrast was not as sharply marked. This is attributed largely to the fact that in winter the sun shines on the northern slopes for a short period only of the day, while the southern slopes get most of the available sunlight.

6. During 1920 the shrubs were divided into two classes: (*a*) those where the underground parts had survived the fire and from which new shoots arose, and (*b*) those which were killed by the fire and which reproduced themselves by seed. The Rhenoster bush falls in class (*b*), and is clearly favoured by burning.

7. The removal of the vegetation by the fire helped the process of soil erosion. This process was also aided by man and cattle. Several small washaways occurred on the area subsequent to the fire.

8. The area is shown to be deficient in several typical south-western families, but to what extent this may be attributed to the influence of repeated fires is not clear, and the view is brought forward that soil may be the determining factor in this case.

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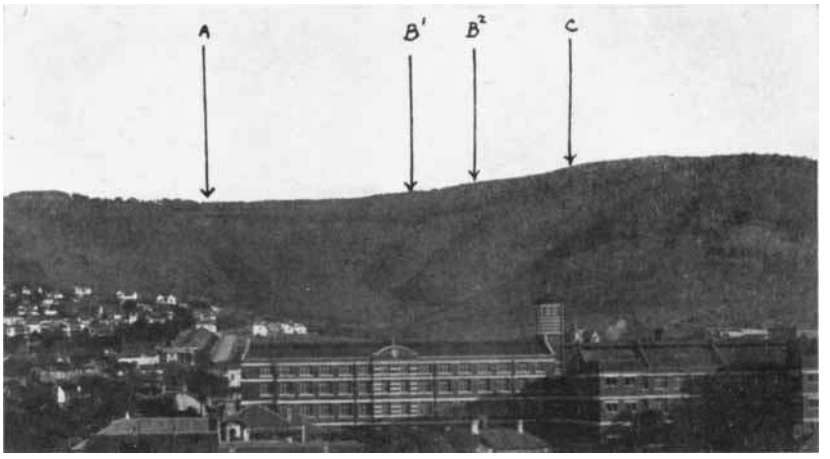

FIG. 2.—Photograph of burnt area on Signal Hill, taken from the roof of the Natural Science Building, University of Cape Town, two and a half years after the fire.

FIG. 3.—Southern part of the burnt area, looking up the hill. The foreground is covered with bushes of *Acacia horrida*, and was not touched by the fire. The fenced-in region may be distinguished from the open hillside by the presence of numerous old inflorescences of *Andropogon hirtus*.

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FIG. 4.—Detailed view of some of the seedlings which have grown since the fire. In the foreground is a patch of *Borbonia cordata* and a few plants of *Cliffortia ruscifolia*. The plants in the background are mainly *Elytropappus Rhinocerotis*, the two larger shrubs being *Rhus lucida*.

FIG. 5.—A "school" of young plants of *Psoralea hirta*. The darker bushes are *Rhus lucida*.

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FIG. 6.—Small landslide on the southern slope of valley A. Photograph taken from the northern slope of the same valley.

FIG. 7.—Looking up valley A. The water-course has been much cut up by the rush of mud and stones from the landslide depicted in fig. 6.

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