READING THE SIGNS

INAUGURAL ADDRESS

BY

S. C. SEAGRIEF

RHODES UNIVERSITY

GRAHAMSTOWN

1976

"READING THE SIGNS"

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INTRODUCTION

The title of my address tonight - "Reading the Signs" - has arisen out of a lasting interest in observing Nature which was acquired at an early age and which has largely determined the direction of my research in the fields of ecology, pollen analysis and marine algology.

Plants are very accurate indicators of the climatic, edaphic and biotic factors which affect them. Their presence in a given locality means that all the conditions necessary for their survival have been met. Moreover, through the normal processes of growth, reproduction and succession, distinctive plant communities will be developed and these will be in dynamic equilibrium with all the factors of the environment. Should changes occur to upset the complex balance of these factors their signs will be reflected by changes in the species composition and the structure of the plant communities themselves.

It is my purpose to review the evidence of the nature and direction of some of these changes as they affect the plants of the land and, also, of the sea.

EVIDENCE FROM THE PAST

Climatic factors have always had a major influence on the distribution of plant communities over the landscape. Any interpretation of climatic trends must be viewed against the background of the geological time scale.

The following is a Geological Time Scale:

GEOLOGICAL TIME SCALE

ERA	PERIOD	PLANT LIFE AND MAN	M. YE
	QUATERNARY	DOMINANCE OF MAN ANCESTRAL MAN	1
CENOZOIC			
	TERTIARY		6
	CRETACEOUS	DOMINANCE OF ANGIOSPERMS	13
MESOZOIC	JURASSIC		19
	TRIASSIC	CYCADS ?ANGIOSPERMS	22
	PERMIAN	GLOSSOPTERIS	28
	CARBONIFEROUS	SEED FERNS CONIFERS	34
PALAEOZOIC	DEVONIAN	SPHENOPSIDS FERNS LYCOPSIDS CORDAITALES PSILOPSIDS	39
	SILURIAN	FIRST LAND PLANTS	44
	ORDOVICIAN		50
	CAMBRIAN	ABUNDANT MARINE LIFE	57
PROTEROZOIC			
		ALGAL STRUCTURES	270
ARCHAEOZOIC	APPROX AGE OF EARTH		4600-500

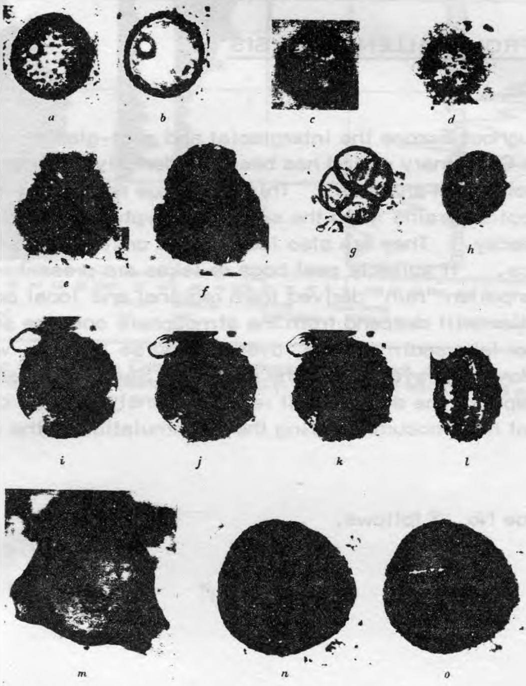
In Permo-carboniferous times a vast land mass, known as Gondwanaland occurred in the southern hemisphere. It consisted of South America, Antarctica, Africa, India, Australia and New Zealand all fused into one and separated from the northern hemisphere by the Tethys Sea.

About the time the Permian Ice Age took place a very distinctive flora, the Glossopteris flora, had appeared and its presence is indicated by fossils in all parts of the southern hemisphere.

Much later in geological time the angiosperms evolved and, by the end of the Cretaceous and before the land masses finally separated, had ousted more primitive floras. The presence of such distinctive families as the Proteaceae, Restionaceae and Rutaceae in South America, South Africa and Australia indicate that they had originated before the separation of the continents took place.

Mountain building and major geological upheavals were largely over in South Africa by the time the Tertiary period began. Thus for the past 65 million years the land surface of South Africa has been comparatively stable, except that the present shore line has been modified on several occasions by changes in sea level with depositions of limestone laid down under marine conditions in the Malmesbury, Bredasdorp, Mossel Bay and Uitenhage divisions. South Africa also escaped the four Quaternary glaciations that drastically affected the vegetation of the northern hemisphere in the last million years. The last of these glacial periods only receded from Europe and North America 15,000 years ago. Instead, South Africa's vegetation has been greatly affected by alternating pluvial and dry periods which are thought to correspond with the glacial and interglacial periods of Europe. Thus rainy periods would allow the extension over the landscape of mesic elements while during dry periods, the reverse trend would happen and xeric elements such as the karoid flora would extend into the former territory of the mesic elements. The mountain ranges have always been a reservoir and refuge for the mesic elements and, to this day, are of great botanical interest because of the relic species that have survived on them. So, although there have been great migrations of the South African floras according to changing climatic regimes there has never been the drastic elimination of floral elements that resulted from the ice age in Europe. This no doubt accounts for the present day richness of the South African flora and the great diversity of the vegetation types.

PLATE XXII



Pollen grains from Late-glacial deposits at Nazeing (Lea Valley), Essex: *a, b*, *Campanula* cf. *rapunculoides* (1 gr., 2 planes of focus); *c*, *Silene* type (1 gr.); *d*, *Sonchus* type (1 gr.); *e, f*, *Armeria maritima*, type A (1 gr., 2 planes of focus); *g*, *Typha latifolia* (tetrad of 4 gr.); *h*, *Centaurea* cf. *scabiosa* (1 gr.); *i–l*, *Valeriana officinalis* (1 gr., 4 planes of focus); *m*, *Epilobium* (1 gr.); *n, o*, *Succisa pratensis* (1 gr., 2 planes of focus). (Magnifications of *a–h*, × 740; *i–m*, × 820; *n, o*, × 660.)

EVIDENCE FROM POLLEN ANALYSIS

Throughout Europe the interglacial and post-glacial vegetational history of the Quaternary period has been wonderfully documented through the medium of pollen analysis. This technique relies on the fact that the walls of pollen grains (and the spores of cryptogams) are extremely resistant to decay. They are also identifiable on their morphological characteristics. If suitable peat bogs or lakes are present in the landscape the pollen "rain" derived from regional and local components of the vegetation will descend from the atmosphere onto the surface of the peat bog or lake sediment and, over the course of time, will become incorporated layer by layer within the deposit. Samples taken at intervals through the depth of the deposit will reveal on analysis any changes in the vegetation that have occurred during the accumulation of the deposit.

Slide No. 3 follows.

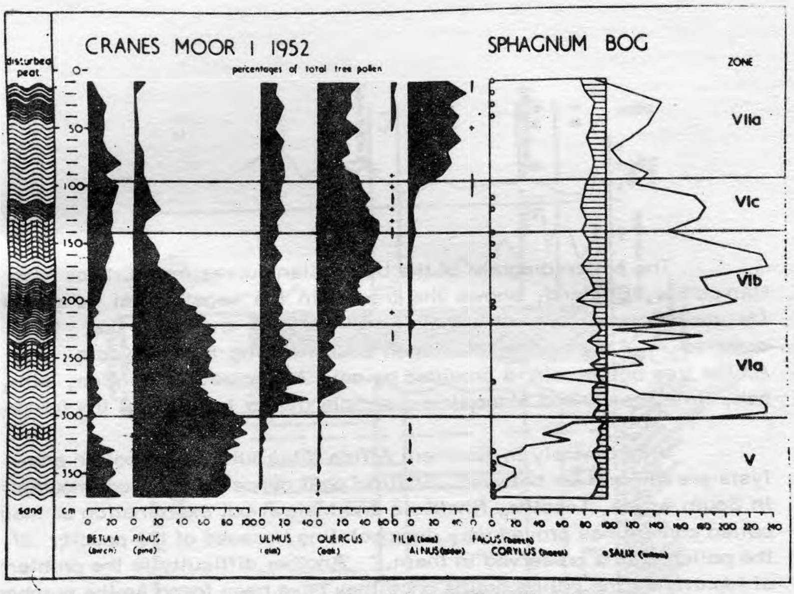


Fig. 2. Tree pollen diagram from Cranes Moor Sphagnum Bog. Block diagram on right shows tree pollen (blank) and non-tree pollen (horizontal shading) as percentages of total dry-land pollen.

The pollen diagram of the tree pollen curves from Cranes Moor, Hampshire, England, shows the trends in the vegetational changes (following closely on the heels of the climatic changes) that have occurred in a deposit which began accumulating 8,000 years ago. As the tree pollen rain is provided by only 7 species, birch, pine, elm, oak, lime, beech and alder, it is a simple matter to interpret the trends.

Unfortunately in Southern Africa sites suitable for pollen analysis are few and far between. Shallow peat deposits occur on mountains in South Africa, Lesotho, Rhodesia and Malawi but examination of their pollen content has proved very disappointing because of the paucity of the pollen grains preserved in them. Another difficulty is the problem of identifying the pollen grains once they have been found as the number of possible species involved is so large. Professor van Zinderen Bakker and Dr. Coetzee of the University of the Orange Free State in Bloemfontein have built up a type collection of the pollen grains of more than 6 000 species, which is about one-third of the total number of flowering plants of South Africa. Professor van Zinderen Bakker has published pollen diagrams from the Florisbad deposit, in the Free State, of estimated age between 17 500 and 26 500 years, and also a long pollen sequence from the Cherangani Hills in Kenya covering the past 15 000 years. He (1963) has attempted to correlate the data from these sites with the chronology from Europe.

Slide No. 4 follows.

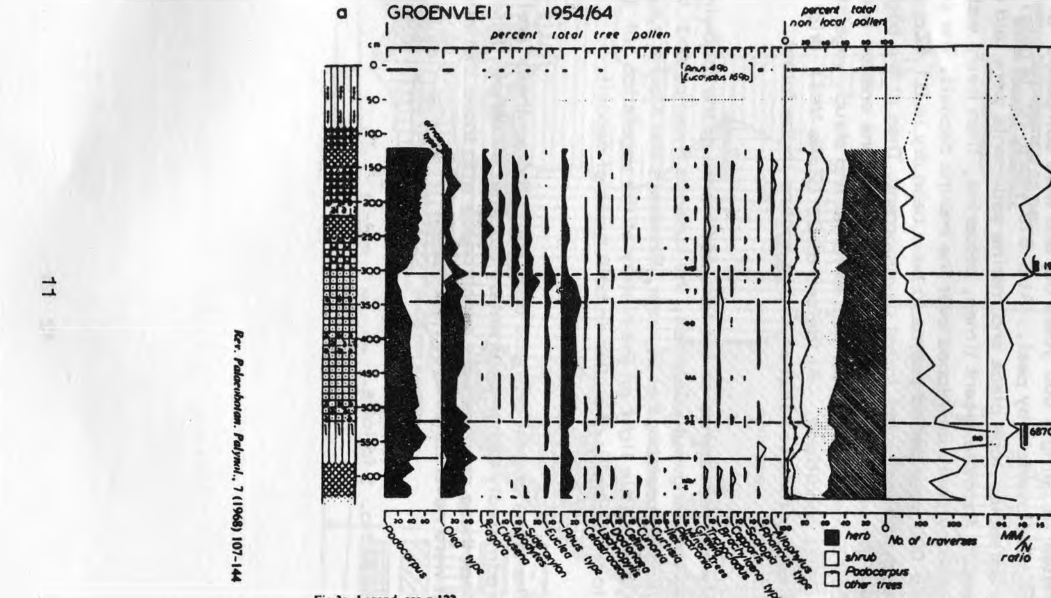


Fig.3a. Legend, see p.122.

More recently Dr. Martin (1967), who was formerly on the Botany Staff of Rhodes University, has published the results of his pollen analytic investigations of the fen deposits at Groenvlei, one of the Wilderness lakes. He, too, has attempted to correlate his findings with the European chronological time scale. The oldest sediments have been estimated as being 8 000 years old and were composed of soft muds which were overlain by peat. At 6 870 years (C 14 date) a marine transgression took place and marine sediments were laid down over the peat. In more recent times, estuarine, then fresh water muds followed by peats developed over the marine deposit. The climate during the 8 000 year period seems to have been dry in B1 (Zone VI) with dry heath and restricted forest development. Then at the beginning of B2 (Zone VII) a short period of moister conditions ensued but it is not until C1 (Zone VIII) is reached that forest and shrub vegetation spread in moist conditions. At the end of C2 (Zone VIII) drier conditions appear to have returned with a decline in the forest.

My own researches on the lake sediments at the following sites in Zambia, the Bangweulu Swamps, the Lukanga Swamps and Lake Tanzania, and on peat bogs at Inyanga, Rhodesia and Mount Mlanje, in Malawi, shed little light on the history of the vegetation of those parts due to the scarcity of pollen in both types of deposit.

The signs of past climatic changes in the southern part of Africa are admittedly rather fragmentary but what evidence there is suggests that these changes were synchronous with those that affected Europe but were never as severe.

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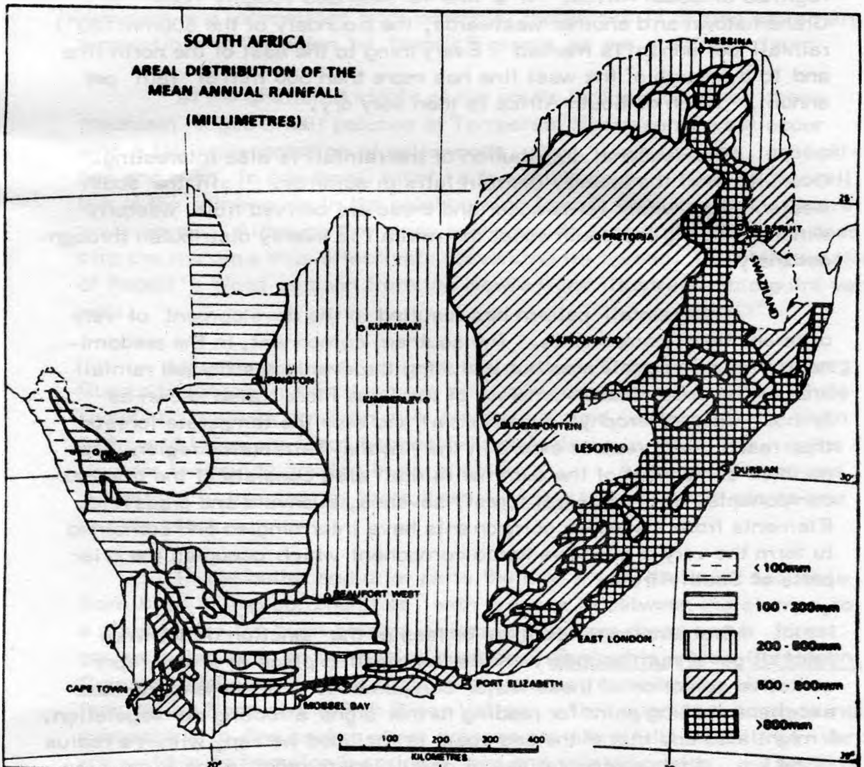
RAINFALL


SOUTH AFRICA
AREAL DISTRIBUTION OF THE MEAN ANNUAL RAINFALL
(MILLIMETRES)
MESSINA
PRETORIA
NELSPRUIT
SWAZILAND
KURUMAN
UPINGTON
KIMBERLEY
KROONSTAD
BLOEMFONTEIN
LESOTHO
DURBAN
BEAUFORT WEST
EAST LONDON
PORT ELIZABETH
CAPE TOWN
MOSSEL BAY
< 100mm
100 - 200mm
200 - 500mm
500 - 800mm
>800mm
0 100 200 300 400
KILOMETRES

RAINFALL

It is instructive at this stage to examine the present rainfall regimes of South Africa. If a line is extended roughly north of Grahamstown and another westwards, the boundary of the 500mm (20") rainfall per annum is marked Everything to the east of the north line and to the south of the west line has more than 500 mm of rain per annum. Much of South Africa is then very dry.

The seasonal distribution of the rainfall is also interesting. Over much of the country the rain falls in summer. In the south western Cape winter rains occur and these are derived from westerly winds. Along the south coast the rainfall is evenly distributed throughout the year.

This rainfall pattern has resulted in the development of very different floral components. The southern component, in the predominantly winter rainfall area but including the evenly distributed rainfall area of the south coast, consists of the Cape Flora (also known as fynbos, Cape sclerophyll or macchia) and also the temperate forests that reach their greatest extent in the Knysna-Tsitsikama region. The northern component of the summer rainfall area consists of the tropical components, of the tropical forest, savanna, bushveld and grassveld. Elements from these two components have intermingled and combined to form the very distinctive karoo component which occupies the drier parts of South Africa.

Grahamstown lies more or less at the junction of 500 mm rainfall per annum boundary and is the meeting place of a very representative selection of these major components. It is therefore an excellent starting point for reading further signs affecting our vegetation. I might also add that if the sea coast is included we can, within a radius of 64 km., find representatives of nearly every order in the Plant Kingdom, which is something I have never come across anywhere else.

LOCAL COMPONENTS OF VEGETATION

On the ridges and the moister south-facing slopes of the Witteberg Quartzite ranges elements of the Cape flora or fynbos thrive. Here one can find representatives of typical Cape genera such as Protea, Leucospermum, Leucodendron, Restio, Berzelia, many legumes, composites, buchus (Agathosma) and a marvellous array of monocotyledons belonging to the Liliaceae, Iridaceae and Amaryllidaceae. A characteristic indicator of the Witteberg Quartzite is Oldenburgia arbuscula which is confined to outcrops of this stratum and is limited in distribution to the Eastern Cape Mountains. The fynbos is fire-resistant and regenerates from perennial rootstocks. It is also extremely susceptible to invasion by "exotic" plants as we shall see later.

In the sheltered kloofs of the south-facing slopes of these mountain ranges small patches of Temperate Evergreen Forest occur with a fair representation of yellowoods, Olea, white pears, assegaibos and even, in one small kloof, a few stinkwoods. One might well ask if the stinkwoods in the neighbouring forests were cut out in the early days? Although fire never burns inside temperate forests it does clip the margins thus effectively preventing its spread. The static outline of Rabbit's Wood as seen from the Kowie Road illustrates this point very well.

Mixed grassveld occurs on the northern slopes of the Witteberg Quartzite ranges in the Highlands and Jameson Reservoir areas. While sweetveld grasses occur on drier plateaus around Grahamstown. Both grassveld types are burnt frequently, particularly in the winter months in order to provide grazing in early spring. Also both types are vulnerable to invasion by thorn trees (Acacia karoo) karoid plants and prickly pears.

In the hotter and drier parts there is a very distinct sequence from bush clump communities, with grasses in between the clumps, to a stage where the bush clumps coalesce and form dense scrub forest communities with an increasing number of Euphorbia, Aloe, Cotyledon, Crassula and other genera of succulent plants, culminating in the fascinating flora of the Fish River Valley. This succulent scrub is not susceptible to fire except where grasses are plentiful. But it is very susceptible to invasion by prickly pear and jointed cactus. Much of the plateau between Grahamstown and Kowie was formerly covered with scrub forest but clearance for pineapple fields has decreased its area considerably.

To the west of Grahamstown one meets the karoo vegetation type with a mixture of low growing bushes of Pentzia, Chrysocoma, Felicia (to mention but a few genera) and mesems and other succulents intermingled with grasses of various kinds. Fires are a rare sight in karoid regions as the spacing of the low bushes is such that it is difficult to get a real blaze going.

MAN-INDUCED CHANGES

Having illustrated the representative South African veld types that occur within the vicinity of Grahamstown I will now consider the various signs of man-induced activities which are affecting the quality of our vegetation. Until the arrival of the European in South Africa the climate, particularly the rainfall, must have been the chief moderating factor in the development of the vegetation. It seems unlikely that the indigenous inhabitants had hitherto had much effect.

Acocks, in a remarkable monograph, first published in 1953 and reprinted in 1975, has attempted to reconstruct what the vegetation must have looked like in A.D. 1400 i.e. before man's activities had really got going. Starting from the west coast we find the succulent karoo and the karoo, whose boundary lies roughly from Kimberley, De Aar, Murraysberg to Graaff-Reinet. Then travelling eastwards we encounter the sweet grassveld, the mixed grassveld and the sour grassveld, which merge into the bushveld and other vegetation types in the north and east. In the south the fynbos and the temperate forest and forest scrub occur.

By 1950 the impact of man's activities can be clearly seen. There are many changes in the distribution of the vegetation types but the major one concerns the karoo. The karoo has invaded the sweet grassveld to an incredible extent and has reached Bloemfontein. The heavy (red) line marks the eastward extension of karoo patches and outliers of karoo species are to be found in Natal and the Transkei. The Earth Resources Technology Satellite (ERTS) in 1973 showed that the karoo has advanced a further 70 km. (44 miles) into the sweetveld since 1950. Acocks reckons that the extension of the karoo into the sweetveld is entirely due to the selective grazing habits of farm animals.

GRAZING

Sheep and cattle are grazers, while goats are basically browsers, though they will eat literally anything. Naturally enough, these animals will eat the palatable species first, and largely ignore the unpalatable species unless they are in dire straits. So there is the inevitable tendency for the unpalatable species to thrive at the expense of the palatable ones and this leads very quickly to veld deterioration if the process is allowed to go on in an unrestricted fashion.

We are so accustomed to the sight of neatly fenced "camps" on farms that it comes as something of a shock to realise that barbed wire was only invented in 1874. Its introduction to this country has had marked effects. Once a farm is fenced into camps it is possible to leave the animals there overnight, instead of returning them to the kraal for the night as was the old custom. It is also possible to leave them in the camps year in and year out with disastrous effects on the vegetation, as it never has time to recover. For many years now farmers and Pasture Research Personnel have been aware of the necessity for devising effective veld management methods to prevent further deterioration of the veld. There is general agreement now that the "camp" system will work if a careful watch is kept on the palatable species. When these have been closely cropped this is the time to remove the animals to another camp and leave the former camp to rest until these species have recovered. The length of the recovery time is dependent on the season of the year, the rainfall distribution and the vegetation type.

Good veld management retains the species composition and the structure of the plant community. Bad veld management reduces the number of species and often alters the structure of the plant community.

The karoo is particularly sensitive to overgrazing as the recovery time is so slow in such a dry area. Not only is the species composition disturbed, the grasses being among the first to be eliminated, but the bare spaces between the remaining plants are vulnerable to the errosive forces of wind and, sometimes, rain.

I am indebted to Mr. T. Daines of the Dohne Pasture Research Station, for providing me with the following contrasting slides of the results of good and bad veld management methods on sweetveld, sourveld and the valley bushveld. Where good veld management of the sweetveld occurs there is an unbroken cover of the grasses and little sign of disturbance.

In the example of bad veld management of the sweetveld two effects can be noted. The first is the invasion of woody plants such as Acacia karoo into the grassveld. The second example illustrates the virtual elimination of grasses with low growing karoo bushes taking their place.

Good veld management of the sourveld is a pleasure to see and there are abundant seeds available for renewing the parent plants. Poor veld management is indicated by the invasion of weeds, such as Senecio retrorsus and Senecio pterophorus, while the grasses are grazed so intensively that seeds are seldom formed.

In the case of the valley bushfeld from Uitenhage, the "good" example shows a dense woody scrub. In the "bad" example grazing by goats has broken down completely the structure of the woody scrub and the spaces between have been occupied by low-growing bushes of various kinds and often with karoo affinities.

Thus good veld management retains the species composition and the structure of the vegetation type, so from the point of view of the botanist this is a good sign. Bad veld management, on the other hand, impoverishes the flora, alters the structural composition of the plant community and allows the bare areas to be subjected to erosion or to the invasion of weeds. Could more farmers be persuaded to fence off and preserve portions of their more interesting vegetation types?

AGRICULTURE

The signs of agricultural activities tend to be overwhelming from the botanist's point of view. Although I do not query for one moment the ever increasing necessity to produce more and more food for more and more people, I would like to make the point that I hope we can find ways of growing crops more intensively instead of using up more and more land for this purpose. To cite one example, if one travels along the Garden Route from Riversdale to Caledon virtually all one sees are wheat fields. Fragments of indigenous vegetation only exist in places too rocky to plough or along the fenced verges of the roads and railway embankments. Fortunately there are the mountains, but even these are not inviolate. This is a matter of serious concern for the botanist as the south west Cape is the home of the Cape Flora (or fynbos) which is one of the richest floras in Africa.

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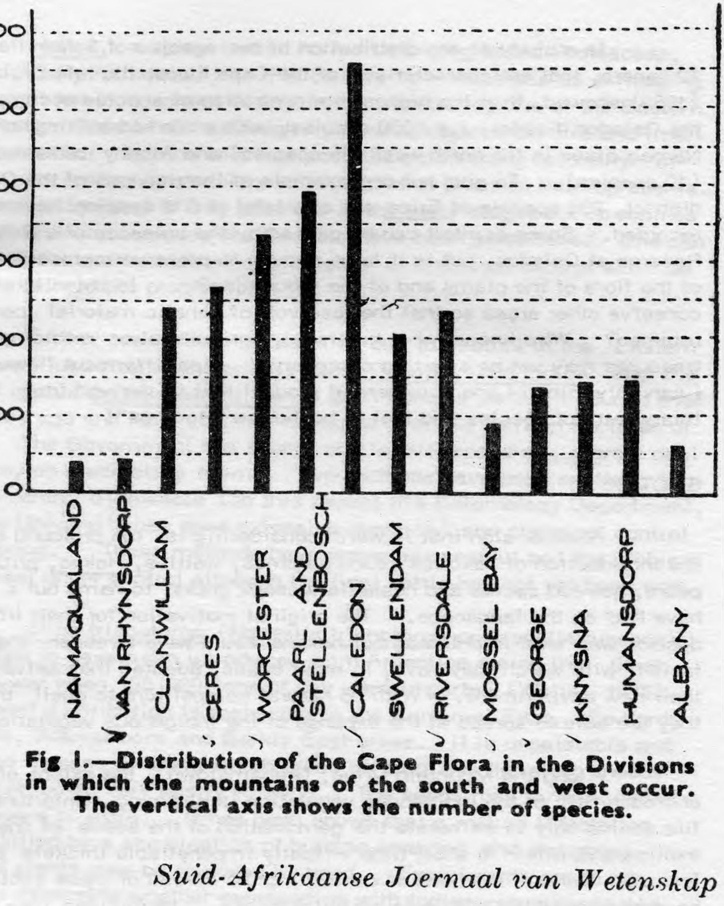

Fig I.—Distribution of the Cape Flora in the Divisions in which the mountains of the south and west occur. The vertical axis shows the number of species.

In a study of the distribution of the species of 3 families and 12 genera, that are characteristic of the Cape Flora, the late Dr. Levyns (1952) showed, that the highest concentration of species occurred in the Caledon district, i.e. 560 species, with a marked trailing off to Namaqualand in the north west (36 species) and Albany in the east (10 species). To give but one example of the richness of the Caledon district, 238 species of Erica out of a total of 612 species have been recorded. Some comfort can be gained by the presence of a Botanic Reserve at Caledon, but is it large enough to preserve representatives of the flora of the plains and of the mountains? Is it too late to conserve other areas so that the reservoir of genetic material can be retained? Who knows what botanical, agricultural or medicinal treasures may yet be awaiting discovery? Apart from cut flowers, I can only think of one commercial product that is derived from all this wealth of species and that is buchu tea "Rooibos"!

EXOTICS

Another sign that is worth considering is the profound effect the introduction of "exotics" such as pines, wattles, Hakea, prickly pears, jointed cactus and nassella tussock grass, to name but a few, have had on the landscape. The original motivation for their introduction was well intentioned but no-one could have foreseen the facility with which they have, in most cases, adapted themselves to their new environment. With no natural competitors to quell them they are able to spread at the expense of the indigenous vegetation.

Along the Mountain Drive, Grahamstown, the extent of the encroachment of the indigenous vegetation is alarming. Unfortunately fire seems only to stimulate the germination of the seeds of these exotics and within a short time virtually impenetrable thickets are formed. Various methods of controlling the spread of these exotics have been tried but with only partial success. Herbicides may be the answer but they are difficult to apply in such crowded conditions.

Unfortunately there are many other areas in this country where the pines and the black wattles are spreading over the landscape and suppressing the indigenous vegetation - chiefly the fynbos and sourveld types. In the Tsitsikama region the pines have spread out from their original plantations to the highest peaks. The black wattles seem to spread particularly vigorously along the water courses and are now to be found far from their point of origin.

Hakea, a spiny-leaved horror belonging to the Proteaceae, was originally introduced into this country from Australia as a hedging plant. It has now spread widely in the moister regions of the Eastern and Western Cape. It has tough fruits which open after fire and liberate the seeds. Anyone who has seen the astonishing fecundity of Hakea can realise what a very serious control problem this represents. Elimination by hand is only possible in the early stages but becomes difficult and arduous once the thickets have been established. One can only hope that some method of biological or chemical control will be found to relieve the problem.

Further examples of infestation due to exotics in the Eastern Cape are illustrated by the prickly pear, Opuntia ficus indica and the jointed cactus Opuntia aurantiaca. Both species were introduced over a century ago and have at times occupied over one million hectares of land. The Government has spent, and is still spending, a great deal of money on eradicating them. Two methods have been applied, biological control by insects (on this aspect the Entomology Department, Rhodes University has done extensive research) and chemical control by spraying. These methods have proved successful and the problem is at least under control although the final battle has not yet been won.

Stipa trichotoma (Nassella trichotoma or nassella tussock) is thought to have been introduced from Argentina during the South African war when 138 000 tons of hay were imported (Wells, 1975). Its present distribution is restricted to the Somerset East, Bedford, Amatola, Sterkstroom and Barkly East areas. It is unpalatable and produces masses of seeds which break off from the flowering heads to be distributed very easily by wind. The seeds may remain viable for 15 years or more. It has been shown that a mature infestation can be killed by a combination of burning,spraying and ploughing. Isolated plants may be removed by hand. Experiments are in progress to determine whether overseeding with indigenous grasses and fertiliser treatments might produce a denser and taller cover than the Stipa, thus shading it out.

Recently on a field trip in the Oudtshoorn district I found a flowering specimen of oleander (Nerium oleander) on an island in the Gouritz River far removed from the source of supply, namely the street-planting in Oudtshoorn. Oleanders are commonly planted along the freeways (viz. the free way west of Port Elizabeth) to cut down the glare of the lights of oncoming traffic as well as providing an attractive sight when in flower. But is oleander to become one of our new pests? As it is highly poisonous to man and his animals its escape into the surrounding countryside could pose a serious problem in the future.

STABILIZATION OF SAND DUNES

The stabilisation of the large areas of sand dunes along the coasts of the Cape Province originally involved the almost exclusive use of wattles, the Rooikrans, Acacia cyclops, the Port Jackson willow, Acacia cyanophylla and Acacia longifolia. Of these species the rooikrans is the easiest to eliminate as it does not coppice after being cut down. Although the wattles have done the job they were intended to do; they have since spread out onto the neighbouring landscape causing grave problems not to mention the formidable fire hazard.

An encouraging sign concerning reclamation of sand dunes is the increasing use of indigenous plants. Experiments in the Sea Vista area, south of Humansdorp, conducted by Mr. Leighton Hulett, and monitored by Dr. Lubke, myself and our students, have illustrated very clearly that if indigenous vegetation is cut, baled and spread out as a layer over the raw sand dunes, the immediate effect is for the movement of the sand to be stopped and in a matter of months seedlings of indigenous plants appear.

The root systems of sand dune colonisers are enormous.

This method of spreading the mowings from neighbouring vegetated areas onto sand dunes has now caught on and, in future, if sand-dunes must be reclaimed, they should be treated in this way and the use of wattles discontinued altogether.

EVIDENCE FROM ESTUARIES AND SALT MARSHES

Along the South African coastline there are many drowned river valleys where estuaries and salt marshes occur. Both ecosystems are particularly susceptible to damage from a variety of causes, and great changes have taken place in recent years wherever they are close to cities. A comparatively new development is the construction of the coastal road. The practice of building earth-fill embankments or causeways across salt marshes with a bridge only over the actual channel is already having a marked effect on the existence of salt marshes in the eastern Cape. When fresh water floods occur the waters are impounded on the upstream side of the embankment due to the restricted outlet and the silt, which would normally be washed out to sea, is deposited on the salt marsh in a suffocating cloak. The daily tidal cycle of flushing by salt water is also restricted by the aperture of the bridge and delays the influx of salt water penetration into the minute and intricate channels of the salt marsh in the upstream portions. The solution to this problem surely lies in the provision of many more drainage conduits in the embankment or even, the more expensive method of spanning the entire estuary by a bridge without embankments. The Kromme River Estuary is the next on the list and we are accumulating evidence of the "before" scene so that direct comparisons can be made with the "after" scene.

As far as I am aware the only estuarine system that is actually increasing in extent is at Sea Vista where canals have been pumped out of the sand on the south side of the Kromme River in order to make a marina. As the canal system is extended, plants and animals from both marine and estuarine habitats are colonising the newly available sites. One of the most interesting findings has been the colonization of the basal parts of the canals over extensive areas by a marine alga, Caulerpa filiformis - which normally grows in turbulent wave-washed areas at the lowest intertidal levels of the eastern province coastline. That an alga could adapt itself to the still waters of a canal system means that turbulence and high oxygen content of the sea water are not necessarily limiting factors for this species. Even red bait is making an appearance which will please the fishermen.

EVIDENCE FROM MARINE ALGAE

Having examined some of the effects of man on the land plants I will now turn my attention to his effect on the marine plants or seaweeds that grow along our coastline, as they are the last remaining resource for economic exploitation. Information on seaweeds is not as readily available as it is for land plants so I will outline briefly some facts about them. In size they range from microscopic unicellular forms to macroscopic multicellular forms. As they are bathed in a nutrient solution they can absorb the substances necessary for growth through any part of the plant body and lack the conducting systems of the roots, stems and leaves of land plants. The larger seaweeds possess a holdfast for attaching themselves to the rocks. They reproduce by spores which germinate immediately as there is no need for a resting stage in the sea - this is in sharp contrast to the higher land plants with their dormant seeds acting as a vital resting stage in a hostile environment.

Because of different proportions in their photosynthetic pigments and resultant food reserves their colour varies and gives the clue to the classification into green, brown and red seaweeds. The blue-green, golden brown and yellow-green groups need not concern us here. The number of species involved is nothing like as great as that of the land flora. In a catalogue of South African marine algae I have listed 110 greens, 79 browns and 331 reds. The species composition of the other groups has not yet been tackled.

Seaweed distribution along the South African coasts is governed by the temperature differences of two great ocean currents. The warm Agulhas current bathes the eastern shores and is deflected southwards by the Agulhas bank, while the very cold Benguela current sweeps up the west coast. Because of these temperature differences the seaweed flora falls into 3 categories, the warm-water component of the east coast, the cold water component of the west coast and an intermediate temperate component along the south coast where seaweeds of both the warm and the cold-water components can be found as well as some species confined to this part.

Seaweeds have very strict ecological requirements. Their uppermost limit is the high water mark of spring tides. Very few species can withstand the dessication and wide temperature fluctuations of this part of the intertidal zone. Seaweeds only become common in the mid and lower parts of the intertidal range. Here we have <u>Gelidium pristoides</u> in the mid tidal range and <u>Caulerpa filiformis</u> in the sandy gullies.

Below the level of the lowest spring tides seaweeds are abundant, until, with increasing depth and decreasing light intensities, they can no longer exist. Thus around the coasts of the world there is a narrow fringe of attached seaweeds limited to a maximum depth of about 200 metres.

Seaweed products are of great value to the modern world. The brown algae provide alginates which have a multitude of uses in industrial processes, while the red algae are the source of agar, a product of vital importance in the culturing of microorganisms. They are also a source of food of high protein content, as in the case of Porphyra which is cultivated in the quiet lagoons of Japan.

The reason why the artificial cultivation of Porphyra has been so successful in Japan is because it has been based on a clear understanding of the life cycle of this species. Porphyra has two very different vegetative phases in its life cycle - a flattened sheet (as is seen in the slide) is produced in summer. Spores from this phase germinate on the shells of molluscs into a minute filamentous second phase which develops during winter. Spores from the latter phase will germinate in spring into the flattened sheet stage. Tanks are filled with sea water and crushed mollusc shells. Spores of the Porphyra phase are introduced into the tank to produce the filamentous phase. In spring nets are placed in the tanks to receive the spores from the filamentous stage. As soon as the young Porphyra plants appear the nets are placed in the lagoons.

Until fairly recently most of the harvesting of South African seaweeds for various purposes has been by collecting the drift washed up on the shores. This is a harmless method as it does not touch the source of supply i.e. the attached living plants. However, concessions have been granted for harvesting Gelidium pristoides, (an agar-producing seaweed), along the coasts of the Eastern Province. Gelidium pristoides is commonly found in the mid and low intertidal range and is thus easy to collect. What worries me is the way in which this alga is collected. It is chopped off the rocks by means of a tyre lever, a method which rapidly denudes the rocks. As this alga is perennial and can regenerate rapidly from its spreading basal holdfast, the only sensible way of harvesting it is to cut it off above the holdfast region, thus allowing the plant to recover. There is another factor which does not seem to have been appreciated by the promoters of this budding industry and that is the life cycle of this alga. Three separate plants are involved in the life cycle in order for reproduction to take place. The male plant produces sex cells which fertilize the eggs of the female plant. This fertilized egg is retained on the female plant and further development in situ gives rise to a special type of diploid spore which, when released, will germinate into an asexual plant. At maturity this asexual plant will produce haploid spores by the process of meiotic division of which half the spores will germinate into male plants and half into female plants.

Now, should the random harvesting methods eliminate any one population of the three types of plant, the sequential reproductive cycle will be broken.

We still do not know (although we are working on this problem) the periodicity of the reproduction of this species. The answer to this question might dictate a "closed" period to allow the alga to reproduce itself.

Along the coasts of the south western Cape the extent of the kelp beds has been mapped by the Department of Sea Fisheries with the view to commercial exploitation. The kelps provide a source of alginates. The method of collection has to be very carefully done as the growth region is situated between the stalk and the lamina (or fronds). Should the seaweed be harvested below this point no further growth from that plant can be anticipated. Therefore if the seaweed populations of Gelidium and the kelps are to be maintained for commercial use it is very important to devise harvesting methods based on a sound knowledge of the life cycles, the growth pattern and the periodicity of the reproduction.

Unfortunately, South Africa has a difficult coastline from the point of view of farming seaweeds artificially. Most of the coastline is very exposed and there are few sheltered bays or inlets where seaweeds could be cultivated. However, if the colonization of the canals by marine life at Sea Vista is anything to go by, perhaps the dredging of canals into sand dunes may open up possibilities for seaweed culture in the future?

MARINE RESERVES

At the present time there are very few marine reserves in South Africa where there is total protection of marine organisms. In the Tsitsikama Coastal National Park the Seaweeds are protected but bait collecting is still allowed. I feel very strongly that, when new marine reserves are proclaimed, no collecting of any kind should be permitted so that at least some areas of the coastline will be kept in a natural state.

Riet River, 15 km. north of Kowie would make an excellent reserve of this kind as it is still relatively unsppoilt. Fortunately, there are still many similar localities for preservation.

CONCLUSION

In the course of this Inaugural Address I have attempted to read some of the signs of the past and the present that have affected the indigenous vegetation of this country. The effect of man has far outweighed the effect of climatic changes and some of these man-induced changes are alarming to say the least. But what is encouraging is that there is a burgeoning interest in our environment from all parts of the community, from the Prime Minister and his Senior Scientific Advisers, from relevant Government and Provincial Departments, from Municipalities, from Universities and industry, from farmers and from an increasingly enlightened public. We already have a number of wilderness areas, floral reserves, marine reserves, botanic gardens and national parks but I feel it is urgent that more areas of botanical interest should be proclaimed before we lose forever the wide diversity of vegetation types with which we have been endowed. The botanists have a very important role to play in encouraging the preservation of our flora by continuing their researches on indigenous plants and by insisting that they are a renewable resource and not a vanishing one.

Our natural vegetation should be considered in the light of a capital investment and we must learn to protect that capital until we have the scientific knowledge to utilise it in the best possible way.

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