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A REPORT ON THE "FYNBOS" VEGETATION OF THE SOUTH WESTERN CAPE PROVINCE

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Report on the Fynbos Vegetation of the Cape

1. Definition:

"Fynbos"- term coined by Bews (1916) for evergreen bush with small hard leaves found in areas with winter rainfall and warm dry summers. Phillips (1971) regards fynbos as a type of thicket with complex physiognomic types which vary from site to site depending on local climate in a winter rainfall region.

2. Locality:

Fynbos is found in the south western and eastern parts of the Cape Province occurring in an "L" shaped belt with the centre of the fynbos in the angle of the "L". The belt encompasses Worcester to Stellenbosch to Caledon, tailing out northwards beyond the Cedarberg and extending eastwards as a thin double line along the two major mountain chains, the Swartberg-Baviaanskloof mountains and the Langeberg-Outeniqua-Tsitsikama mountains along the coast to Port Elizabeth.
(Latitude S. 29^{o} 36' - 34^{o} 09'
Longitude E. 17^{o} 52' - 21^{o} 16')
Altitudinal range extends from $\pm$ 12m to 2 130m.

3. Environmental Factors

3.1. Climate - is "Etesian" (Medit erranean type - after Köppen) ie humid and mesothermal with dry summers - average temperature $\pm$ 22^{o} C.

Rainfall - There is seasonal distribution of rainfall with more than 60% falling in winter. The total amount varies from 300 to $\pm$ 1750 or 2000 mm with an average of 4000 to 1250 mm. The highest rainfall occurs on the mountain slopes on the eastern side. Reliability of the rainfall increases towards the coast from further inland. Mist contributes significantly to total precipitation.

Snow - Falls on the coastal mountains regularly at heights of over 1200m, but thaws and disappears after a few days.

Atmospheric Temperature - There is a considerable annual range, chiefly caused by hot days in summer and mild days in winter. It can be very hot, occasionally greater than 38°C. Diurnal fluctuations are greater in summer than in winter:- nights are mild to cool. Frosts are rare but occur in the valleys. The cold does not generally induce a marked rest period in the growth of vegetation and tree growth is practically continuous throughout the year.
In the sclerophyll scrub vegetation on drier slopes, many plants are dormant during, the hot, dry summer, and where ground water remains available phreatic vegetation grows and transpires. There is therefore a significant vapour loss throughout the year which is particularly high in summer. (Summer T° 17-22°C. Mean annual T° 15,5°C. Winter T° 10-14°C Mean winter min. T° 5,5-10,5°C).

Wind - Weather is affected in summer by the high pressure zone of the horselatitudes (25-35°S). Anticyclonic winds blow from high pressure centres from the south east. Cold air being cooled causes condensation in drops. Adiabatic heating and reabsorption of the condensed moisture then occurs. Occasionally the cooling effect is enough to permit cloud to persist - get exceptional rains from the South East. The south east wind is desiccating causing such heating of the air that the highest T° are recorded after such winds. These winds of "bergwind" character persist for ± 2-3 days. In winter, low pressure centres move towards the East from the Atlantic.Cyclonic winds of the westerly wind system blow from the North West and bring warm moisture-laden air, resulting in heavy orographic rainfalls.

Insolation - This is intense in summer due to long periods of cloudlessness. However occurrence of clouds may reduce the sunshine by 2.84 hours per day on average (measured at Jonkershoek). The restriction of sunshine duration and consequently the radiation reduction significantly increases the effectiveness of rainfall by reducing the vapour loss.

3.2. Edaphic

Geology - The region is part of the Cape system of Devonian age with volcanic basement rock on the pre-Cape formation of ancient granite and gneiss.
The rocks are strongly folded about axes roughly parallel to the coast to give rise to mountain ranges of rugged character ie. the Cape folded Belt.
The Cape rocks of hard sandstone lie on the old rocks with their associated younger granite with interspersed shale bands. The Cape flats was a sea strait formerly separating the mainland from the peninsula ± 175000 years ago. The flats are comprised of sand with interlayered clay bands, resting on Malmesbury shales and granite. Fossilised marine deposits are confined to the coastal belt.

Soils - Table Mountain Sandstone gives rise to coase grained siliceous soils, white in colour, acidic and dificient in nutrients. It is excessively leached of soil colloids and there is rapid water run off as seen in Baines' Kloof (Surface layer = 10 - 15 cm). The sandy soils of the Cape flats are also pale in colour with lime from the shell debris. The sand layer is up to 30 m deep with the surface neutral to acidic with alkaline conditions further down. In regions with a high rainfall, the soil is "podsol" - like with a dark surface layer containing little humus overlaying a stratum of shallow bleached soil. The soil is developed from quartzites and has pH 4.5 - 5. It also has trace element deficiencies; cation exchange capacity is postulated to be very low or almost zero. As regards mycorrhiyas, endophytes of the Ericaceae occur in acid soils and no specific host/fungus relationship appears to exist. Work is being done on this at present.

3.3 Topography -

Aspect - Fynbos occurs over very uneven surfaces. The vegetation on flat lands, as well as that where there is a higher seasonal rainfall,viz in the more southern areas,tends to be more mesic. The tallest mesophyte Macchia and forest areas occur where the summer heat is tempered by the South East mist clouds. Gentle undulating topography occurs in the Dune fynbos with resulting distinct floristic and physiognomic types. In the northerly and westerly reaches of the fynbos belt where it becomes very dry, the vegetation becomes sparse throughout the altitudinal variations.

Altitude - Altitudinal range varies from ± 12 m to ± 2 130 m. There appears to be some vertical zonation floristically but not structurally, as evidenced by the ability to subdivide the Sclerophyllous vegetation into 5 subdivisions viz. according to Adamson (1938).

i) Sclerophyll bush on the plains and lower slopes, at about 900 m.

ii) Wet Sclerophyll bush (Coastal Fynbos) -0-300m

iii) Mountain Bush-occurs above ± 900 m.

iv) Dry sclerophyll - found in a wide variation dependent on local conditions, usually on very thin soils in exposed sites.

v) Rhenosterveld. (regarded more as a :trasitional zone) - occurs on plains and slopes with a different soil type to the others. It is considered as the most arid of Sclerophyll types, occurring mainly on the Cape Flats sands in association with Malmesbury shales.

Land Forms - Mountains with T.M.S. geology. Rounded hills of intrusive granite. Low land plains of Malmesbury shale Coastal Dunes.

4. Floristic Composition

Generally the fynbos is characterised by lack of single species dominance and a conspicuous presence of Restionaceae. The flora is noted for its richness in species and a high degree of endemism (restricted distribution). Three basic elements emerge in the flora. (Taylor 1972)

i) The Restionaceae (already mentiond) as represented by genera Restio, Elegia, Hypolaena, Thamnochortus, Hypodiscus, Leptocarpus.

ii) The Ericoid element which also seems to be a constant physiognomic feature is represented by the genera Erica (Family Ericaceae), Cliffortia (Roseaceae) Metalasia, Euryops, Helichrysum (Compositae), Elytropappus rhinocerotus (Compositae, "rhenosterbos").

iii) The Proteoid element which may/may not be present depending on habitat factors. This is represented by Faurea, Protea and Leucadendron and Leucospermum, Cymnosporia and Heeria.

Besides these dominant "shrubs" of the fynbos, other families contribute to the great diversity of the region. Eventhough the composites are numerous, they are ecologically subordinate to the other fynbos shrubs eg. Erica, Elytropappus. The representatives are mainly woody and often dwarfed. Endemic families found include the Bruniaceae eg Brunia, Berzelia, Peneaceae, Grubbiaceae, Myoporaceae.

Rutaceae, Geraniaceae; Leguminosae, Rhamnaceae Selaginaceae, Liliaceae; Amaryllidaceae and Iridaceae are also families found contributing to the general uniformity of the growth form type which can be partly explained by a common origin.

The prevailing growth type is that of a shrub seldom reaching the stature of a small tree. Leaves are small and ericoid,and when broader they have a dull texture. The smaller bushes have erect wiry stems. Geophytes found are numerous particularly after a fire, include Watsonia and Cyrtanthus.

Annuals and grasses are few in number and can become very scarce.

As regards development of the vegetation; where rainfall amounts are ± 500 - 750 mm, a fully developed climax community of dense stratified vegetation with emergent woody Proteaceae and lower small shrubs and herbs (Ericoid, Restioid and geophytes) occurs. Along moister areas, the climax grows taller and denser. In drier areas, the communities are more open, therefore they are simple and less stratified. (Low growing shrubs usually precede erect ericoids).

Two distinct "climax" comminities can be identified viz.

a) the scrub type in drier areas.
b) the "forest" type in wetter areas

However the factors which disallow development of a climax are low soil moisture, exposure, and fire. In particular, fire effects a series of regeneration phases commencing with a non-layered low bush community which must be tolerant to low or little humus in the exposed soil as well as the reduced water holding potential of the soil. Where the sclerophyll is intolerant of the conditions imposed on it, communities of introduced plants are formed, but these are not the only conditions under which invasion is successful. Acacia cyanophylla (Port Jackson willow) and A. cyclops (Rooikrans) were introduced as soil binders on Cape sands and have become widespread due to seed dispersal by birds. A. cyclops regenerates with vigor after fire and both Acacias form dense thickets which are outlasting the last vestiges of the indigenous vegetation.

The Acacias and the other Australian exotics viz. Hakea spp., Albizia and Eucalyptus spp. come from areas with trace element deficiencies and are thus members of an adapted flora which can survive andflourish upon nutrient deficient soils on which unadapted plants can at best barely survive. Thus they seem to be better suited and thus successful competitors.

The original flora is thought to have developed under conditions of better ground coverage and nutritively more balanced soils and is not suited to successful colonisation of bare and impoverished soils and conditions marginally successful for it. (Verfication from experiments of trace element deficiencies).

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Other Mediterranean regions when compared with the Cape do not show the same fynbos characters. They are derived from an open type of temperate evergreen forest which has been modified and degraded by man's activities. This is evidenced by the climax vegetation dominated by evergreen sclerophyll trees in a woodland formation. On more fertile soils, grasses and herbs form the understorey. On infertile soils, evergreen sclerophyllous shrubs are common in the understorey. In drier habitats, climax woodlands are replaced by shrub communities which do <u>not</u> contain the Restioid element.

<u>Fynbos Types</u>

a) Coastal fynbos (on marine sands along the coast in long narrow ridges). The soil is relatively fine grained (recent in origin) and rich in lime. It has a complex species composition with striking variation over short distances. In general, the Restioid element is poor in species and less conspicuous but it still forms the matrix of the ground layer. The Ericoid element is more in evidence and there are more nutritious and palatable grasses. Vegetation is ± 1 m tall.

In sheltered troughs between the dunes where there is greater soil moisture thickets of woody shrubs develop if fire-protected. Melkhout (<u>Sideroxylon inerme</u>) is the dominant small tree.

On small mounds within low lying areas, there are almost pure stands with a single dominant. Species found are <u>Passerina</u>, <u>Aspalathus</u> and <u>Euraitia</u>. Other species found are <u>Pterocelastrus</u> which is excessively wind pruned and <u>Metalasia</u> which is very similar to the inland form.

b) Sclerophyll bush (on the plains and the lower slopes, rainfall 500-750 mm, sea level up to 900 m).

The climax community is dense and more complex. Three layers are discernable eg. i) upper bushes (1,5 m - 3 m) especially <u>Protea</u>, <u>Leucodendron</u> and <u>Leucospermum</u> ii) lower layer (± 1 m) has a dense layer of small shrubs containing Compositae, Ericaceae and Rutaceae. iii) lowest layer - small [illegible] plants, herbs and geophytes. However, a climax is not common as the region is often more open and fewer-layered due to fire destruction.. In protected kloofs, <u>Cunonia</u> and <u>Ilex</u> are the tree genera which predominate.

c) Wet sclerophyll bush (in regions of permanent water).

This is very similar to b) only denser and less xerophytic. Layering is less definite and bushes are higher (± 3 m). <u>Berzelia</u>, a taller <u>Erica</u>, <u>Leucodendron</u> and <u>Cliffortia</u> are found.

d) Mountain fynbos (occurs above 900 m in very shallow soils which are acid and porous).
As the altitude increases, rainfall increases and temperature decreases. This has a marked effect on the vegetation together with the soil factor. The fynbos is progressively lower and less stratified often with only up to two layers. There are abundant Ericoid and Restioid members present. The prostrate or semi-prostrate habit seen is correlated with wind, and snowfall exposure. There are few species in common with other levels but structure of the plants is similar.

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The eastern extension of the mountain fynbos has more evenly distributed rainfall and hence, the grasses increase. Forest patches develop in folds and valleys when protected from fire.

e) Dry Sclerophyll Bush (occurs where precipitation is in the 400-500 mm range)

The vegetation is not so distinctly layered here and there are fewer species with ericoid leaves. The bush found has small dry flat leaves. However a wide variation occurs with local conditions. Restios are confined to the sandy areas.

f) Renosterveld (on deeper fine grained clayey soils in regions with less than 300 mm rainfall).

According to Adamson (1938) this type can be considered as a subgroup of the Fynbos but it seems to have a more transitional character and is the most arid of the sclerophyll types. Open communities are found with subsidiary associated shrubs. Pteronia and Elytropappus rhinocerotis are the dominant species. All characteristically have cupressoid leaves of grey colour. Accourding to Rourke (pers.com.) Rhenosterveld is a veldtype distinct from "fynbos". There are evidently differences of opinion as to what should and should not be included in the composite and very generalised "fynbos" vegetation type.

5. Adaptations

5.1. Anatomical

Evolutionary tendencies show some or all of the following features:-

a) Increased hardiness of leaves by the production of fibre (lignified and sclerified) for increased resistance to water loss. It is also suggested that it might be an advantage in coping with the unfavourable wind factor.

b) Reduction in leaf size - this is seen in the majority of species except Proteaceae (which have dull leathery leaves and are considered to be more mesic forms). Restios have no leaves, but photosynthetic stems.

c) Ericoid leaf type:- the leaf tends to curve downwards at the margins enclosing the stomata on the underside to presumably lessen transpiration rate and reduce windflow across open stomata, and hence conserve water.

d) Tendency towards reduction in size and retention of woody character Trees are rare in the Fynbos and there is an increase in branching with transition to the shrub form. Root systems are well developed and penetrate deeply as well as spreading superficially.

e) Prevalence of minor xerophytic characters - hairy or woolly coverings, thick cuticles, sunken stomata. Pubescence is seen particularly in mountain types.

Negative characters of the Fynbos.
Succulence is not a characteristic of the flora. Thorn development seems to occur only in the outliers. Prickly, spiny members number only a few of the species found - altogether not more than 2 or 3% of the shrubs are spiny (Taylor 1972). Spininess is seen in Cliffortia, Aspalathus and Mundia for example. Compound leaves are rare.

Although there is considerable diversity in detail among sclerophylls, there is on the whole a great unanimity of general sclerophyllous type.

5.2. Physiological

Photosynthetic mechanism - Most of the fynbos species are C_3 plants, which are especially prevolent in the winter rainfall areas and at higher altitudes along the higher mountain ranges in summer rainfall areas. Of the C_4 species which are dominantly on the drier, hotter interior plateau and along the tropical eastern coastal belt a few are found in the Cape fynbos. These include the grass species Cynodon dactylon, Pennisetum macruorum, Eragrostis sp., Enneapogon sp. and Themeda triandra.

Depending on the relative quantities of aspartate and malate formed, two subgroups of the C_4 type are recognised. It appears that aspartate formers appear to increase with a decrease in precipitation and that they have a system which exhibits low sensitivity to N_2. The grass species listed however are not all aspartate formers but also include the malate formers (Themeda + Pennisetum).

5.3. Chemical

Secondary organic compounds are present in plant tissues eg phenolic substances which include tannins, terpenoids, resins, alkaloids and organic cyanides. It is likely that these substances form a spectrum of wastes from the plant's metabolism and are advantageous in repelling the plant's enemies. Sometimes these compounds are so substantial that they leak into the environment, especially the water soluble allelotoxins. Others are volatile and are released during the dry season and become adsorbed onto soil particles. The volatile substences of the terpenoid group appear to be more important in the more arid climates.

These compounds thus are effective in competition as well as in reducing utilisation and productivity. The latter case could occur as some of the phenols are potentially toxic to the plant. However, some can be stored in chemically inactive states (eg toxic alkaloid combined with a sugar) and become actively toxic when released from the plant (autotoxic) or when eaten by animals.

Although the above discussion refers to general phenolic effects, they would all seem applicable to the fynbos on the basis of what the fynbos "looks like" and "what it does".

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6. Utilisation

6.1. Man

Commercial utilisation by the sales of seeds, plants, freshly cut flowers and dried flowers for ornamental purposes has increased the country's revenue eg. in the period July 76 - June 77 , R1.5 million was obtained from protea export to Europe. Freshly cut flowers netted ± R1. million internally with dried flowers netting about the same. Total sales earned the country ± R3.5 million for ± 3000 tons of plant material. Of this, 25% came from plantations and nurseries and 75% came from the veld (especially the non proteaceous element) e.g. everlastings.

In 1945 the direct economic value of fynbos was considered not enough to necessitate its protection as it yielded no major and few minor products (Wicht, 1945). However, the increased sale of cut flowers now, has increased the awareness of the value of the fynbos and stimulated the incentive for preservation of the fynbos.

As the fynbos occurs on poor acidic soils and is considered unpalatable vegetation, the economic exploitation as far as the rearing of livestock is concerned, is minimal. Agriculturally, it is also of low potential. However, afforestation is proving to be quite profitable in certain areas.

In terms of recreation, fynbos provides a splended and colourful vegetation type for hiking through. It is of great scientific interest and ought to have a graded use for Nature Conservation eg. botanical reserves and wilderness areas. Emphasis however, must be placed on the conservation of mountain catchments for water. Wicht (1945) maintains that sclerophyll is best to improve water supplies as it maintains the "water supply stability of the soil".

6.2. Animals

The heaviest impact from animals utilising the veld for grazing is when the vegetation is young following a burn. Older vegetation is unpalatable for livestock due to the high phenolic content of the species and the wax impregnation of Renosterveld.

Pollinators of the flora include birds, insects and rodents. Representative bird species found are the Orange Breasted Sunbird, the Cape Sunbird, the Cape Rock Thrush and the Protea Seedeater. Insect pollinators include examples from the Diptea, Hymenoptera and Curculionidae.

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A variety of invertebrate pests are found utilising the fynbos, particularly the Proteas. An eriophyed mite causes witches broom, a minute orange grub eats the shoots of P. neriifolia, weevils chew the bark and scales parasitize P. macrocephala.

7. Productivity

As very little work has been done, the productive potential of the vegetation has not yet been assessed. A small amount of work done at Baines Kloof indicates a flush of growth in late summer (December - February) particularly when it is excessively dry. Otherwise productivity of the vegetation seems to be both low and very slow. (Cresswell, pers. com).

Do water relations, nutrients and temperature form the major contribution in limiting growth? It would seem so but this then does not account for what one might call the anomalous flush in a very limiting period.

As the fynbos has highly branched shrubs, stem photosynthesis can occur in quite appreciable amounts. However why should this feature have evolved? Do leaves not suffice? (Could stem photosynthesis have evolved as a compensatory mechanism?). It is not yet possible to provide answers to these questions.

8. Management

The development and execution of management policies for any area are strongly influenced by the character of area, and the reasons for managing it. Mangement programmes depend on what the area is being managed for.

This is expecially true in the Cape Fynbos, where the area and the vegetation type have their own unique characteristics - many of which are elucidated in the preceding sections. Conflicting demands are made on the fynbos, with different lobby groups and "involved organisations" considering different management priorities. There is the preservationist group, who wish to ensure the eternal preservation of every endangered endemic plant; the industrialists and urban residents who require and demand a reliable and adequate source of high quality water; demands from both timber and wild flower markets; and demand for recreational facilities for differing - intensity recreation.

In a number of cases these demands (and not all are listed above) are not compatible within the same area. Fortunately the fynbos area, within the bounds of its intrinsic unique characterisation, displays a high degree of heterogeneity - in terms of topography, vegetation, water supply and human settlement densities. And herein may be the answer to the numerous conflicts - diversification of priorities in accordance with local requirements, but in accordance with an overall development programme.

It is necessary to consider those management priorities which are essential to the maintenance of longterm ecological stability and resilience of the fynbos region. There are three essential characters which must be maintained,

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and these are interrelated, each influencing the other. These three priorities are the maintenance of i) soil stability, of ii) vegetation cover, and of iii) controlled water yielding ability. It is possible now to consider the other demands made on the fynbos regions in terms of their effects on these three essential characters, and to determine the degree of compatibility of these forms of land use with each other, and with the maintenance of the character and stability of the region.

Management may be practised for a number of different purposes, including some of the following:- retention of "fynbos character" (pretty flowers with aesthetic appeal and tourist-attracting potential), fynbos "preservation", especially for rare endemics and endangered species, maintenance of water catchments for high quality, high volume, reliable water yield; soil stability mainly tied in with the previous purpose, provision of recreation facilities of different intensities, economic exploitation of the area, in the various forms of indigenous forest yield, exotic timber plantations, supply of material for the dried flower market, attempts at pasturage, protection of area for scientific study. There are of course numerous other forms of fynbos utilization.

A number of these can be seen to be compatible with the maintenance of the essential charcters even in the highly sensitive areas. The maintenance of water catchments and soil stability (the first is dependent on the second) is currently the task of the Department of Forestry who hold jurisdiction over many South African river catchments, and thus much of the non-agriculturally productive mountainland. A further responsibility of the same department is the supply of timber, mainly from exotic plantations of pine and eucalyptus but also to a minor extent from indigenous forests. It is accepted though that it will be many years before the indigenous forests of the mesic fynbos will have recovered sufficiently from the tremendous exploitation of the eighteenth and ninteenth centuries to support exploitation of low intensity on a sustained yield basis. Experiments carried out at forest research stations in the S.W. Cape - especially at Jonkershoek seem to indicate that there is little difference in yield from water catchments which are under exotic plantations or under indigenous woody vegetation, with exotics requiring a little more water, and thus giving a lower water yield.
Soil stabilizing effects and soil development are comparable under good plantation management and under indigenous forests. It has also been shown though that water yield is much higher if the catchment is under non woody indigenous fynbos.

As the demand for rural recreational space has increased it has become recognised that this is a further task of forestry - because there is a fair degree of compatibility between these forms of land use. Realisation is increasing that the realistic utilization of especially the mountain fynbos regions must come from multiple land-use practises of a compatible nature. The fynbos vegetation is considered to be not ideally suited to pasturing of domestic livestock - not only because of its relative unpalatability, but also because of soil and vegetation degradation which easily occurs in the fragile mountain areas of thin soils and high rainfall.

Exotic forestry is also not always feasible because of topographic difficulties. Because exotic plantations do not have the same aesthetic appeal as indigenous forest or open fynbos, they are not suitable for recreation.

However, the heterogeneity of the area of the S.W. Cape designated "fynbos" can be used to advantage by allowing compatible forms of land use in the same areas which are suitable for these uses. Where there is non-compatibility of requirements, the priority ranking of the land use in terms of ecosystem stability, economic or social necessity and the current availability of the resource, in that order, must influence the planning decision.

Having decided why and for what an area is to be managed, it is then necessary to investigate different management strategies, and their effect on the resource in the light of its intended utilization.

The major management tool for the fynbos is fire, and the relative merits and demerits of burning and fire protection are mentioned in virtually every publication on fynbos.

Fynbos is considered to be a "fire adapted" vegetation type (Taylor, 1972; Wicht, 1945; Luckhoff, 1971; et al). Evidence proposed to support this includes the remarkable ability of the fynbos to recover after fire (Taylor 1972) with regeneration from seed released by the fire, sprouting from rootstocks, growth from dormant buds on well insulated stems and regrowth from soil storage organs being considered features of adaptation to fire; the apparent requirement for fire to stimulate germination in some Leucospermum species (Rouke, 1972) inter alia; and the flush of geophyte flowering shortly after burning. It is evident that burning has a beneficial effect on fynbos vegetation by stimulating germination and flowering, and in opening up the nature of the vegetation by its effect on the woody elements - that of damaging the plants and causing regrowth to occur from rootstocks. This effect of burning is to maintain the fynbos in a low, essentially non-woody state dominated by the Restioid and Ericoid growth forms - ie. in a herbaceous condition with a preponderance of brightly coloured flowers.

This state of the fynbos has much aesthetic appeal, and certainly serves as a tourist attraction. It is also fynbos in this condition which provides most of the material for the wild flower markets. From these points of view, burning the fynbos is a necessary and desirable management option.

Burning does, however also have detremental effects on the fynbos. The case of the Clanwilliam Cedar (Widdringtonia cedarbergensis) of the Cape Cedarberg is often quoted. These trees, which have very high volatile aromatic contents appear to have no fire resistance adaptations, other than their occurence on very bare rocky ground. The distribution of this endemic Widdringtonia has been very severely reduced by frequent devastating fires in the Cedarberg, and the condition of the remaining population is considered to be very poor (Luckhoff, 1971) due to apparent inability to regenerate after fire.

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There are numerous other examples which can be quoted where fire has a detremental effect on components of the fynbos. This is particularly so in the case of frequently recurring fires, where the period between fires is insufficient to allow newly germinated seedlings to grow to maturity and set seed. In many areas of the Cape fynbos this too-frequent burning is resulting in the gradual removal of the woody shrub element in particular, which suffers most under fire, and requires greater length of time to achieve maturity and seed-set. Many Protea and Leucospermum species are threatened by "too much fire" (Rourke, 1972 and pers.com).

Although for many years (± 1930 - 1960) the policy of the Forestry Department was that of "fire protection" for the moutain fynbos, this is no longer the case. Fire protection precautions were taken in the forestry regions, but fires still occurred - some by natural causes such as lightnining and falling stones and others accidental or deliberate man-made fires. The intensity of and damage caused by these fires in protected veld was such as to cause a reversal of policy. If the fynbos is protected for extensive periods (greater than ± 15 years) it does on moister sites develop a more woody character. With natural death of woody species and the vast amounts of highly inflammable litter which collects in protected areas, the potential for fires of very high intensity is great during the hot dry season.

The generally accepted policy now (Wicht, 1975) is that controlled burning of the fynbos at irregular intervals of "sufficient magnitude" is preferable to either total perpetual protection or too-frequent burning. Work is currently in progress to determine what is "sufficient" magnitude, and this is necessarily a long term project. It is felt that at least 8 years is required to allow maturity of Protea veld (Wicht, 1971) while longer periods are suggested by Moll and MacKenzie (1977) to allow the development of a permanent tree form in the fynbos.

Fire has always played a role in the history of the Cape fynbos since before the arrival of the first white settlers. Apart from natural fires which occurred, the veld was also deliberately fired by the native Hottentots to provide new browse and attract game. The effect of the advent of the white wood-cutters and increased fire frequency, together possibly with climatic changes, has served to reduce greatly the extent of woody fynbos which was present in mesic sites and espicially along water courses (O. Kerfoot, pers. com). This has resulted in the deterioration of what were natural fire barriers, which is why uncontrolled fires today spread over very large areas. In previous times, fires which did occur were more locally contained by larger belts of phreatic vegetation.

Complete fire protection in mesic sites results in development of the woody layer, dominated by Proteaceous shrubs or small trees.eg. Bosboukloof at Jonkershoek. After a time this vegetation takes on a moribund appearance, as trees die after reaching maturity. This vegetation is less easily penetrable, has less aesthetic appeal than more open fynbos. It would appear that here, complete protection is not desirable. It is however recognised and recommended (Wicht, 1945, Taylor, 1972 inter alia) that fire protection should be applied

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in the moist areas, especially of catchments to allow the development of moist climax forest fynbos on mature soil profiles.

The role of burning or protection in the Cape fynbos is a management problem which is still being resolved. Controlled burning on a rational basis at a "reasonable" frequency (Taylor 1972) which is still being determined is recommended to keep the fynbos attractive,viable and productive.

In addition to the question of fire in the fynbos, there is another very urgent management problem - that of exotic weed control. As mentioned previously there is severe infestation of the fynbos with the introduced Australian Acacias and Hakea species, introduced for sand stabilization and hedging. In addition to these, commercial timber trees such as Pinus pinaster and P. radiata are invading fynbos from plantation edges. The position regarding the Australian weeds is aggravated by the fact that they are fire stimulated.

The control of these weeds is urgently necessary, but very expensive and labour intensive. A Botanical Research officer has this year been taken on to co-ordinate erradication research (F.J. Kruger, pers. com). The possibility of biological control is being investigated, with the use of the plants' natural insect pests from Australia being considered, and tests undertaken.

As long ago as 1945, Wicht made recommendation on the erradication of the exotics. He proposed that the efforts of all relevant bodies should be concentrated in containing the spread, by mechanical erradication in the areas of encroachment, concentrating initially on the lightly infected areas, and then moving in towards the denser areas. He also recommended very intense efforts in areas of proclaimed and intended nature reserves. However, very little impact has been made on the exotics, and this remains a management priority.

It is also coming to be universally agreed that the fynbos vegetation is not suitable for use as pasturage and that this should be excluded especially from catchment slopes and recently burnt areas, because of the damage to vegetation and soil by browsing under marginal conditions.

In summary there are three major considerations in fynbos management-the maintenance of vegetation cover (preferably indigenous fynbos), soil stability and quality water yield. Other forms of land use can be allowed in the fynbos where these are compatible with the three essential considerations. Development for utilization of the fynbos must procede along rational lines according to a development programme. Multipurpose land-use of this nature is the only way of ensuring conservation of the fynbos.

Fire can be a useful tool in fynbos management and fire regimes are currently being investigated. Controlled burns appear to be preferable to complete protection (which appears to be not really feasible). Exotic weed encroachment must

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be halted as it is reducing the utilization potential of the fynbos. Grazing in marginal areas must be excluded because of the reduction of fynbos stability under this form of land use.

Management of the fynbos is made more difficult by the heterogeneous nature of the regions, but it is this heterogeneity which allows the potential for multipurpose use and conservation of the area.

9. Conclusion

The "fynbos" of the South Western Cape has a number of unique characters which serve to set it apart as a distinct vegetation type. One of the most demonstrable characters is its range of variation in a number of aspects - its very high floristic diversity, topographical variation, and range of microclimates.

And yet it has characteristic uniformities as well - parallel evolution of adaptive features, ability to survive on very nutrient - poor substrates and similarity of growth forms.

It is very difficult to generalise about the fynbos in a valid manner because the variability within the fynbos is so immense. It is not possible to extrapolate findings from research in one area to another area very readily. This complicates fynbos research.

Much of the research energy expended up to now has been purely at a taxonomic level, in an attempt to organise the floristic diversity of the fynbos. Only now are community studies starting to be carried out. Very little is known about the ecology of the fynbos, because of the need to identify the reactants of the system before trying to sort out the immensely complicated interrelatedness of the system.

Fynbos is, nonetheless, an interesting and exciting vegetation type, which still requires much investigation before we can say that we understand it.

This report is far too brief and superficial to deal adequately with the complexity and variation of the fynbos. It is hoped however that some aspects of the variations, as well as the uniformities, have been indicated here.

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