A study of certain ecological aspects pertaining to a *Leucadendron laureolum* community at the Silver Mine Nature Reserve, South Africa.

by

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ABSTRACT

This survey was conducted in three phases, viz.

1. The Braun-Blanquet phytosociological technique was used to describe the vegetation of the study area and adjacent areas. Two major communities, based on plant community structure environmental factors and floristics, are recognised.

2. A determination of phytomass was obtained from five sites in the study area by means of clip-plots from a plant community of post-fire ages of about twenty years, ten years and one year. In this study three structural elements of the fynbos were distinguished viz. proteoid, restioid and "remainder". It was established that the average growth rate for the approximately 20 year old proteoid community was 656 kg/ha/yr and for the ten year old community it was 309,2 kg/ha/yr. The marked difference in growth rate of the proteoid element is due to a slow growth rate until the community is some ten years old and thereafter there is a rapid increase in growth. The restioid component tended to show a decrease in phytomass with increasing age viz. 225, 123,4 and 207,3 kg/ha for one year, ten and approximately twenty year post-fire ages. For the "remainder" it was found that this also decreased with increasing age viz. 380, 54,5 and 25,5 kg/ha for one year, ten and

approximately twenty year post fire ages.

3. The effect of the June fire on the bush-cut vegetation of the study area in the Silver Mine Nature Reserve is discussed. The regeneration of plant species was monitored for twelve months in five randomly selected, permanently marked plots. Field observation revealed that 65,1% of the species regenerated from underground organs, such as rhizomes and corms, and the remaining 34,9% of the plant species regenerated from seed.

Based on the phytomass study and rate of regeneration of the plant species in the area it appears that an approximate 15 year fire interval is the most acceptable.

# INTRODUCTION

The ecology of the Fynbos Biome (Day, Siegfried, Louw and Jarman (eds) (1979); which includes Acocks (1953) Veld Types 34, 46, 47, 69 and 70, has recently received considerable attention. Much more information has become available pertaining to the ecosystem structure and convergence, as well as more detailed floristic information on various plant communities (Kruger, 1977a, 1979; Goldblatt, 1978; Taylor 1978; Cowling and Campbell, 1980), particularly Veld Types 47, 69 and 70 - the most important heathlands found in the Republic of South Africa (see Specht, 1979).

Cape fynbos, which has also been known as sclerophyll bush (Adamson, 1938), covers most of the mountain areas of the South-western Cape (Acocks, 1953). These folded mountains are to a large extent composed of Table Mountain Sandstone (du Toit, 1954). The soils derived from these rocks are sandy and are essentially skeletal lithosols which characteristically have low pH values (3 to 5) and are highly leached i.e. of low nutrient content (Kruger, 1974, 1979; Lambrechts, 1979).

Floristically fynbos can be defined by such important features as the lack of single species dominance (Taylor, 1978), a high degree of endemism (Oliver, 1977; Goldblatt, 1978) and the almost ubiquitous presence of the family

Restionaceae (Taylor, 1978). Other characteristic families such as the Proteaceae, Ericaceae, Penaeaceae, Compositae, Cyperaceae, etc. commonly occur in many communities over the distributional range of fynbos (Oliver, 1977; Goldblatt, 1978; Taylor, 1978).

The Silver Mine Nature Reserve, in which the study area is situated, is about 30 km from the centre of Cape Town and is some 2 151 ha in extent (Mr. S. Brent, Cape Town City Council, *pers. comm*, 1979).

The Cape Town City Council gave their total co-operation to the present study; firstly by allowing the research to be conducted freely in the Nature Reserve, and secondly by assisting with the bush-cutting and burning of the vegetation in the study area. The study itself was undertaken from 1977 to 1980 and focussed attention on the fire ecology of various fynbos communities, particularly the response of a *Leucadendron laureolum* community to a prescribed burn.

The first phase of the research was a reconnaissance survey in which the Braun-Blanquet phytosociological technique (Werger, 1974) was used to classify the major plant communities adjacent to and in the study area. Data were also collected on the pre- and post-fire phytomass of the *Leucadendron laureolum* community, as well as the post-fire floristic regeneration following a prescribed burn in June 1978.

This plant ecological study was aimed not only at increasing the current state of knowledge of the vegetation of the Silver Mine Nature Reserve, but also to assist with accumulating data concerning the ecological effects of fire on fynbos. It is hoped that the results of this, and other current fire ecology projects, will assist in placing the fynbos fire management programme on a more thorough scientific basis.

# CHAPTER 1

## PHYSIOGRAPHY

### 1.1 LOCALITY

The Silvermine Nature Reserve, approximately 18° 23' 55" E and 34° 4' 30" S, is situated at the northern, and continental, end of the Cape Peninsula which eventually ends at Cape Point some 29,6 km to the South (Fig. 1).

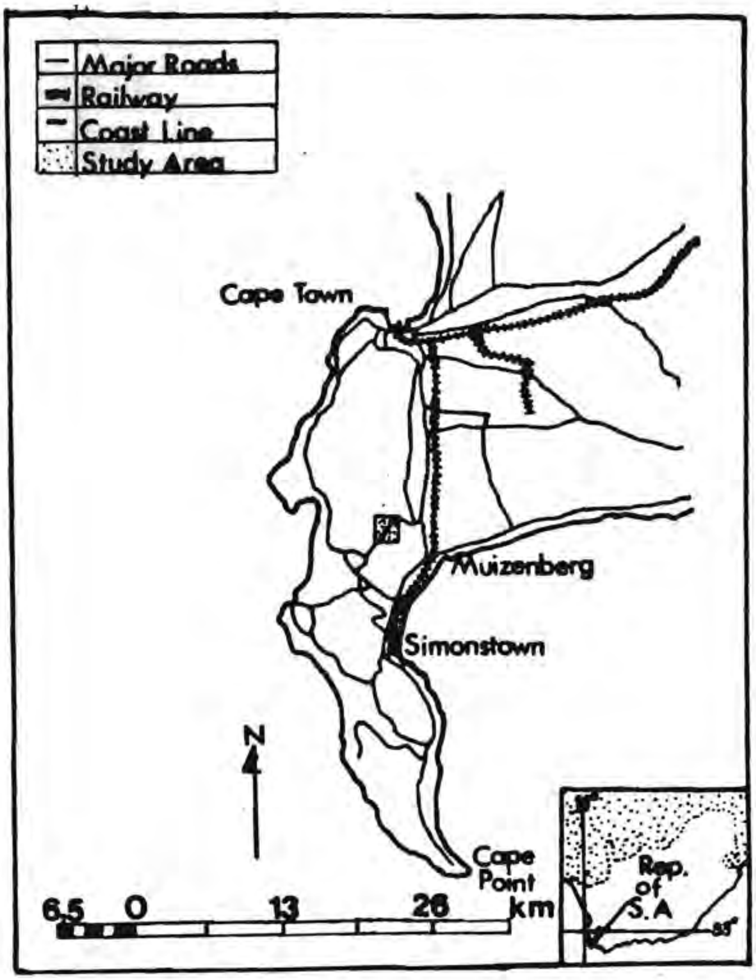


Fig. 1 Cape Peninsula showing the location of the SILVER MINE NATURE RESERVE. Inset shows the location of the Cape Peninsula in the Republic of South Africa.

The altitude of the study area ranges from approximately 500 to 750 m above mean sea level. This elevation is relatively low in comparison to the surrounding area because the study area lies on a saddle between the Muizenberg Mountains to the east and the Dassenberg Mountains to the west (Fig. 2). These mountains form part of the southern section of the Peninsula mountain chain and are characterised by Table Mountain and the Constantiaberg, Steenberg, Muizenberg and Simonstown Mountains. The study area itself forms an important part of the catchment area for the Silver Mine River, which has its outlet into False Bay near Fish Hoek.

Insert Fig. 2

Finally vehicle entry to the site is restricted by the nature of the terrain which is rugged. The only access is via Ou Kaapseweg which links the Constantia Valley with the Noordhoek-Fish Hoek break. The specific location of the study area makes it unique in terms of its physical characteristics i.e. climate, soil and geology, and it is these physical attributes that are referred to in Chapter 2.

## 1.2 GEOMORPHOLOGY

The underlying rock of the entire study area is Table Mountain Sandstone (Cole, 1966). Bedrock is often exposed, especially on the north-western and southern parts of the

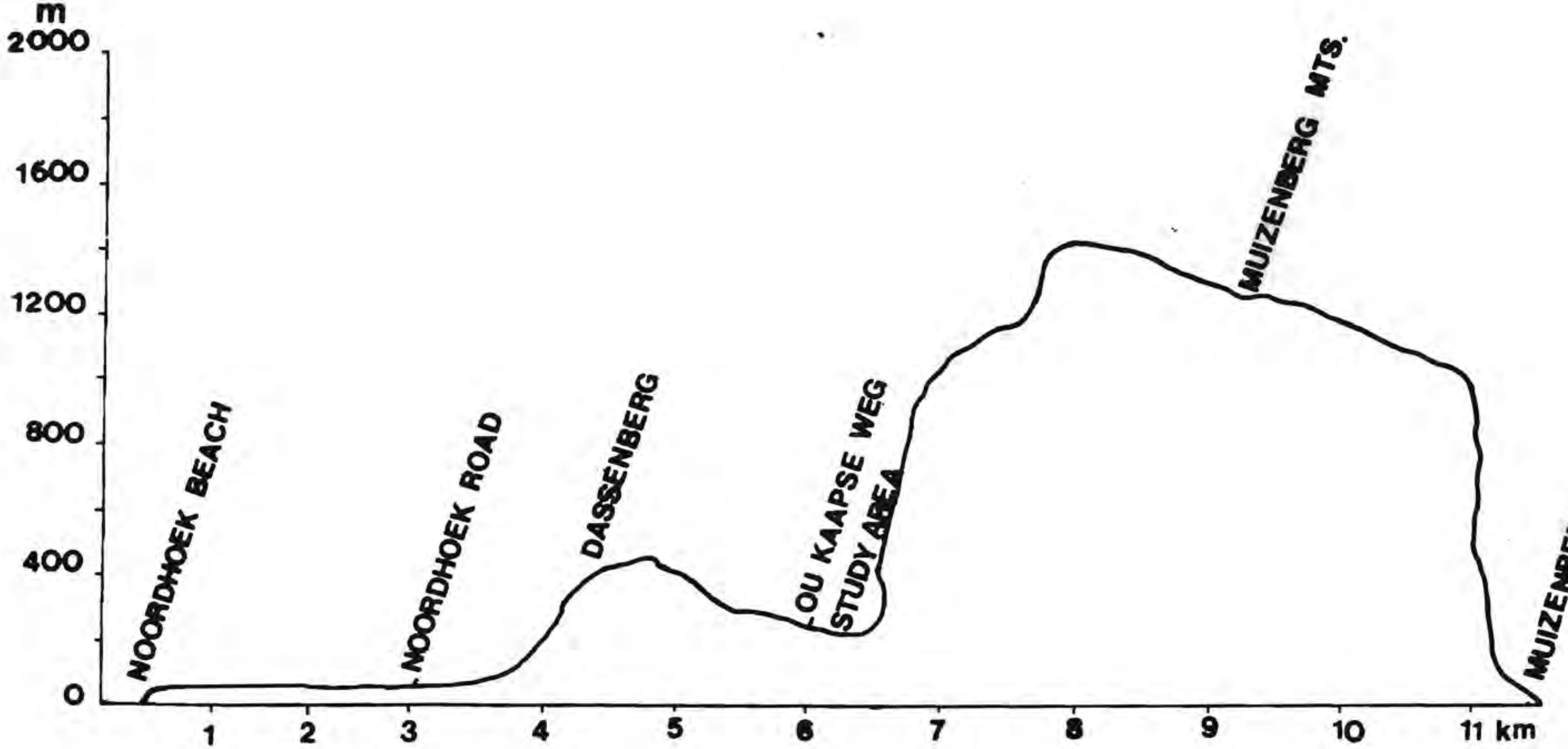


Fig. 2 Topographic section across the Cape Peninsula in the vicinity of the Study Area (from 1:50 000 Topographic Map 3418 AB and AD Simonstown).

area. The derived soils are generally coarse sands, of depths varying from 20 mm to 50 mm, and generally low in nutrients (Lambrechts, 1979).

# CHAPTER 2

## 2. CLIMATE

### 2.1 Introduction

The South-western Cape, where the study area is situated, is characterised by two definite gradients common to all climatic elements in South Africa: a north-south gradient from the great escarpment (32$^{o}$S) to the southern coast (34$^{o}$S), and a west-east gradient from the west coast (18$^{o}$E) to the south-east coast at 28$^{o}$E (Fuggle and Ashton, 1979). These gradients are superimposed upon the mountainous topography making the southern tip of Africa a mosaic of spatially diverse climates.

Although a range of climatic data are available from some stations located in fynbos areas, many stations, including the Silver Mine Nature Reserve, only record the rainfall (Fuggle and Ashton, 1979), and only rainfall data are available for the study area. Data for the other three major climatic parameters viz. temperature, mists and winds, were obtained from the most suitable adjacent weather station which was Kirstenbosch, and these data are also briefly reviewed.

## 2.2 Rainfall

Because the study area is situated at the south-western tip of the African continent it experiences predominantly winter rains with a fairly dry summer (see Table 1 and Fig. 3).
Fuggle and Ashton (1979) indicate that the rainfall pattern is complex but closely related to topography, and depends to a great extent on the exposure of the mountain slopes to the north-westerly and south-westerly winds. In addition to this mountain peaks are often cloud capped for several days especially in summer, and it has been estimated that over 500 mm of water may be precipitated per annum from these clouds without being recorded in standard rain gauges (Marloth, 1903; Nagel, 1956 and 1961). No reliable data is, however, available on this subject (Fuggle and Ashton, 1979) but that mist is an undeniable source of additional moisture in summer is widely accepted (Marloth, 1903 and 1905; Schulze, 1965; Edwards, 1967; Taylor, 1969; Moll, 1971; McKenzie, 1976; Moll and Campbell, 1976; Kruger 1979).

The study area normally experiences a high rainfall during the winter months viz. 1977 (June 404,0 mm; July 270,0 mm); 1979 (June 162,2 mm; July 131,5 mm). However, exceptionally dry winters such as in 1978 are also experienced (June 55,0 mm; July 52,0 mm). The

Table 1. Rainfall data in mm for the Silver Mine Nature Reserve (Cape Town City Council, Waterworks, Pers. Comm., 1980)

| Year / Month | Season | 1976 | 1977 | 1978 | 1979 | 1980 | 69 year Average |
|---|---|---|---|---|---|---|---|
| December | | 123,5 | 56,0 | 54,0 | 6,1 | | 45,6 |
| January | Summer | | 2,0 | 28,0 | 71,0 | 31,5 | 46,1 |
| February | | | 54,0 | 44,0 | 85,0 | | 38,8 |
| March | | | 48,0 | 81,0 | 90,0 | | 47,3 |
| April | Autumn | | 110,0 | 61,0 | 30,0 | | 98,5 |
| May | | | 227,0 | 138,0 | 170,2 | | 156,8 |
| June | | | 404,0 | 55,0 | 162,2 | | 195,0 |
| July | Winter | | 270,0 | 52,0 | 131,5 | | 194,8 |
| August | | | 216,0 | 166,0 | 123,9 | | 183,1 |
| September | | | 113,0 | 114,0 | 180,1 | | 125,6 |
| October | Spring | | 49,0 | 101,0 | 238,8 | | 88,7 |
| November | | | 36,0 | 21,0 | 7,5 | | 62,1 |
| Total | | | 1 617,0 | 915,0 | 1 296,3 | | 1 282,4 |

average rainfall for a 69 year period is 1 282,4 mm (Mr. R. Fisher, Waterworks, Cape Town City Council, pers. comm. 1980). These long term averages do indicate that 1978 was relatively dry with a total rainfall of 915 mm for the year; 367 mm below the 69 year average. The percentage rainfall for the winter months (June to August) for 1977 to 1979 is 55,30 and 32% respectively. This is somewhat less than the 65% calculated for a period of six months, which is Aschmann's (1973) definition of the Mediterranean Climate Type.

The rainfall is mainly cyclonic and orographic, while thunderstorms occur only occasionally (Schulze, 1965). For instance the Simonstown lightning recording station, which is about 15 km south of the Silver Mine Nature Reserve, recorded an average of 0,2 flashes/$km^2$/annum for the period 1975 to 1979. In the Highveld for the same period an average value of 7 flashes/$km^2$/annum has been recorded (A.J. Erikson, C.S.I.R., pers. comm. 1980). If the rate of lightning flash at Simonstown is compared with that in the Highveld, it is evident that on the Highveld there is a 35 times greater lightning fire risk than at Simonstown.

The study area, which is situated on the windward side of the mountain, experiences a fairly high rainfall (Moolman, Liebenberg and Van Huysteen, 1973) in comparison with the surrounding Cape Flats (Fuggle, 1979).

Table 2. Temperature data ($^{o}C$) for Kirstenbosch (from climate of South Africa, Weather Bureau, 1954)

No. 20/779 Kirstenbosch Period 1915 - 1950
Lat.= 33° 59'S; Long.= 18° 26'E; H = 88 m

| Month | Mean of Daily Max. | Mean of Monthly Max. | Extreme Daily Max. | Year | Mean of Daily Min. | Mean of Monthly Min. | Extreme Daily Min. | Year | Max. + Min./2 | Range Max. - Min. |
|---|---|---|---|---|---|---|---|---|---|---|
| I | 24.4 | 32.3 | 38.3 | 1924 | 15.1 | 11.0 | 9.0 | 1938 | 19.7 | 9.3 |
| II | 25.0 | 34.5 | 38.6 | 16 | 15.2 | 11.5 | 7.2 | 28 | 20.1 | 9.8 |
| III | 23.8 | 33.1 | 37.5 | 43 | 14.4 | 10.6 | 6.8 | 29 | 19.1 | 9.4 |
| IV | 21.3 | 33.4 | 36.8 | 33 | 12.6 | 6.8 | 6.2 | 17 | 17.2 | 8.7 |
| V | 19.1 | 28.2 | 33.6 | 32 | 10.7 | 6.9 | 4.4 | 36 | 14.9 | 8.4 |
| VI | 17.4 | 24.6 | 28.7 | 22 | 9.4 | 5.8 | 3.3 | 31 | 13.4 | 8.0 |
| VII | 16.4 | 24.8 | 31.8 | 34 | 8.7 | 5.2 | 1.8 | 26 | 12.6 | 7.7 |
| VIII | 16.9 | 26.1 | 31.8 | 36 | 8.8 | 4.5 | 1.4 | 22 | 12.6 | 8.1 |
| IX | 17.8 | 26.7 | 32.2 | 43 | 9.6 | 5.4 | 2.8 | 28 | 13.7 | 8.2 |
| X | 19.6 | 28.8 | 33.4 | 22 | 10.8 | 6.8 | 3.9 | 34 | 15.2 | 8.8 |
| XI | 21.6 | 29.9 | 36.0 | 31 | 12.6 | 8.0 | 6.0 | 28 | 17.1 | 9.0 |
| XII | 23.4 | 31.7 | 36.4 | 41 | 13.9 | 9.7 | 6.8 | 26 | 18.7 | 9.5 |
| YEAR | 20.6 | - | 38.6 | 1916 | 11.8 | - | 1.4 | 1922 | 16.2 | 8.8 |

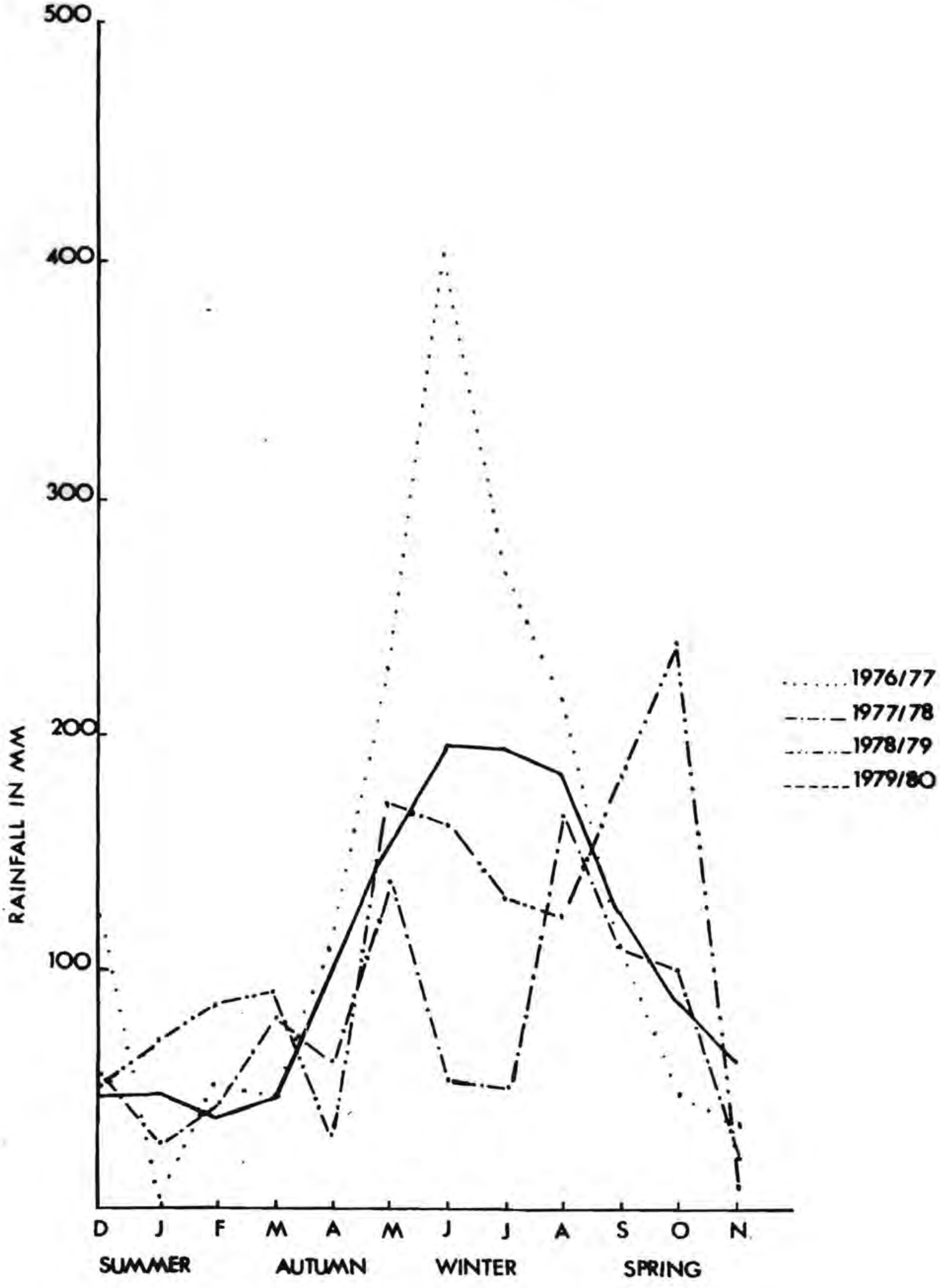


Fig. 3 Rainfall for the SILVER MINE NATURE RESERVE (Cape Town City Council Waterworks, Pers. Comm., 1980).

However, the total amount of rainfall for June, July and August (Table 1 and Fig. 3), as well as the total rainfall from 1977-1979, as shown on Table 1, illustrates that the rainfall pattern is both complex and erratic (Fuggle, 1979).

## 2.3 Temperature

Temperature figures were only available from Kirstenbosch, about 12 km north of the study area.

It is evident from Table 2 that an extreme summer maximum temperature of 38,6°C in February has been recorded, whereas the mean monthly maximum in summer is between 31,7 to 34,5°C. In winter an extreme minimum of 1,4°C in August has been recorded and the mean monthly minimum is about 5°C (McKenzie 1976). The daily temperature range throughout the year is between 7,7 to 9,8°C, which is relatively small.

## 2.4 Mist

Marloth (1905) and Nagel (1956 and 1961) consider that mist is a very important contributor to the total precipitation of an area such as the Silver Mine Nature Reserve. The upper mountain slopes of the Reserve are often covered by orographic cloud, which is induced by the anti-cyclonic south-easter, especially during the summer months (which is the dry season) (See photo 1).

It has also been observed that precipitation from mist is sufficient to increase the rate of flow of mountain streams, which indicates that a large volume of water is deposited from mist (Campbell and Moll, 1977). The presence of the mist over the study area renders the vegetation and soil fairly moist and in summer this is an important source of precipitation (pers. obs.).

## 2.5 Winds

The weather of the Silver Mine Nature Reserve is dominated by the general circulation of the sub-tropical anticyclones. "The winter circulation of the South-western Cape is associated with disturbances in the circum-polar westerly winds, taking the form of a succession of eastward moving cyclones (depressions) and anticyclones. Originating in areas of cyclogenesis far to the south and west of Southern Africa, these disturbances first bring rain to the south-western areas (where the study area is situated) and later to the south and south-eastern coast and may even extend far inland. Fronts are associated with the depressions: warm fronts are diffuse, difficult to recognise and almost impossible to follow; cold fronts are more usual, sharper and more easily recognised. Following the passage of a cold front, winds back from north-west to west and south-west and the pressure starts rising, temperatures fall and instability showers and storms may occur. Most winter rain in the South-western Cape (the study area included), however, occurs in association with north westerly pre-fontal winds" (Jackson and Tyson, 1971). Föhn-like "bergwinds" often precede winter anticyclones when dry subsiding air moves off the interior plateau in response to strong coastward pressure gradients (Jackson and Tyson, 1971). These bergwinds (Tyson, 1964) are characterised by a sudden increase in temperature and a decrease in humidity creating a fire hazard (Wicht and de Villiers, 1963).

Summer weather results from a slight southward displacement of the subtropical high pressure belt over the oceans; viz. the Atlantic (which affects the study area) and the Indian oceans. This belt appears as a dynamic system of anticyclones which travel eastward and along the coast blocking the westerly cyclones. As a result the South-western Cape experiences weather characterised by warm, dry conditions with south-east winds blowing frequently (Wellington, 1955; Schulze, 1965; Kruger, 1979).

The wind-rose for the D.F. Malan weather station is given in Fig. 4 (Weather Bureau, 1975) to show the variations in strength and direction of wind from an area which is 50 km to the north-east of the study zone. The percentage calm for January is 17,9 and for July it is 38,7 (Mr. B. Sciocatti, <u>pers. comm.</u> 1980).

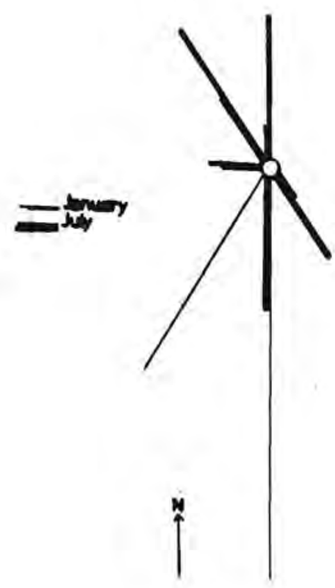


Fig. 4 Windrose for D.F. Malan; the length of line indicates the relative duration of wind from any particular direction (data from Weather Bureau, 1975).

## 2.6 Synopsis of climatic factors

The interaction of mist, wind, rainfall and temperatures which are considered to be the four most significant climatic parameters influencing the vegetation of the Silver Mine Reserve, are briefly summarised below.

The cooling winds in summer are almost exclusively from the south-east, producing orographic cloud responsible for the mists which are an important additional source of precipitation. In winter north-westerly winds are frequent and bring rainy weather. The rainfall is profoundly influenced by orographical features resulting in annual amounts of 900 - 1 600 mm of rain. The seasonal and daily temperature fluctuations are moderate.

The principal climatic features are summarized graphically in Fig. 5 (the stippled area indicates a period of water deficit).

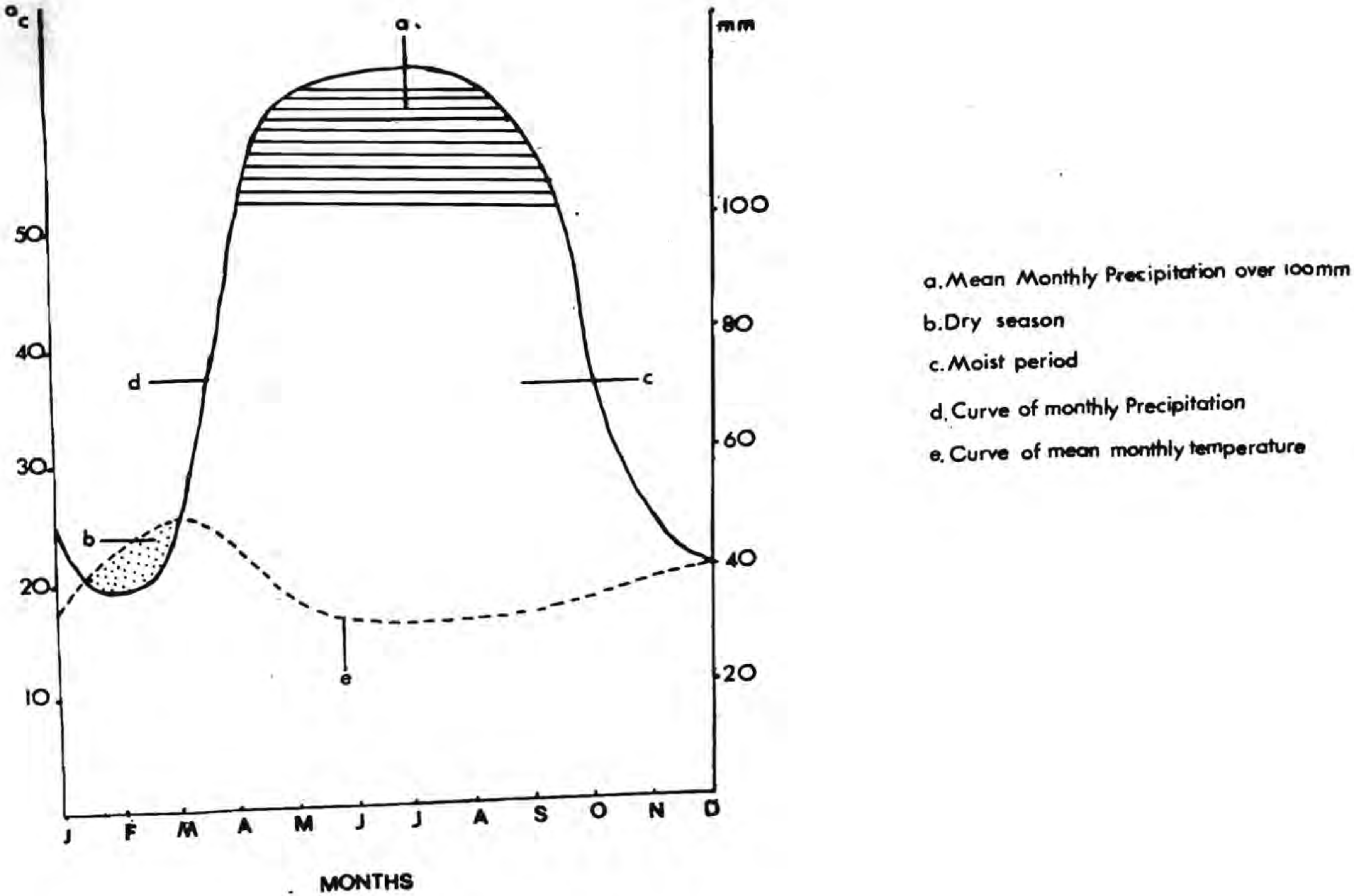


Fig. 5 An ombrothermic climate-diagram (Walter, et. al. 1960) for SILVER MINE NATURE RESERVE (rainfall) and Kirstenbosch (temperature).

# CHAPTER 3

# PHYTOSOCIOLOGICAL SETTING

## 3.1 Introduction

The Braun-Blanquet method of sampling and synthesis as applied by the Zürich-Montpellier School of Phytosociology was used to describe the plant communities (Werger, 1974; Mueller-Dombois and Ellenberg, 1974; Boucher and Jarman, 1977). The Zürich-Montpellier approach was chosen for the present study because it was considered to be:-

(a) a suitable method for the present study (see Werger, 1974); and

(b) capable of providing the classification of plant communitities at an appropriate level.

## 3.2 Sampling

### 3.2.1 Choice of relevés

A total of 35 plots were sampled, five in each of seven stands of vegetation. Thirty of these plots were chosen subjectively in accordance with the community unit theory which postulates that "vegetation consists of natural entities generally contacting each other along narrow boundaries"

(Braun-Blanquet, 1932; Whittaker, 1960; Mueller-Dombois and Ellenberg, 1974; Werger, 1974). The remaining five plots were located randomly in part of the study area, (see Fig. 6) so as to determine the relationships of the vegetation of the study area to that of the surrounding area. This method of subjective selection of samples is believed to give maximum efficiency because heterogeneous plots are to a large extent avoided (Ellenberg, 1956; Becking, 1957; Dahl, 1957; Barkman, 1958; Gounot, 1961, 1969; Braun-Blanquet, 1964; Daubenmire, 1968; Knapp, 1971; Werger, 1974).

The remaining five permanent plots were selected randomly because they were also to be used to monitor periodically the regeneration strategies and rates of growth of the fynbos species after fire, so any form of bias was to be avoided. The data collected from the permanently marked plots are discussed in Chapter 4.

### 3.2.2 Representativeness

The stands for sampling were selected so that each was a representative of the vegetation of which it was part, and each plot sampled was a typical representative of the vegetation present.

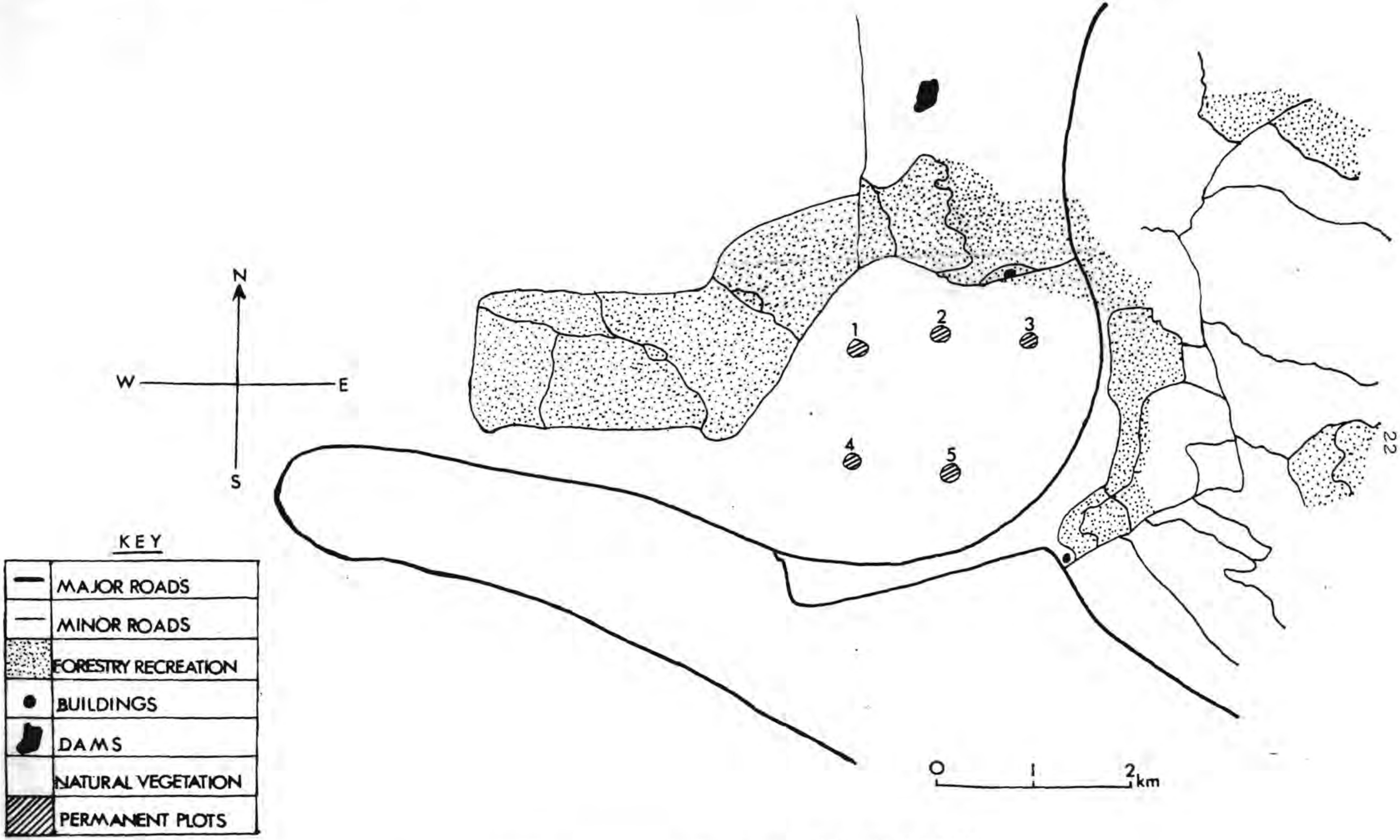


Fig. 6 The position of the permanent plots in the study area.

### 3.2.3 Homegeneity

From the study of available literature on ecology a clear and concise meaning of homogeneity was not available. Because the term appears to be a polemic between various ecologists, it was decided for the purpose of the present investigation to accept the view point adopted by many ecologists (Dahl and Hadac, 1949; Ellenberg, 1956; Dahl, 1957; Braun-Blanquet, 1964; Daubenmire, 1968; Knapp, 1971), who take the practical approach in assessing homogeneity of the plot subjectively in terms of as little as possible obvious hetrogeneity in floristics, structure and habitat (Werger, 1974).

### 3.2.4 Plot size

Thirty five, 10 x 10 m plots were used to sample the vegetation. This size was found to be suitable for both fynbos vegetation and forests in previous phytosociological surveys in south-western Cape. (Werger, Kruger and Taylor, 1972; and Campbell and Moll, 1977).

In the Zürich-Montpellier method one is not tied down to a fixed plot size, nor to a fixed plot form in sampling the vegetation of a region, because species are rated on a cover-abundance scale with relative values. But it is imperative that the plot size and the vegetation in the plot represents an example of a single vegetation type only (Werger, 1974).

3.2.5 Data collected

The following data were collected at each sample site:-

3.2.5.1 Soil depth: deep (>50 mm); medium (50-20 mm); or shallow (<20 mm).

3.2.5.2 Slope: Flat (0-3$^{o}$); gentle (3-8,5$^{o}$); or very steep (>8,5$^{o}$)

3.2.5.3 Surface Rockiness: No rocks; medium rocks, or rocky.

3.2.5.4 Position in landscape: ridge top; slope (protected) and slope (exposed).

3.2.5.5 The age after fire, by using the node count or bud imprint method on members of the Proteaceae.

3.2.5.6 A complete list of species occurring in each plot was made. The plant species were identified at the Compton Herbarium, Kirstenbosch.

3.2.5.7 The relative importance of each species in each relevé was assessed on the following cover abundance scale (Werger, 1974):

r: Very rare with a negligible cover;

+: Present but not abundant, with a small cover value;

1: Numerous but covering less than 1% of the sample area, or not so abundant but covering between 1 and 5% of the sample area;

2: Very numerous and covering less than 5% of the sample area, or covering between 5 and 25% of the sample area, independent of abundance;

3: Covering between 25% and 50% of the sample area, independent of abundance;

4: Covering between 50% and 75% of the sample area, independent of abundance;

5: Covering between 75% and 100% of the sample area, independent of abundance.

## 3.3. Synthetic Phase

Numerous methods have been published describing numerical aids to phytosociological studies (Ceska and Roemer, 1971; Campbell and Moll, 1976; Ceska and Roemer, 1976). However, in this study the Braun-Blanquet table method as described by Westhoff and van der Maarel (1973), Werger (1974) and Mueller - Dombois and Ellenberg (1974) was used to construct the final phytosociological table. Although this method is subjective the results are often similar to those obtained by numerical methods (Werger, 1974). Coetzee and Werger (1973) and Coetzee (1974) in fact argued in favour of the table method being superior to the numerical methods they tested. Campbell and Moll (1976) pointed out that the numerical methods used by these workers and others had undesirable properties, indicating that the efficiency of the method often depended on the nature of the raw data. However, even if possessing undesirable properties, numerical methods are most useful when very large numbers of relevés and species are involved. In the present research the table method was used because of the limited number of relevés and the fairly small number of species recorded. The process involved from the "raw table" to the final phytosociological table have been well documented and are not discussed here (Westhoff and van der Maarel, 1973; Werger 1974; Mueller and Dombois and Ellenberg, 1974).

It should be noted that the species recorded in each relevé and its life form, according to Raukiaer (1934) based on the height of the perrenating buds, is indicated in Table 3.

All species recorded are retained in Table 4 for ease of reference, though as a general rule workers usually place rare species, those occurring in only a few relevés, in an appendix.

Table 3. The species are taken from the Braun-Blanquet phytosociological table and arranged alphabetically, according to Raunkiaer (1934).

| Binomial | Family | Life form |
|---|---|---|
| Anthospermum aethiopicum L. | Restionaceae | Nanophanerophyte |
| Aspalathus callosus L. | Leguminosae | Therophyte |
| Asparagus rubicundus Berg. | Liliaceae | Nanophanerophyte |
| Chondropetalum tectorum (L.f.) Pillans | Restionaceae | Hemicryptophyte |
| Clutia alaternoides L. | Euphorbiaceae | Nanophanerophyte |
| Corymbium glabrum | Compositae | Geophyte |
| Cryptadenia grandiflora (L.f.) Meisn. | Thymelaeaceae | Nanophanerophyte |
| Dilatris corymbosa Berg. | Haemodoraceae | Therophyte |
| Drosera cistiflora L. | Droseraceae | Therophyte |
| Elegia juncea L. | Restionaceae | Hemicryptophyte |
| Elegia stipularis Mast. | Restionaceae | Hemicryptophyte |
| Elegia vaginulata Mast. | Restionaceae | Hemicryptophyte |
| Elytropappus scaber (L.f.) Levyns | Compositae | Nanophanerophyte |
| Erica coccinea (E.Abietina) L. | Ericaceae | Nanophanerophyte |
| Erica mammosa L. | Ericaceae | Nanophanerophyte |
| Erica multumbellifera Berg. | Ericaceae | Nanophanerophyte |
| Erica nudiflora L. | Ericaceae | Nanophanerophyte |
| Erica plukeneti L. | Ericaceae | Nanophanerophyte |
| Erica subdivaricata Berg. | Ericaceae | Nanophanerophyte |
| Euryops abrotanifolius (L.) DC. | Compositae | Therophyte |
| Ficinia filiformis (Lam.) Schrad. | Cyperaceae | Hemicryptophyte |
| Gnidia pinifolia L. | Thymelaeaceae | Nanophanerophyte |
| Gnidia viridis Berg. | Thymelaeaceae | Nanophanerophyte |
| Helichrysum vestitum (L.) Schrank | Compositae | Therophyte |
| Hypodiscus aristatus (Thg.) Nees | Restionaceae | Hemicryptophyte |
| Hypolaena digitata (Thg.) Pillans | Restionaceae | Hemicryptophyte |
| Leucadendron laureolum (Lam.)Fourcade | Proteaceae | Nanophanerophyte |
| Leucadendron salignum Berg. | Proteaceae | Nanophanerophyte |
| Leucadendron xanthoconus (O. Ktze.) - K. Schum. | Proteaceae | Nanophanerophyte |
| Lobelia pinifolia L. | Campanulaceae | Therophyte |
| Lobelia setacea Thg. | Campanulaceae | Therophyte |

| Binomial | Family | Life form |
|---|---|---|
| Pelargonium cucullatum (L.) Ait. | Geraniaceae | Therophyte |
| Penaea mucronata L. | Penaeaceae | Nanophanerophyte |
| Pentaschistis steudelli (Achneria Capensis) McClean | Gramineae | Hemicryptophyte |
| Pentaschistis tortuosa (Trin.) Stapf | Gramineae | Hemicryptophyte |
| Protea lepidocarpodendron L. | Proteaceae | Nanophanerophyte |
| Restio cuspidatus Thg. | Restionaceae | Nanophanerophyte |
| Restio filiformis Poir. | Restionaceae | Hemicryptophyte |
| Saltera sarcocolla (L.) Bullock | Renaeceae | Nanophanerophyte |
| Senecio burchellii DC. | Compositae | Therophyte |
| Senecio pubigerus (L.) | Compositae | Therophyte |
| Senecio rigidus L. | Compositae | Therophyte |
| Simocheilus depressus (Licht.) Benth. | Ericaceae | Nanophanerophyte |
| Scyphogyne muscosa (Ait.) Druce | Ericaceae | Nanophanerophyte |
| Staavia radiata Dahl | Bruniaceae | Nanophanerophyte |
| Staberoha distachya (Rottb.) Kunth | Restionaceae | Hemicryptophyte |
| Thamnochortus dichotomus (Rottb.)R.Br. | Restionaceae | Hemicryptophyte |
| Thamnochortus gracilis Mast. | Restionaceae | Hemicryptophyte |
| Wachendorfia paniculata Burm. | Haemodoraceae | Geophyte |
| Watsonia pyramidata (Andr.) Stapf | Iridaceae | Geophyte |
| Watsonia tabularis Mathews & L. Bol. | Iridaceae | Geophyte |
| Willdenowia lucaeana Kunth | Restionaceae | Hemicryptophyte |

## 3.4 Description of vegetation

### 3.4.1 Introduction

A Braun-Blanquet phytosociological investigation of the study area which formed part of the Silver Mine Nature Reserve, revealed that the two communities recognised were related to habitat.

The description given below of these communities is based on a synthesis of relevé data given in Table 4. These communities are:-

(a) a Leucadendron laureolum - Erica plukeneti shrub community.

(b) an Elytropappus scaber - Watsonia pyramidata shrub community.

### 3.4.2 Description of communities

3.4.2.1 The Leucadendron laureolum - Erica plukeneti Shrub Community occurring on ridge tops and flat slopes. This community is represented by 28 relevés viz. 1, 3, 5, 2, 4, 19, 24, 23, 25, 28, 26, 31, 6, 30, 33, 34, 32, 14, 15, 35, 29, 27, 22, 21, 15, 12, 13 and 16. The differentiating species are Leucadendron laureolum and Erica plukeneti and the community occurs on shallow, medium to deep soils; on rock free to rocky areas (here reference is being made to visible surface bedrock; and on ridge tops and slopes.

In this community L. laureolum occurs in all relevés except 6, 30 and 35. The absence of this erect shrub from these relevés could be due to seasonal waterlogging as this species usually occurs in well drained areas (Adamson and Salter, 1950).

Three sub-communities were recognised, these are:-

Sub-community 1

Leucadendron laureolum - Erica plukeneti - Helichrysum vestitum Sub-community which is found on the saddle between Dassenberg and the Muizenberg Mountain.

This Sub-community is represented by 5 relevés viz. 1, 3, 5, 2 and 4. The differentiating species are Helichrysum vestitum - Elegia vaginulata, Ficina filiformis, Aspalathus callosa, Lobelia setacea, Senecio pubigerus and Staavia radiata.

Floristics

(i) Therophyte

(1) H. vestitum is a single stemmed, half-woody shrub that regenerates from seeds following fire.

(2) A. callosus is an erect compact shrub with many ascending branches.

(3) L. setacea is a low growing half-woody plant which is short lived.

(4) S. pubigerus is a half-woody and single stemmed short lived ruderal.

(ii) Hemicryptophytes

(1) E. vaginulata is a rhizomatous, dwarf shrub with narrow sclerophyll leaves.

(2) F. filiformis is an evergreen dwarf shrub with a single main stem and ericoid leaves.

(iii) Nanophanerophytes

S. radiata is an evergreen shrublet with a massive lignotuber. It is a long-lived species with ericoid leaves.

In this community the abundance of a number of species are increased by frequent fires, examples are H. vestitum, E. vaginulata and S. radiata. The former is propagated by means of seeds, whereas the last two resprout from lignotubers.

In this community the nanophanerophyte

L. laureolum has high cover value in relevés 1, 19 and 16. All these nanophanerophytes species have high cover values and found in rockless, ridge top and deep soil areas.
It appears that the E. plukeneti favours medium and shallow soils, but not deep soils. This is evident from relevés where it has a high cover value, as in relevés 29, 27, 26 and 31.

Sub-community 2

Leucadendron laureolum - Erica plukeneti - Watsonia tabularis Sub-community is found in the visibly damp slopes of the study area viz. in areas where there is an accumulation of moisture.
This species is represented by two relevés viz. 19 and 6, consisting of a single differentiating species of Watsonia tabularis.
This species is found in medium to deep soils in flat ridge top and gentle protected slopes.
This agrees with Adamson and Salter's observations on the distribution of the species (1950).

Floristics

W. tabularis which is a semi-evergreen, erect geophyte with strap-shaped leaves.

Sub-community 3

Leucadendron laureolum - Erica plukeneti - Hypolaena digitata Sub-community.

This Sub-community is represented by 21 relevés viz. 24, 23, 25, 28, 26, 31, 30, 33, 34, 32, 14, 15, 35, 29, 27, 22, 21, 18, 12, 13 and 16.

The differentiating species in this Sub-community is Hypolaena digitata, Wachendorfia paniculata, Staberoha distachya, Pentaschistis steudellii, Elegia stipularis, Restio filiformis, Pelargonium cucullatum and Scyphogyne muscosa.

This Sub-community is found in areas where the soil is shallow to medium, with the exception of relevé 16 which has deep soils. The slope of the area varies from gentle to very steep, with the exception of relevé 16 which is found in a flat ridge top area. This Sub-community grows in well-drained areas.

Floristics

(i) Hemicryptophytes

(1) H. digitata is a soft, tufted rhizomatous forb with mucronate sheaths.

(2) S. distachya is a dwarf evergreen, rhizomatous forb.

(3) P. steudellii is a perennial overgreen forb.

(4) E. stipularis is a tufted evergreen perennial with a rhizomatous base.

(5) _R. filiformis_ is a tufted perennial with closely convolute sheaths which are rounded at the apex with a tiny mucron.

(ii) Geophytes

_W. paniculata_ is a deciduous, perennial herb, with a bright red underground corm and leaves which are pleated.

(iii) Nanophanerophytes

_S. muscosa_ is a low, dwarf, evergreen shrub with ericoid leaves.

(iv) Therophytes

_P. cucullatum_ is a half-wooded evergreen shrub with a single main stem.

Sub-community 4 - has three variations viz.

(1) _Leucadendron laureolum_ - _Hypolaena digitata_ - _Simocheilus depressus_ variant is found on well-drained slopes.
This variant is represented by 5 relevés viz. 30, 33, 34, 32 and 14. The differentiating species are _Simocheilus depressus_, _Dilatris corymbosa_, _Asparagus rubicundus_, _Leucadendron xanthoconus_ and _Euryops abrotanifolius_.

This variation is found in soils with a medium depth and having an intermediate cover of rocks. This variation is found on areas with gentle slopes. With the exception of relevés 30 and 14 which is situated in areas with shallow soils; and relevé 30 is found on a very steep northern slope.

Floristics

(i) Nanophanerophytes

(1) S. depressus is an evergreen, low shrub with a stout woody main stem and ericoid leaves.

(2) A. rubicundus has a woody stem with cladodes; it has a massive underground root-system which produces annually stems from the underground root-system.

(3) L. xanthocormus is a large dominant, evergreen shrub consisting of a single main stem.

(ii) Therophytes

(1) D. corymbosa has fan-shaped, evergreen leaves and a rhizome.

(2) E. abrotanifolius is an evergreen, woody, sub-shrub with a single main stem.

In this variation S. depressus has a

high abundance rating in relevés 30, 33, 34, 32 and 14, which has an exposed gentle slope with the exception of relevé 14, which is situated in an area with a protected slope.

(2) Leucadendron laureolum - Hypolaena digitata - Lobelia pinifolia variant variation easily recognised, and found on rocky slopes. This variant is represented by 6 relevés viz. 24, 23, 25, 28, 26 and 31. The differentiating species are: Lobelia pinifolia, Saltera sarcolla and Chondropetalum tectorum. All species are found in shallow soils in rocky and exposed slopes; with the exception of relevés 24 and 23 which are found on steep and gentle slopes respectively.
These relevés are probably waterlogged in winter.

Floristics

(i) Hemicryptophytes

C. tectorum is an erect evergreen giant restio with a rhizomatous base.

(ii) Nanophanerophytes

(1) S. sarcocolla is an upright shrub which is multiple stemmed arising from subterranean lignotubers.

(2) E. nudiflora is a low evergreen herbaceous sub-shrub with a single main stem.
In this community the highest abundance cover for the hemicryptophyte, Cotectorum is found in relevés 28, 26 and 31. The latter two relevés are found in very steep, and rocky areas with shallow soils. Most of the nanophanerophytes are evergreen. S. sarcocolla is totally adapted to fire because of the subterranean lignotuber.

(3) There is a third variant which is found in medium to rocky sites, in which S. depressus and L. pinifolia are absent. The absence of the afore-mentioned two species could possibly be ascribed to the frequency of burning in this particular area.

3.4.2.2 Elytropappus scaber - Watsonia pyramidata Shrub Community which occurs on well-drained slopes and ridge tops.
This community is represented by 28 relevés viz. 30, 33, 34, 32, 14, 15, 35, 29, 27, 22, 24, 23, 25, 28, 26, 31, 21, 18, 12, 13, 16, 17, 10, 11, 7, 8, 9, and 20.
The differentiating species are Elytropappus scaber, Watsonia pyramidata, Pentachistis toruosa and Cryptadenia grandiflora.

This community occurs in shallow and medium as well as deep soils; in a variety of rocky areas, on ridge tops with protected and unprotected slopes. The largest number of species (20) was recorded in relevé 8 and 23. The former relevé is situated in deep soils with rocks and exposed slopes.

Floristics

(i) Geophytes

W. pyramidata is a decidious corm with strap-shaped leaves.

(ii) Hemicryptophytes

P. tortuosa is a tufted perennial. The lower leaf sheaths have apressed hairs. The leaf blade is narrow and rolled.

(iii) Nanophanerophytes

C. grandiflora is a low lax, evergreen shrub with ericoid leaves and a single main stem. The decidious geophyte W. pyramidata has the highest cover abundance value (3) in relevé 8, which is on deep, rockless soil on a ridge top. The perennial, P. tortuosa, with a high cover value of 3 in relevés 7, 8 and 9, is found in deep soils on flat ridge top areas. The evergreen nanophanerophyte, C. grandiflora is 40 cm tall and is found in two relevés in well-drained areas.

Within the E. scaber - W. pyramidata Community two Sub-communities are recognised:-

Elytropappus scaber - Watsonia pyramidata Leucadendron salignum Sub-community which is found on well-drained ridge tops. This Sub-community is represented by four relevés viz. 20, 7, 8 and 9.

The differentiating species are Leucadendron salignum, Athospermum aethiopicum, Gnidia viridis, Erica mammosa, Protea lepidocarpodendron, Thamnochortus gracilis, Clutia alaternoides, Corymbium glabrum, Elegia juncea, Drosera cistiflora and Senecio rigidus.

Floristics

(i) Geophytes

(1) Corymbium glabrum is a dwarf, rhizomatous herb with linear leaves.

(2) D. cistiflora is a tuberous, decidious, geophyte with a glandular stem and leaves.

(ii) Hemicryptophytes

(1) T. gracilis has a flowering stem clustered on a creeping rhizome.

(2) E. *juncea* has flowering stems with sheaths which are caducous, oblong, lanceolate and mucronate.

(iii) Nanophanerophytes

(1) L. *salignum* is an evergreen shrub with a multiple stem which arises from a persistent lignotuber.

(2) A. *aethiopicum* is a dwarf evergreen and upright shrub with woody stems and ericoid leaves.

(3) G. *viridis* is a low, evergreen shrub, which has multiple stems arising from a persistent rootstock.

(4) E. *mammosa* is a sparsely branching shrub with ericoid, evergreen leaves. The stem arises from a lignotuber.

(5) P. *lepidocarpodenton* is an upright, evergreen shrub with broad leaves and a single main stem. It is a gregarious species growing in dense, localised stands.

(6) C. *alternoides* is an evergreen shrub with broadish, flat leaves. It has multiple stems arising from the lignotubers.

(iv) Therophytes

(1) Senecio rigidus is a half-woody sub-shrub. In this Sub-community 18,18% of all species are geophytes and the same percentage are hemicryptophytes. 54,55% are nanophanerophytes and 9,09% are therophytes.

A high cover abundance value of 1, was assigned to the tuberous geophyte, C. glabrum, which is found on ridge tops in deep soils and rockfree areas. The hemicryptophytes e.g. E. juncea possess flowering stems and rhizomes. A high cover value was assigned to relevés 8 and 9. The nanophanerophytes are generally evergreen shrubs with subterranean structures such as rhizomes and lignotubers which enables these plants to regenerate easily after a fire. In C. glabrum, flowering is enhanced by a fire.

3.4.2.3 The accompanying species of the two communities are found on visibly well-drained slopes.

The accompanying species of the two communities are: Hypodiscus aristatus, Erica subdivaricata, Thamnochortus dichotomus, Erica coccinea, Penea mucronata, Restio cuspidatus, Gnidia pinifolia and *Willdenovia lucaena*.

## Floristics

(i) Hemicryptophytes

(1) *H. aristatus* is a tufted, evergreen plant with a rhizomatous base.

(2) *T. dichotomus* is a tufted evergreen plant with a rhizomatous, cylindrical stem with finely divided foliage.

(3) *W. lucaena* is a tufted, evergreen plant with a rhizomatous base.

(ii) Nanophanerophytes

(1) *E. subdivaricata* is a low, woody, evergreen shrub with a single main stem.

(2) *E. coccinea* is a woody, evergreen shrub with a single main stem.

(3) *P. mucronata* is an evergreen shrub possessing multiple stems which arise from persistent rootstock.

(4) *R. cuspidatus* has stems which are terete, and wiry.

(5) *G. pinifolia* is a woody, evergreen shrub with a single main stem and needle-like leaves.

**Table 4. A Braun-Blanquet phytosociological table showing some of the plant communities in the vicinity of the study area in the Silver Mine Nature Reserve.**

| Community | Ridge top | | | | | | | | | | | | | | | | | Slope | | | | | | | | | | | | | | Ridge top | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SOIL DEPTH | ds | ds | ds | ds | ds | ds | ms | ss | ss | ss | ss | ss | ss | ss | ms | ms | ms | ss | ss | ms | ss | ss | ms | ms | ms | ms | ms | ds | ds | ms | ms | ds | ds | ds | ds |
| ROCKINESS | o | o | o | o | o | o | m | r | r | r | r | r | r | r | m | m | m | r | r | m | r | r | m | m | r | m | r | o | o | m | m | o | o | o | o |
| SLOPE | f | f | f | f | f | f | g | s | g | vs | vs | vs | vs | vs | g | g | g | g | g | g | vs | vs | g | g | g | g | g | f | f | g | g | f | g | g | g |
| POSITION IN LANDSCAPE | a | a | a | a | a | a | a | c | c | c | c | c | c | c | b | b | b | c | c | b | c | c | b | b | b | b | c | a | a | b | b | a | a | a | a |
| NUMBER OF SPECIES | 11 | 13 | 7 | 14 | 11 | 8 | 11 | 15 | 8 | 14 | 12 | 14 | 12 | 17 | 12 | 17 | 18 | 10 | 9 | 13 | 13 | 14 | 9 | 10 | 9 | 11 | 11 | 9 | 9 | 12 | 13 | 8 | 18 | 20 | 14 |
| RELEVÉ NUMBERS | 1 | 3 | 5 | 2 | 4 | 19 | 6 | 24 | 23 | 25 | 28 | 26 | 31 | 30 | 33 | 34 | 32 | 14 | 15 | 35 | 29 | 27 | 22 | 21 | 18 | 12 | 13 | 16 | 17 | 10 | 11 | 20 | 7 | 8 | 9 |
| **Differentiating species of the Leucadendron laureolum - Erica plukeneti Shrub Community** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Leucadendron laureolum | 4 | 3 | + | r | 2 | 4 | | 2 | 4 | 2 | 1 | 2 | 2 | | 1 | 2 | 2 | 3 | 4 | | 2 | 2 | 3 | 3 | 4 | 1 | 2 | 4 | | | | | | | |
| Erica plukeneti | + | 1 | | + | + | | | 1 | + | + | + | 2 | 2 | | | + | | | | | 2 | 2 | r | | | | | | | | | | | | |
| **Differentiating species of the L. laureolum - E. plukeneti - Helichrysum vestitum Sub-Community** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Helichrysum vestitum | + | 2 | 1 | + | + | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Elegia vaginulata | + | r | + | + | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Ficina filiformis | 1 | 3 | r | | + | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Aspalathus callosa | + | | + | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Lobelia setacea | | + | | + | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Senecio pubigerus | | | | r | r | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Staavia radiata | | | | + | + | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Differentiating species of the L. laureolum - E. plukeneti - Watsonia tabularis Sub-Community** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Watsonia tabularis | | | | | | 2 | 2 | | | | | | | | | | | | | | | | | | | | | | r | | | | | | |
| **Differentiating species of the L. laureolum - E. plukeneti - Hypolaena digitata Sub-Community** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Hypolaena digitata | | | | | | | | 2 | 2 | 2 | | | + | 2 | | + | 2 | + | + | | | | 3 | | | 1 | | + | + | | | | | | |
| Wachendorfia paniculata | | | | | | | | r | | | | + | r | | 1 | 1 | 1 | | | 1 | r | | r | r | + | | | | | | | | | | |
| Staberoha distachya | | | | | | | | | 2 | 2 | 2 | 1 | | | | | 2 | | | 2 | | | 1 | 2 | | | | | | | | | | | |
| Pentaschistus steudellii | | | | | | | | | | + | | + | r | 1 | | + | 1 | | | 3 | + | | | | | + | r | | | | | | | | |
| Elegia stipularis | | | | | | | | r | | r | | + | | 1 | | | + | | | | | r | r | + | | | | | | | | | | | |
| Restio filiformis | | | | | | | | | | + | | 1 | | | | | | r | | | | 2 | | 2 | + | | | | | | | | | | |
| Pelargonium cucullatum | | | | | | | | r | | | | + | | | | | | | | 1 | + | | | | + | | | | | | | | | | |
| Scyphogyne muscosa | | | | | | | | | | | | | | | | | | | | | | | | | | + | + | | | | | | | | |
| **Differentiating species of the L. laureolum - H. digitata - Lobelia pinifolia Variation** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Lobelia pinifolia | | | | | | | | r | + | + | + | | | | | | | | | | | | | | | | | | | | r | | | | |
| Saltera sarcolla | | | | | | | | | + | + | | + | 1 | | | | | | | | | | | | | | | | | | | | | | |
| Chondropetalum tectorum | | | | | | | | | | | 1 | 1 | 1 | | | | | | | | | | | | | | | | | | | | | | |
| **Differentiating species of the L. laureolum - H. digitata - Simocheilus depressus** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Simocheilus depressus | | | | | | | | | | | | | | 2 | 1 | 3 | 2 | 1 | | | | | | | | | | | | | | | | | |
| Dilatris corymbosa | | | | | | | | | | | | | | r | + | r | | | | | | | | | | | | | | | | | | | |
| Asparagus rubicundus | | | | | | | | | | | | | | + | 1 | + | | | | | | | | | | | | | | | | | | | |
| Leucadendron xanthoconus | | | | | | | | | | | | | | 1 | 1 | 2 | | | | | | | | | | | | | | | | | | | |
| Euryops abrotanifolius | | | | | | | | | | | | | | + | + | | | | | | | | | | | | | | | | | | | | |
| Erica nudiflora | | | | | | | | 2 | | | | 2 | | | | | | | | | | | | | | | | | | | r | | | | 2 |
| **Differentiating species of the Elytropappus scaber - Watsonia pyramidata Shrub Community** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Elytropappus scaber | | | | | | | | | | | | | | | | | | + | | | | | | | + | + | | | 1 | 1 | r | + | 2 | 1 | + |
| Watsonia pyramidata | | | | | | | | | | | | | 1 | | 1 | | | | | | | | | | | | | | | 2 | r | | 2 | 3 | 2 |
| Pentaschistus tortuosa | | | | | | | | | | r | + | | 1 | + | | 2 | + | + | + | | | | r | r | | | | + | | 1 | 2 | + | 3 | 3 | 3 |
| Cryptadenia grandiflora | | | | | | | | | | | | | | | | | | | | | | | | | | | + | | | + | | | | | |
| **Differentiating species of the E. scaber - W. pyrimidata - Leucadendron salignum Sub-Community** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Leucadendron salignum | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 3 | 3 | 3 |
| Athospermum aethiopicum | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2 | 2 | |
| Gnidia viridis | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | + | + | |
| Erica mammosa | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | + | + | + | |
| Protea lepidocarpodendrum | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | + | |
| Thamnochortus gracilis | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | + | | + |
| Clutia alaternoides | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | + | + |
| Corymbium glabrum | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 1 |
| Elegia juncea | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 3 | 3 |
| Senecio burchelli | | | | | | | | | | | | | | | | | | | | | | | | | | | | + | | | | | + | | |
| Drosera cistiflora | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | + | + |
| Senecio rigidus | | | | | | | | | | | | | | | | | | | | | r | | | | | | | | 1 | | | | r | r | |
| **Accompanying species of the two communities** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Hypodiscus aristatus | | | | | | + | + | | | r | r | + | + | 4 | 2 | 4 | 3 | r | r | | + | 1 | | | | 1 | + | | r | + | 1 | | | | |
| Erica subdivaricata | | | | | | 1 | r | 1 | + | + | r | + | + | + | | 1 | | r | + | | + | | | 1 | 1 | 1 | | | + | + | + | | | | |
| Thamnochortus dichotomus | | | | | | r | | 1 | | r | r | + | r | | + | 3 | + | r | 1 | | + | 2 | 1 | | | 1 | 1 | | | r | + | | | | |
| Erica coccinea | | | | | | 1 | | r | | | r | | | + | | + | 1 | | | | | | | | + | 1 | + | | r | + | 1 | | | | |
| Penaea mucronata | | | | | | r | | r | | | r | + | + | 1 | + | | | | | | 2 | + | r | | | | 2 | + | + | | + | | | | |
| Willdenowia lucaena | | | | | | | | + | + | r | + | | | | | | | | | | | | + | | | + | | | + | + | 1 | | 2 | | |
| Restio cuspidatus | | | | | | | | | | | | | | 1 | | | | | r | | | r | | | r | | | | | | + | | | | |
| Gnidia pinifolia | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | + | + | | + | | | | | |

SPECIES NOT INCLUDED IN THE ABOVE TABLE: (name, relevé number, cover abundance value)

Adenandra villosa (1) +; Agapanthus africanus (17) 1; Agathelpis dubia (14) +; Alciope tabularis (7) +; Amphithalea ericaefolia (4) +; Aristea glauca (20) +; Aspalathus retroflexa (2) r; Berzelia intermedia (20) +; Blaeria ericoides (6, 8) 1; Carpobrotus edulis (2) +; Cliffortia filifolia (7) +; Cliffortia stricta (16, 34) +; Cliffortia subsetacea (6) +; Cryptadenia uniflora (3) +; Diosma hirsuta (2, 30) +; Erica corifolia (35) 1; Erica cerinthoides (28, 32) +; Erica hispidula (35) +; Erica imbricata (32) +; Erica phylicifolia (6) +; Euphorbia tuberosa (30) +; Gladiolus brevifolius (11,24) r; Hakea tenuifolia (32) +; Hermas villosa (11,24) r; Indigofera mauritanica (8) +; Knowltonia hirsuta (8) +; Lobelia comosa (8) +; Metalasia muricata (3) +; Macrostylis villosa (7) +; Oftia africana (10,11) r; Othonna quinquedentata (9) r; Oxalis polyphylla (5,7) r; Passerina vulgaris (9) r; Pelargonium myrrhifolium (8) +; Pentaschistis thunbergii (2,13) +; Phylica imberbis (9) r; Pinus radiata (1) +; Plagiochloa uniolae (3) +; Polyarrhena reflexa (7,16) +; Restio triticeus (2,6) 3; Rhus laevigata (18) r; Crassula coccinea (1) +; Schizaea pectinata (20) 1; Senecio rosmarinifolius (3) +; Stilbe vestita (4,10) +; Stoebe incana (2,7) 2; Syndesmanthus articulatus (21) +; Tetraria compar (10,34) 1; Tetraria microstachys (7) 1.

KEY:

1. Soiled depth:
   - deep: ds: 30 mm
   - medium: ms: 30 - 20 mm
   - shallow: ss: ≤20 mm
2. Rockiness:
   - no rocks: o
   - medium rocks: m
   - rocky: r
3. Slope:
   - flat: f
   - gentle: g
   - steep: s
   - very steep: vs
4. Position in landscape:
   - ridge top: a
   - slope (protected): b
   - slope (exposed): c

The accompanying species consists of 50% restioids, which are rhizomatous, evergreen hemicryptophytes. These species are fairly well distributed in the majority of relevés. The remaining 50% of the species consist of woody, evergreen seed regenerating nanophanerophytes.

## 3.5 Comparison with other fynbos communities

To establish whether the same communities were found in other phytosociological studies of fynbos in adjacent areas, the following works were consulted:

(a) Taylor (1969) - A survey of the Cape of Good Hope Nature Reserve.

(b) Boucher (1971) - The vegetation of the Cape Hangklip area.

(c) McKenzie, Moll and Campbell (1977) - The phytosociological study of the Orange Kloof, Table Mountain.

(d) Glyphis, Moll and Campbell (1978) - A Phytosociological study on Table Mountain: Back Table.

(e) Laidler, Moll, Glyphis and Campbell (1978) - A phytosociological study on Table Mountain: Front Table.

The results are indicated in the following table:

Table 5. Of the 51 species listed in Table 4 only 18 were recorded from surveys in adjacent areas. These are listed below and are indicated by an X, where they were found in other surveys.

| Name of Species in Present Research | Taylor 1969 | Boucher 1971 | McKenzie et al 1977 | Glyphis et al 1978 | Laidler et al 1978 |
|---|---|---|---|---|---|
| R. cuspidatus | X | | | | X |
| E. plukeneti | X | | X | X | X |
| S. depressus | | | X | X | X |
| E. abrotanifolius | | | | | X |
| P. mucronata | | | X | X | X |
| Watsonia spp. | | | | X | X |
| H. aristatus | X | X | X | | X |
| C. glabrum | X | X | | X | |
| E. coccinea | | X | | X | |
| L. pinifolia | X | X | X | | |
| L. xanthoconus | | | X | | |
| S. muscosa | X | X | | | |
| E. juncea | X | X | | | |
| L. salignum | X | X | | | |
| F. filiformis | X | X | | | |
| E. stipularis | X | X | | | |
| S. sarcocolla | | X | | | |
| G. pinifolia | | X | | | |

The species found by other research workers which also occur in the Silver Mine Nature Reserve are indicated in the above table. The following should be noted:

- The study areas represented fynbos vegetation.
- Only eighteen species were found to be common in most of the studies.

- Although the same species were found in other study areas, they were never recognized in the same community. This could possibly indicate the variable nature of the fynbos community.

3.6 Summary

The vegetation of the Silver Mine Nature Reserve was classified using the Braun-Blanquet technique. Two major communities and four sub-communities and three variations, related to habitat e.g. ridge top area, slopes which are exposed or protected with a gentle or very steep gradients, were recognised. Each of the recognised communities, sub-communities and variations were described in terms of its floristic, structural and environmental factors.

Floristically the communities which were sampled contained the typical constituents of the South-western Cape flora i.e. the fynbos which is distinguished physionomically by the constant presence of two growth forms viz. ericoid shrubs and restioid herbs, and the frequent presence of proteoid shrubs. The ericoid shrubs are low, evergreen shrubs with hard, narrow rolled leaves. The restioid herbs are aphyllous, evergreen, tufted perennials. The proteoid shrubs are medium to tall-broad sclerophyllous shrubs, with hard, leathery iso-bilateral leaves.

Various life forms were found among the species viz.

hemicryptophytes, geophytes, nanophanerophytes and therophytes.

In the vegetation studies the following are species that generate after a fire:

(1) by sprouting from lignotubers e.g. L. salignum, E. mammosa, C. alternoides and C. glabrum;

(2) by seeds, e.g. H. vestitum, which is a sub-woody shrub. These shrubs are said to occur in the greatest abundance eight years after a fire (Kruger, 1979). This was not the position at the Silver Mine Nature Reserve because the vegetation found around the H. vestitum was approximately 20 years old.

From the physiography, rainfall, diagnostic growth forms, characteristic leaf forms and characteristic functional features such as evergreenness and the adaptation of the species to fire regime, makes this study area one of a mountain fynbos type (Kruger, 1979).

# CHAPTER 4

## PHYTOMASS STUDY

### 4.1 Introduction

On completing the reconnaissance vegetation survey of part of the Silver Mine Nature Reserve in which the Braun-Blanquet phytosociological technique was used to determine the relationships of the Laucadendron laureolum - Erica plukeneti Community to the adjacent fynbos types, a phytomass and post-fire regeneration study was undertaken in the L. laureolum - E. plukeneti Community. In this chapter the results of this phytomass study, which was conducted on the flat, north-eastern side of the Silver Mine Nature Reserve (see Figs. 1 and 6), are discussed.

### 4.2 Definition of terms

Phytomass is defined for the purposes of the present study as the above-ground oven dried, plant biomass and does not include the dead wood category (Rutherford, 1979). The cropped material was separated into selected categories (see below), chosen because the proteoid and restioid elements are characteristic of fynbos vegetation.

- Proteoid element: shrubs including microphanerophytes and nanophanerophytes of the family Proteaceae, mainly Laucadendron laureolum.

- Restioid element: aphyllous, evergreen hemicryptophytes of the family Restionaceae, and sometimes, Cyperaceae, which have many photosynthetic stems and few narrow, linear leaves.

- Remainder: Nanophanerophytes, Chamaephytes and Geophytes of families such as Compositae, Ericaceae, Iridaceae and Liliaceae.

## 4.3 Method

On the 4th of April 1978 four 5 x 5 m plots were permanently marked. Although these plots were also located in the study area they are separate from those mentioned in Chapter 3 of this investigation. These plots were selected subjectively on the basis of structural and floristic homogeneity and contained a representative quantity of the proteoid and restioid elements. It should be noted that the phytomass study on the old vegetation (about 20 years old) was conducted prior to the prescribed burn. A fifth 5 x 5 m plot of the same community which was some 10 years old was also studied to obtain comparative data (this was located some 750 m from the four plots discussed above).

The fifth plot was included to give a comparison of the rate of increase or decrease in the phytomass of the L. laureolum - E. plukeneti Community at various post-fire ages viz. one, ten and approximately twenty years. The phytomass results which were obtained in this way are represented graphically (see Fig. 7).

The phytomass was determined by clipping the five, 5 x 5 m quadrats. The proteoid, restioid and the "remainder" were kept separate and stored in polythene bags. Plants were clipped as close to the soil surface as possible using secateurs. For practical reasons the proteoid element was cut-down in the first two twenty year old quadrats only.

In the laboratory the wet mass of the cropped material was determined to the nearest kilogram. The plant material was subsequently oven-dried for 48 hours at $105^{o}$. By using this method all fresh mass was converted to dry mass (Kruger, 1977b; Rutherford, 1979). Although the procedure for drying the plant material was similar to what has been done elsewhere in phytomass studies conducted in the fynbos, it should be noted all the material was weighed and that the method of sub-sampling as described by Kruger (1977b) was not used.

## 4.4 The Communities

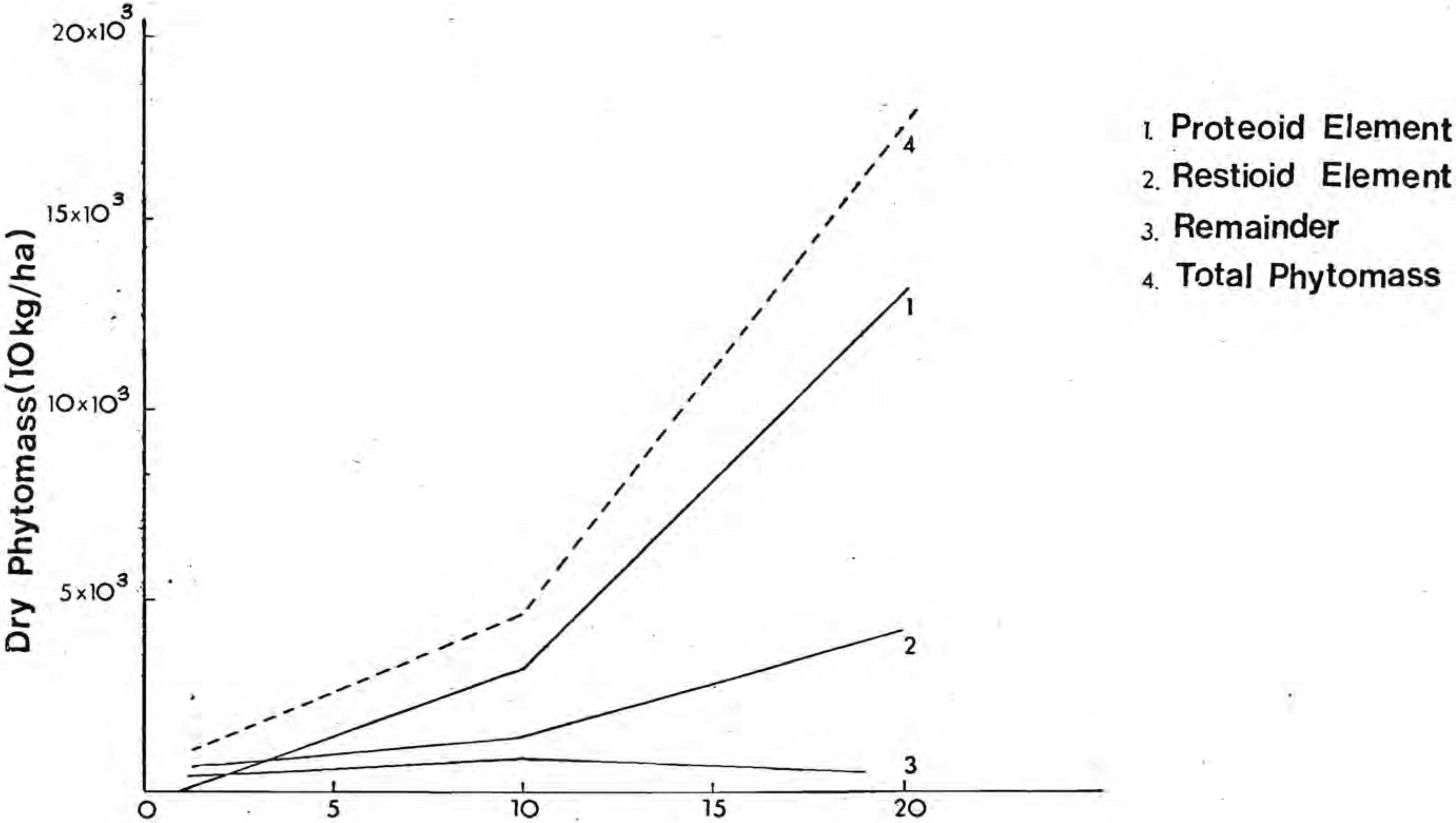


Fig. 7 Change of phytomass with age after fire.

### 4.4.1 The approximately twenty year old community

Four plots were cropped for restioid and the "remainder". Of the four only two were cropped for the proteoid element. Two plots of the one year old community were cropped twelve months after the prescribed burn. These two plots belong to the original four plots occupied by the approximately twenty year old vegetation.

The approximately twenty year old vegetation was reasonably homogeneous and dominated by proteoid and restioid elements. The proteoid element, comprising only *Leucadendron laureolum* was showing signs of senescence. During the senescent phase the mortality among seed-regenerating shrubs is increased, the foliage on the survivors being typically reduced to tufts of a few leaves at the tips of branches, the nodes become shorter and the crowns become more open. With the opening of the canopy some regeneration may occur (Kruger, 1977b). Low shrubs such as the various *Erica* spp. were also beginning to die and large quantities of litter had accumulated (see Table 7). The lower herbaceous strata was reduced in importance. However, no regeneration of any species was observed. See photo 3.

### 4.4.2 Ten year old community (One plot was cropped)

This relatively young phase of the *Leucadendron* laureolum - Erica plukeneti Community was dominated by vigourously growing proteoid and restioid elements. See photo 1.

### 4.4.3 One year old community (Four plots were cropped i.e. after regeneration of those mentioned in para. 4.4.1)

In the one year old community neither the restioid nor the proteoid elements dominated, in fact there was no proteoid element present at all. The most important component was the "remainder", which comprised the nanophanerophytes and geophytes. See photo 4.

## 4.5 Results

The phytomass data for the post-fire period of approximately twenty years, ten years and one year is represented in detail in Table 6 and further depicted in Fig. 8.

The total average phytomass value of vegetation of approximate post-fire age of approximately 20 years was 17 774,5 kg/ha. The total average phytomass value thus obtained consisted of: The proteoid element consisting of L. laureolum from two plots which gave a value of 13 117 kg/ha, the restioid element from four plots gave a value of 4 146 kg/ha, and 511,5 kg/ha was contributed by the "remainder".

Table 6. Phytomass data from the fynbos study area in the Silver Mine Nature Reserve

| Age: (Yrs.) (Post-fire) | Plant type | Phytomass: kg/ha Wet | Phytomass: kg/ha Dry | Percentage Water |
|---|---|---|---|---|
| 20 | Proteoid | 23 040,5 | 13 117,0 | 43,07 |
| 10 | Proteoid | 6 400 | 3 092 | 51,7 |
| 1 | Proteoid | 0 | 0 | 0 |
| 20 | Restioid | 7 634 | 4 146 | 45,69 |
| 10 | Restioid | 2 800 | 1 234 | 55,9 |
| 1 | Restioid | 660 | 255 | 61,36 |
| 20 | Remainder | 1 161,5 | 511,5 | 55,96 |
| 10 | Remainder | 2 340 | 545 | 76,71 |
| 1 | Remainder | 800 | 380 | 52,5 |

Table 7. Mass of litter from the fynbos study area in the Silver Mine Nature Reserve

| Age of vegetation in years | Litter mass kg/ha |
|---|---|
| 20 | 25 440 |
| 10 | 8 000 |
| 1 | 0 |

The total phytomass obtained from the approximately ten year old post-fire vegetation was 4 871 kg/ha and consisted of: the proteoid element 3 092 kg/ha, the restioid element 1 234 kg/ha and the "remainder" 545 kg/ha.

The post-fire vegetation of the one year old stand, gave a total average phytomass value of 635 kg/ha, which consisted of the restioid element contributing 255 kg/ha and the remainder 380 kg/ha. One year after the burn no regeneration of the proteoid element was observed.

From Table 6 it may be concluded that for the proteoid element the average percentage water decreased from 51,7% for the 10 year old vegetation to 43,07% for the approximately 20 year old vegetation. In the case of the restioid element the percentage water is highest for the first post-fire year (61,36%) and lowest (45,69%) for the approximately twenty year old vegetation. The highest percentage of water for the "remainder" vegetation is the tenth year after the burn viz. 76,71%, whereas for the first and approximately twentieth years it was found to be 52,5% and 55,96% respectively.

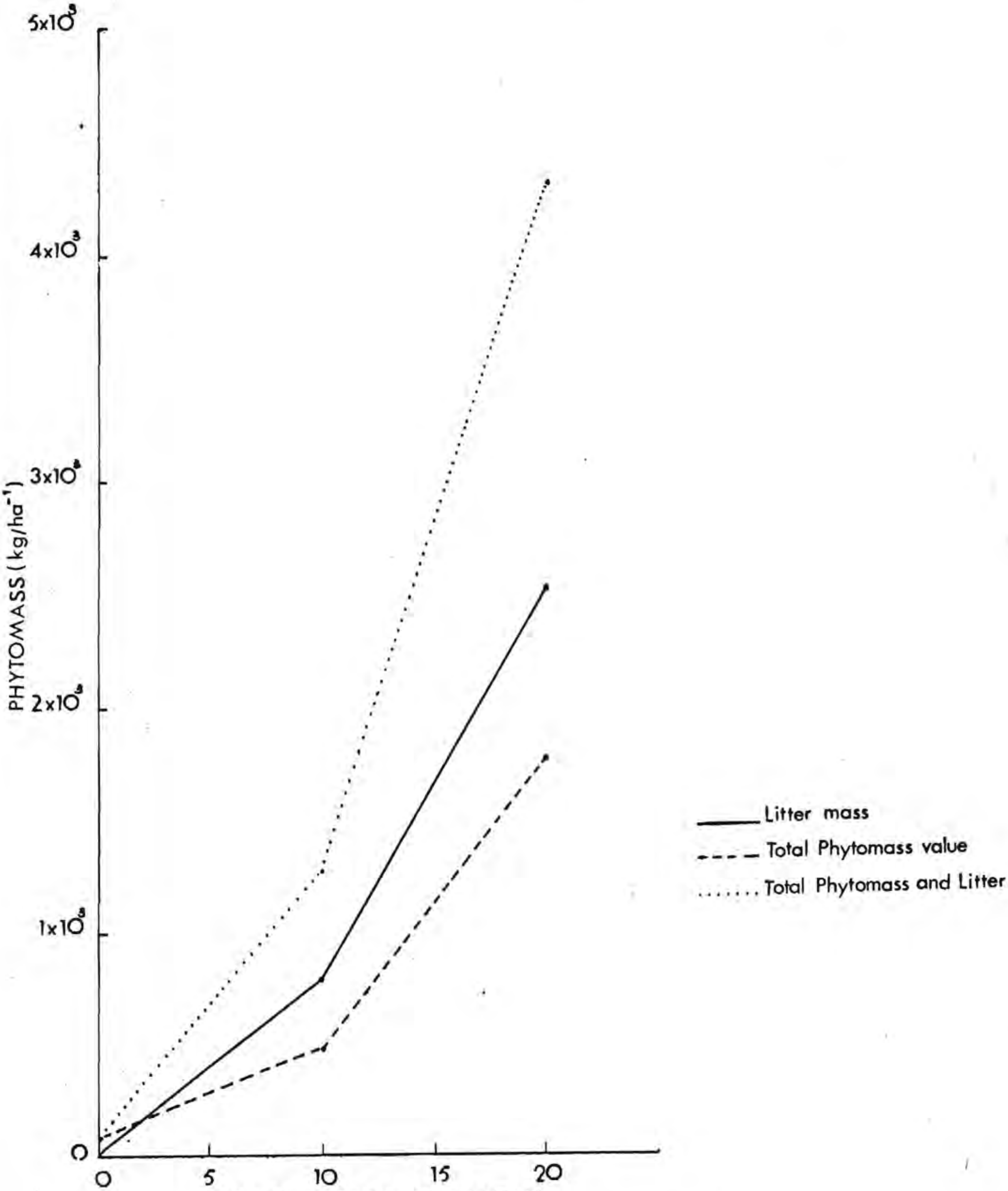


Fig. 8 Comparison of phytomass and litter values from three ages of fynbos after fire at SILVER MINE NATURE RESERVE.

## 4.6 Discussion

### 4.6.1 Silver Mine

Fig. 8 shows the approximate relationship between total live phytomass, litter mass and the post-burn age of the fynbos vegetation at the Silver Mine Nature Reserve. It appears that the total live phytomass increases with age, but according to Van Wilgen (in prep), working at Jonkershoek, there is a decrease in living phytomass after twenty years. This decrease in phytomass results in the litter mass (dead material) increasing as the post-burn age increases. From Table 7 it is evident that the litter mass at Silver Mine for the approximately twenty year old vegetation is 25 440 kg/ha compared with 8 000 kg/ha for the ten year old vegetation. The conclusion being that unlike the Jonkershoek situation, there is no tendency of senescence after approximately 20 years at Silver Mine.

#### 4.6.1.1 Phytomass values

(a) Proteoid element

The phytomass value of an approximately 20 year old *L. laureolum* community was 13 117 kg/ha and for a ten year old community it was 3 092 kg/ha. Hence the average growth rate over a

20 year period was 656 kg/ha/yr, whereas for the ten year old vegetation it was 309,2 kg/ha/yr. The difference in growth rates for the proteoid element can be ascribed to the fact that up to the tenth year the growth is fairly slow and beyond the tenth year a rapid increase in the growth rate is evident (see Fig. 7).

(b) Restioid element

The restioid element for the post-fire ages of one, ten and approximately twenty years has a phytomass of 255 kg/ha; 1 234 kg/ha and 4 146 kg/ha respectively. It is evident that the total phytomass increases with age (see Fig. 7), whereas the average percentage water, as indicated in Table 6, decreases. The decrease in the percentage water with an increase in the age of the vegetation could be ascribed to the decrease in the soft, pliable plant tissue and increase in the fibre element.

(c) "Remainder"

The phytomass of the "remainder" of the vegetation was 380 kg/ha, 545 kg/ha and 511,5 kg/ha for the post-fire ages of one year, ten and approximately twenty years respectively. The ten year old vegetation shows the intermediate phytomass value in comparison with the one and approximately twenty year old vegetation, which could be ascribed to the situation of the plot, which was on the northwest side of the study area, where it appeared to be drier. The following post-fire growth rates were deduced: for the first year it was 380 kg/ha/yr, whereas for the tenth year it was 54,5 kg/ha/yr and for the approximately twentieth year it was 25,55 kg/ha/yr. From the results deduced it appears that the maximum growth rate was in the first few years and thereafter there has been a rapid decrease. The decrease in growth rate could be ascribed to the increase of the fibrous element and litter formation.

## 4.7 Phytomass studies conducted elsewhere in the Fynbos Biome

Kruger (1977b) established from a relationship between fynbos phytomass and age (since the last fire) for the Jonkershoek forest station that the phytomass was 14 000 kg/ha for the restioid element of 10-15 years post-fire age.

The growth rate per annum, if taken for ten years of growth, assuming that the post-fire age of the vegetation was ten years, is 400 kg/ha/yr, which does not compare favourably with the result obtained for the restioid element of about ten years post-fire age at the Silver Mine Nature Reserve which was 1 23,4 kg/ha/yr. This difference in growth rates of the restioid element could possibly be ascribed to the climatic difference between the two areas. The phytomass of 10 year post-fire Protea laurifolia at Jonkershoek showed a growth rate of 1 100 kg/ha/yr, in comparison with the proteoid element at Silver Mine which was 309 kg/ha/yr (28% that of Jonkershoek). The species studied in the two areas were not the same viz. Leucadendron laureolum and P. laurifolia, which could explain the difference. The other possibility is the difference in site viz. soil, climate and past management.

4.7.1 Van Wilgen (in prep) determined the phytomass of 21 year old vegetation at Jonkershoek. The Protea neriifolia a phytomass of 9 065 kg/ha indicates a growth rate of 431,6 kg/ha/yr. Van Wilgen (in prep) also established that P. repens yielded a phytomass of 13 771,8 kg/ha and a growth rate of 655,8 kg/ha/yr. At Silver Mine growth rate of L. laureolum, the only proteoid element, was similar to that of P. neriifolia. However, the growth rate of the P. repens is 38,14% higher than the growth rate of the L. laureolum. The difference in the growth rates of the two species viz.

*L. laureolum* and *P. repens* could perhaps be ascribed to the soil differences and the slightly higher rainfall at the Jonkershoek forest station in comparison with that of the Silver Mine Nature Reserve. Hence, the difference in the growth rates of various species of proteaceae in different areas mentioned under section 4.7.1 is in agreement with the findings by Van Wilgen (in prep).

4.7.2 Rutherford (1978) determined the total phytomass of the restioid element of 14 years post-fire age fynbos in the Riviersonderend mountains as being 14 311 kg/ha, indicating an annual growth rate of 1 022,21 kg/ha. Although the results obtained at Riviersonderend cannot be directly compared with the results obtained at the Silver Mine Nature Reserve, however, it was the intention to establish a personal working basis for future investigations in the study area. This growth rate was 82,83% more than the annual growth rate of the 10 year old restionaceous community found at Silver Mine and 73% more than the value at Jonkershoek (Van Wilgen, in prep). The 14 year old *Protea laurifolia* component indicated a growth rate of 790,2 kg/ha which is about 60% more than the phytomass of the 10 year old *L. laureolum* at Silver Mine and 71,8% of the phytomass for the same species at Jonkershoek. From the phytomass results for the proteoid and restioid elements it appears that if the same species is studied, a slight variation in the phytomass result is obtained whereas with different species, as was found in the composition of the proteoid element at different places of investigation, widely differing results were obtained.

4.7.3 The third year students (Department of Botany, University of Cape Town, 1979) established that the phytomass of a protea community, of about 14 years old, at Bainskloof was 27 269 kg/ha. A high growth rate of 1 947 kg/ha/yr was calculated which was above all other growth rates in the Republic of South Africa which were discussed under sub-section 4.7.

Robertson (1979) is of the opinion that the high growth rate could be ascribed to inaccurate calculation of values, because the full age distribution of Protea laurifolia within each community was not accounted for.

## 4.8 Research completed in other mediterranean areas

Kruger (1977b) and Rutherford (1978) point out, that a great deal of information concerning growth and phytomass in the mediterranean type ecosystems has recently become available (see Fig. 9). This will be evident from the following description:

It was established that the maximum phytomass result obtained was about 49 700 kg/ha at 13 years for

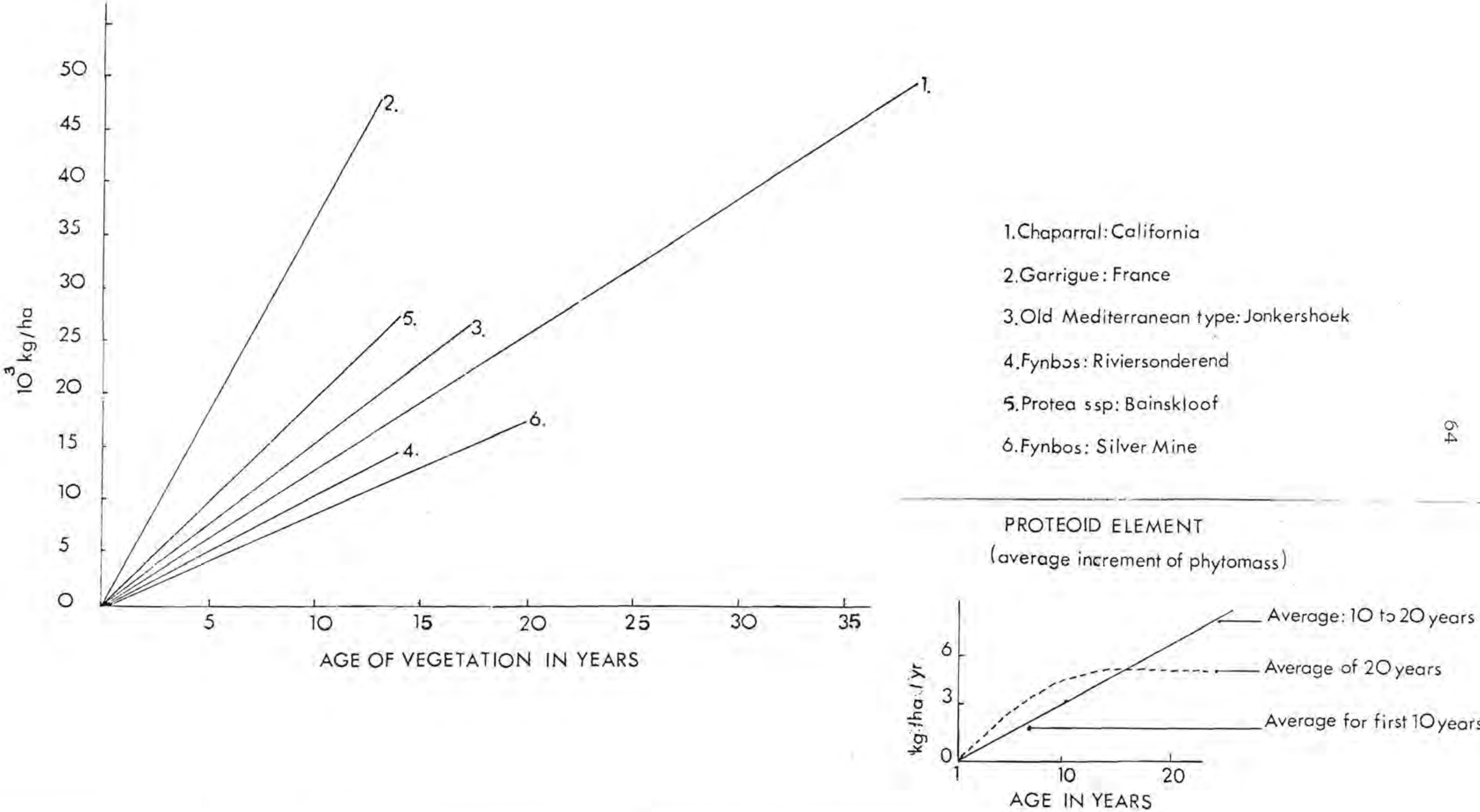


Fig. 9 The relationship between dry phytomass accumulation and age in years after burning; examples from RSA and overseas.

garrigue (France) and 49 100 at 37 years for Chaparral (California), of which 21 800 kg/ha consisted of standing dead sticks. Specht (1969a; 1969b) explains that the data for the typical garrigue indicates a mean increment of about 1 400 kg/ha per annum during the first six years and a total phytomass of about 15 000 kg/ha at 18 years (Long et al., 1967 in Specht, 1969b).

The phytomass of an evergreen chaparral community, with a mean precipitation of 450 mm, amounted to 23 000 kg/ha whereas that of a similar community on a similar site in Chile rendered 7 400 kg/ha (Mooney, Pers. comm. as cited by Kruger, 1977b).

In Australia, growth data for the heath communities for the first five years amounted to about 800 kg/ha per annum (a similar growth rate was observed for the first post-fire year at the study area), whereas for a wet community it amounted to 1 500 kg/ha per annum (Jones and Specht, 1967). For coastal sites the maximum phytomass was about 16 000 kg/ha at 18 years. The growth could be influenced by a taller growing species. Such cases have been reported by Specht et.al. (1958).

The maximum phytomass reported for the 17 year old sclerophyllous scrub community at Jonkershoek was 25 700 kg/ha. This result appears to agree with an

18 year old chaparral community sampled by Specht (1969a; 1969b). The mature heath community at Jakkalsrivier, however, has a lower phytomass than the communities studied elsewhere. The low phytomass result obtained at Jakkalsrivier agrees with a relatively low result obtained at the Silver Mine Nature Reserve of 17 774 kg/ha for a 20 year old fynbos community. This result of 17 774 kg/ha is 69,15 percent of that which was obtained by Kruger (1977b) at Jonkershoek and by Specht (1969a; 1969b) in the chaparral community.

It may be concluded that the growth rates of the characteristic plant communities, which consists of various species, are controlled to a large extent by the certain major factors such as solar radiation and available water (Specht, 1969a; 1969b). Kruger (1977b) indicates that, although more information is needed to explain differences within the data sets, reliable evidence exists that soil moisture overrides the effect of soil fertility, and the community production is influenced by the presence or absence of tall longlived shrubs, both in Australia and the Republic of South Africa.

Phytomass data does indicate that persistent perennial herbs, especially hemicryptophytes, are a feature which distinguishes fynbos from its northern mediterranean and Chile analogues. Chaparral is noted for the rich herbaceous annuals which appear after fire, with maximum abundance within one to five years after a fire and which disappear almost completely thereafter (Sweeney, 1956; Vogl and Schorr, 1972; Mooney and Parsons, 1973; Biswell, 1974). Specht (1969b) indicates these comprised 75% and 14% of total live phytomass one and three year old chaparral respectively, but was not detected in the nine year old stand.

The herbaceous flora of the mediterranean marquis and garrigue also respond strongly to fire, but include perennials which dominate in old stands in small quantities (Naveh, 1974), though their phytomass is not large (Kruger, 1977b). The communities studied by Specht (1969a; 1969b) were dominated from the beginning by phanerophytes and chamaeophytes; herbs amounted to 30 percent of total phytomass in the first year after fire of which the hemicryptophytes contributed to 10 percent of the total phytomass. Westman and Rogers (1977) in Australia established that 42,5% of the total phytomass was below ground. This indicates a high percentage of geophytes and lignotuberous species. In the current study conducted at the Silver Mine Nature Reserve, the hemicryptophytes contributed 31,87 percent of the total phytomass one year after the burn. In the study conducted by Specht (1969b) the hemicryptophytes became insignificant six years after the fire. In the present investigation 10 years after the fire the hemicryptophytes contributed 26,22 percent of the total phytomass. In the approximately 20 year old community at Silver Mine 23,32 percent hemicryptophytes contributed in the total phytomass. These results indicate that the percentage hemicryptophytes in the total phytomass began to decrease. In may be concluded that at no stage were the hemicryptophytes the dominant species (Silver Mine and abroad), in comparison with what was found by Kruger (1977b).

Australian communities are similar in that the hemicryptophytes dominate, but the perennial herbaceous component is not as large as in the fynbos elsewhere in the Republic of South Africa. Data from a "sand heath" at Frankston, Victoria (Jones and Specht, 1967; Jones, 1968) show that the hemicryptophytes reached a maximum of about 2 100 kg/ha at four years, comprising about 32 percent of the total phytomass, whereas one year after the fire the hemicryptophytes at Silver Mine reached this level. Thus it appears that the rate of growth of the present study area is more rapid than that of the Australian community. This rapid growth could be ascribed to relatively high moisture content present in the soil during the growing season when the study was conducted. It appears that the precipitation and ground water is an important factor influencing the phytomass of a vegetation. See Fig. 10.

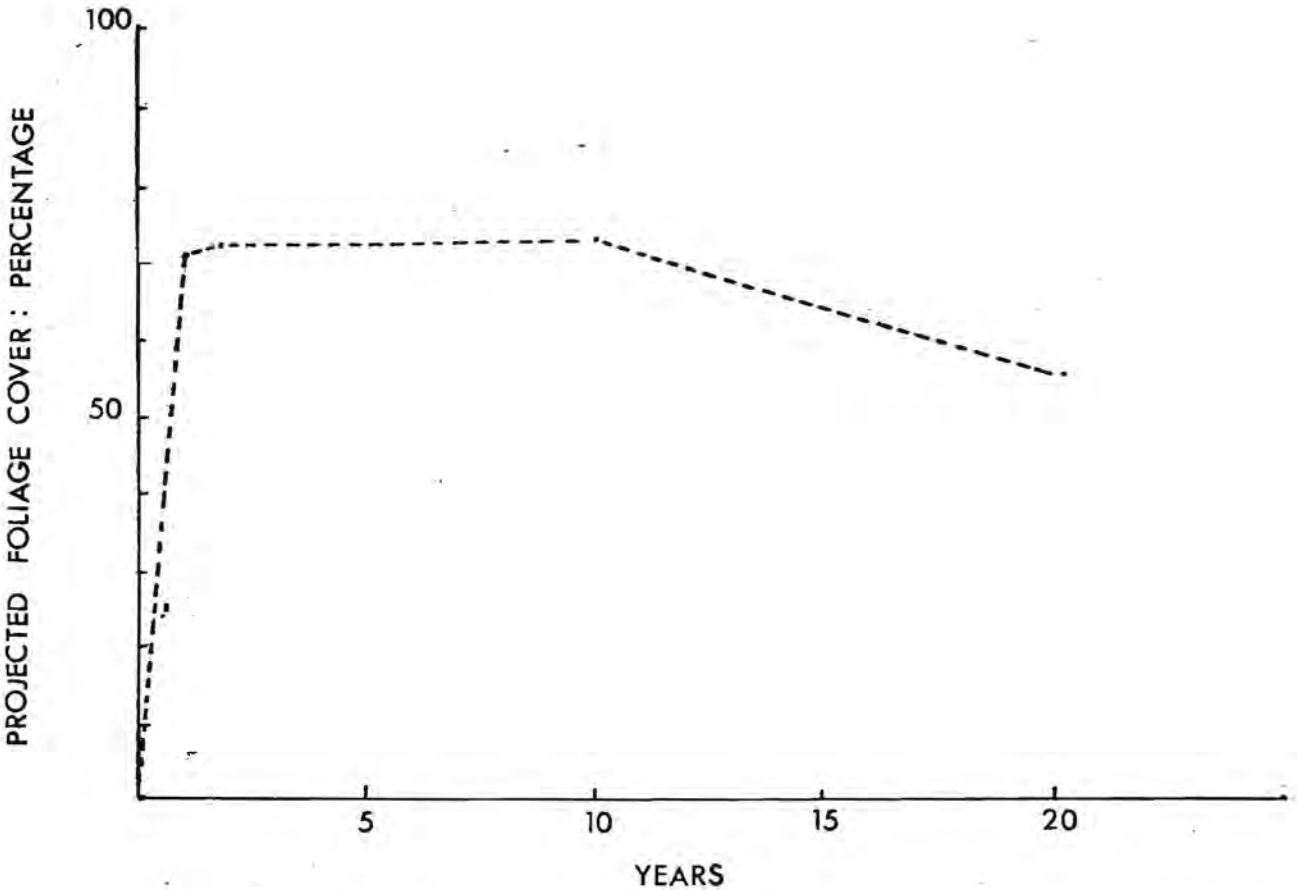


Fig. 10 Foliage projected cover for fynbos communities of different ages (Pers. comm. R. Specht, E. Moll and F. Pressinger)

The relatively low phytomass of the 20 year old proteoid element in the present study could possibly be ascribed to the community having a maximum growth rate for the first 10-15 years. Thereafter, as in the present study, "ageing" sets in (Kruger, 1977b). This period of senescence is affected by the percentage water present viz. 43,07 percent for approximately 20 year old, in comparison with 51,7 percent for the 10 year old proteoid community. However, the water content of senescent vegetation within the community where the phytomass was determined is closely related to the various components which were analysed (see Table 6). The close relationship of the water content appears to indicate that various elements viz. the proteoid, restioid and "remainder" found within the vegetation have adapted themselves to the moisture content of the area. Another factor which appears to influence the phytomass value is the amount of solar radiation received or aridity (Rutherford, 1978).

In conclusion it may be pointed out that a certain amount of knowledge has been acquired from the present study, for different post-fire ages, for instance, the fuel component of the fynbos community, growth rates of the various elements of the fynbos vegetation and the litter content. The conclusions arrived at in the phytomass study served as an important background in the discussion of fire in the next chapter.

# CHAPTER 5

# FIRE

## 5.1 Introduction

The phenomenon of fire in natural ecosystems and especially its utilization in the management of fynbos has generated a considerable amount of discussion - "because it has not been the subject of much serious study and also because of the ambivalence so characteristic of human response to fire" (Kruger, 1979).

The logbooks of Bartholemeus Diaz and Vasco Da Gama recorded the presence of fires on the Cape coast in the late fifteenth century (West, 1965). "Terra de Fume" was the name Vasco Da Gama gave the Cape of Good Hope because of the columns of smoke seen from the sea (Wicht, 1945). Even today veld fires are often prominent features during the dry season in the Cape (Kruger, 1974).

It appears that these early fires were caused by the indigenous people who used fire to stimulate the growth of new vegetation. With the arrival of the Europeans burning continued despite stringent laws to control wild-fires, some of which were passed as early as 1687 (Botha, 1924).

The immigrant farmers learnt from the indigenous herdsmen how to use fire in extensive veld management (Kolb, 1727; Sparrman, 1783; Thunberg, 1796; Clark, 1969; Kruger, 1974).

Veld burning thus continued unabated and it was only at the beginning of the present century that botanists began to express grave misgivings about this practice (Taylor, 1978). Bolus and Wolley-Dod (1904) appear to be among the first to suggest that the practice of veld burning could be more harmful than beneficial from an economic point of view, whereas from a "botanical point of view it tends to the destruction of species and the consequent greater deformity, not necessarily to the greater usefulness, of the vegetation" (Taylor, 1978). Similar views were expressed and enlarged on by Michell, 1922; Marloth, 1924; Pillans, 1924; Compton, 1926 and 1929; Sim, 1943; and Taylor, 1977). Taylor (1978) points out that the following effects of fires were noted viz. fires diminished the flow of streams in summer, increased winter floods and reduced the moisture-trapping ability of the vegetation from the southeast cloud.

Other research workers; for instance Phillips (1936), Hubbard (1937), Adamson (1952), Heyns (1957) and Van der Merwe (1966), stressed that fire had reduced the extent of the former vegetation. However, Levyns

(1924, 1929, 1935) and Adamson (1935, 1938) both described post-fire regeneration and postulated succession after a burn. Wicht (1945) observed that burning under control in a selected season and in the absence of grazing probably appeared to be less harmful to the fynbos in comparison with a hot wild-fire that swept through huge areas during the dry season. Wicht (1945) further stressed that an urgent need existed for the exact effect of fire on the vegetation and the ecosystem to be determined. It is only recently that research workers have recognised that fire is extremely important in the ecology of the fynbos, grassland and savannah biomes which are adapted to regular and frequent firing and have a large variety of plant species, whose evolutionary development accord with community behavioural responses to fire (Bews, 1925; Bayer, 1955; Bean, 1962; Levyns, 1966; Taylor, 1978; Kruger, 1979 and Edwards, 1980). One of the major aims of this study was to observe the plant responses following a prescribed burn in the Silver Mine Nature Reserve. Before this actual burn is described the causes of natural and man-made fires will be briefly discussed.

## 5.2 Causes of veld fires

A variety of natural causes of veld fires include lightning, falling rocks, earthquake activity, spontaneous combustion and volcanic action (Wicht, 1945; Theron, 1974; Kruger, 1979 and 1980; and Horne, in press). Volcanic action is not a causative factor in the Republic of South Africa, whereas the other causative factors, with the exception of lightning have been rarely recorded. Lightning is generally considered the most significant of the natural causes of veld fires and the most frequently documented factor in fynbos (Kruger, 1979).

The prerequisite for lightning fires to occur is the correct fire climate, fire weather, suitable quantity and type of fuel (Edwards, 1980).

The south-western Cape experiences fairly wet winters and, although summers are dry, orographic clouds frequently occur at higher altitudes adding to the total precipitation. The amount and distribution of precipitation occurring in the study area means that it is fairly moist throughout the year. However, the area does experience periods when dry katabatic winds create conditions favourable for fire (see Chapter 2).

The National Lightning Recording Scheme of the C.S.I.R. with over 300 lightning counters over the country provides direct evidence of lightning activity (Anderson, et. al, 1978; Erikson, 1978; Kröninger, 1978).

The lowest values of ground lightning flash density (number of flashes to ground $/km^2/year$) are found in the south and south-western Cape, for instance at Simonstown, the nearest monitoring station to the study area, it was $0{,}22/km^2/year$ for 1979 (Erikson, 1980, pers. comm.). The highest value was found at altitudes over 1 000 m in Natal, the Orange Free State and the Transvaal (Anderson, et.al., 1978). Hence the study area with a ground lightning flash density of 0,22 has a low fire risk in comparison with an area such as in the Highveld with a high lightning flash density of $7/km^2/yr$, indicating a much higher fire risk (in fact 35 times higher).

From the annual reports of the Department of Forestry it can be deduced that the highest percentage of fires have been caused by man. For instance, during 1973-1974, 81% of the fires were man-made (Edwards, 1980). The Silver Mine Nature Reserve, which is popular as a picnic spot, is prone to fires caused by man.

## 5.3 Fire behaviour in fynbos

Another important factor rendering the fynbos biome extremely susceptible to a fire is the large mass of dead standing fuel which is found among the vegetation. This fuel may amount to between 6 and 40 t/ha (Kruger, 1977a) and consists of well-dispersed material. In the herb and shrub strata these fuel beds may be up to 1,5 m but are usually 0,75 m or less, deep. Because of the fine nature of the leaves of the plants belonging to the Ericaceae and other families, and the thick layer of cuticular wax which covers the stems of the Restionaceae, these plants are also regarded as important fuel components (Kruger, 1979).

Although fires may, under rare circumstances, occur in two-year old vegetation (Martin, 1966), at least four years of growth is usually required to sustain a spreading fire (Martin, 1966; Kruger, 1977a), however, for the vegetation to burn readily under average dry conditions it must be somewhat older (Kruger and Bigalke, 1980). In the study area the approximately 20 year old Leucadendron laureolum community was first bush-cut and then burnt six weeks later (on the 8 June 1978). The burn at Silver Mine was clean and only charred sticks (of varying diameters from 20-100 mm) were visible after the fire (pers. obs.). This indicated an intense surface fire (Trollope, 1980). See photo 5.

## 5.4 The regeneration study

### 5.4.1 Introduction

The study area was previously burnt in 1959, i.e. 20 years ago (Mr. J. Venter, pers. comm.). Prior to the burn, as indicated in Chapter 3, five random permanent plots, 10 x 10 m, were staked out using iron pegs. In addition, the position of four to five known plant species were marked in each plot so that the vegetation structure and regeneration could be studied over the post-fire period. Similar studies on permanent plots are being conducted in the Kogelberg State forest (B. Durand, in prep).

The area in which the permanent plots are found, as indicated in Fig. 6, was bush cut. Six weeks after bush-cutting the area was burnt. Drip-torches were used for this purpose. The burning commenced on 4 June 1978 at approximately 08h00 and was completed by 16h00 of the same day. The compactness of the partly dried bush-cut vegetation resulted in a hot surface fire, which consumed all the available fuel. This was a clean burn (*Pers. obs.*)

### 5.4.2 Plant species response to fire after one year

That fynbos contains a large number of sprouting plant species is well documented (Wicht, 1945; Martin, 1966; Van der Merwe, 1966; Kruger, 1977a). One of the first species to reappear in abundance was *Wachendorfia paniculata* followed by other geophytes such as the *Watsonia* spp. and hemicryptophytes; mainly Restionaceae. This confirms other observations that geophytes and some hemicryptophytes rapidly regenerate vegetatively after a fire. This type of regeneration has been reported by Van der Merwe (1966) and Kruger (1977a). Hence, for the purpose of this study, the plant species regenerating after the fire were classified into three types: seed, rhizome and corm regenerators (J. Rourke, *pers. comm.*). It was found that 34,9% of the species were propagated by seeds, 53,5% from rhizomes and 11,6% from corms. (See Tables 8, 9 and 10 and Fig. 11). The high percentage of regeneration from subterranean structures, such as rhizomes and corms is well known and is regarded to be a characteristic feature of vegetation in fire-prone areas (Brutt-Davy, 1922; Martin, 1966; West, 1971; Rourke, 1972; Carlquist, 1977). See photo 6.

Table 8. Plant species that regenerated by means of seeds in the study area in the Silver Mine Nature Reserve.

*Adanandra villosa* (Berg) Licht ex Roem
*Agathosoma* sp.
*Aspalathus retroflexa* L. ssp. *bicolor* E. and Z.
*Erica multumbellifera* Berg.
*Erica pulchella* Houtt.
*Helychrysum vestitum* (L) Schrank
*Lampranthus bicolor* (L) N.E. Br.
*Leucadendron laureolum* R. Br.
*Lobelia coronopifolia* L.
*Lobelia setacea* Thunb.
*Selago spuria* L.
*Senecio arenarius* Thunb.
*Struthiola ciliata* (L.) Lam.
*Thunbergiella filiformis* (Lam.) Wolff.
*Ursinia nudicaulis* (Thunb.) N.E. Br.

Table 9. Plant species that regenerated by means of rhizomes in the study area in the Silver Mine Nature Reserve.

*Aristea glauca* Klatt
*Aristea juncifolia* Baker
*Aristea macrocarpa* Lewis
*Corymbium africanum* L.
*Corymbium glabrum* L.
*Cryptadenia uniflora* Meisn
*Elegia vaginulata* Mast.
*Erica mammosa* L.
*Ficinia bulbosa* Nees
*Ficinia deusta* (Berg.) Levyns
*Ficinia pinquior* C.B.Cl.
*Ficinia radiata* Kunth
*Hypodiscus aristatus* (Thunb.) Nees
*Merxmuellera rufa* (Nees) Conert (*Danthonia lanata* Schrad)
*Pentachistis steudeli* (Nees) McClean
*Pentachistis tortuosa* (Trin) Stapf.
*Pseudopentameris macrantha* (Schrad) Conert
*Staberoha cernua* Durand & Schinz
*Tetraria compar* (L.) Lestib.
*Thamnochortus fruticosus* Berg.
*Trachyandra hirsutiflora* (Adamson) Oberm.
*Rhus* hybrid (persistent rootstock)
*Wachendorfia paniculata* (Burm.) Thunb.

Table 10. Plant species that regenerated by means of corms in the study area in the Silver Mine Nature Reserve.

Drimia modesta (Baker) Jessop

Oxalis polyphylla Jacq. var. pentaphylla (Sims) Salter

Thereianthus bracteolatus (Lam.) Lewis

Tritoniopsis unguicularis (Lam.) Lewis

Watsonia tabularis Mathews and L. Bol.

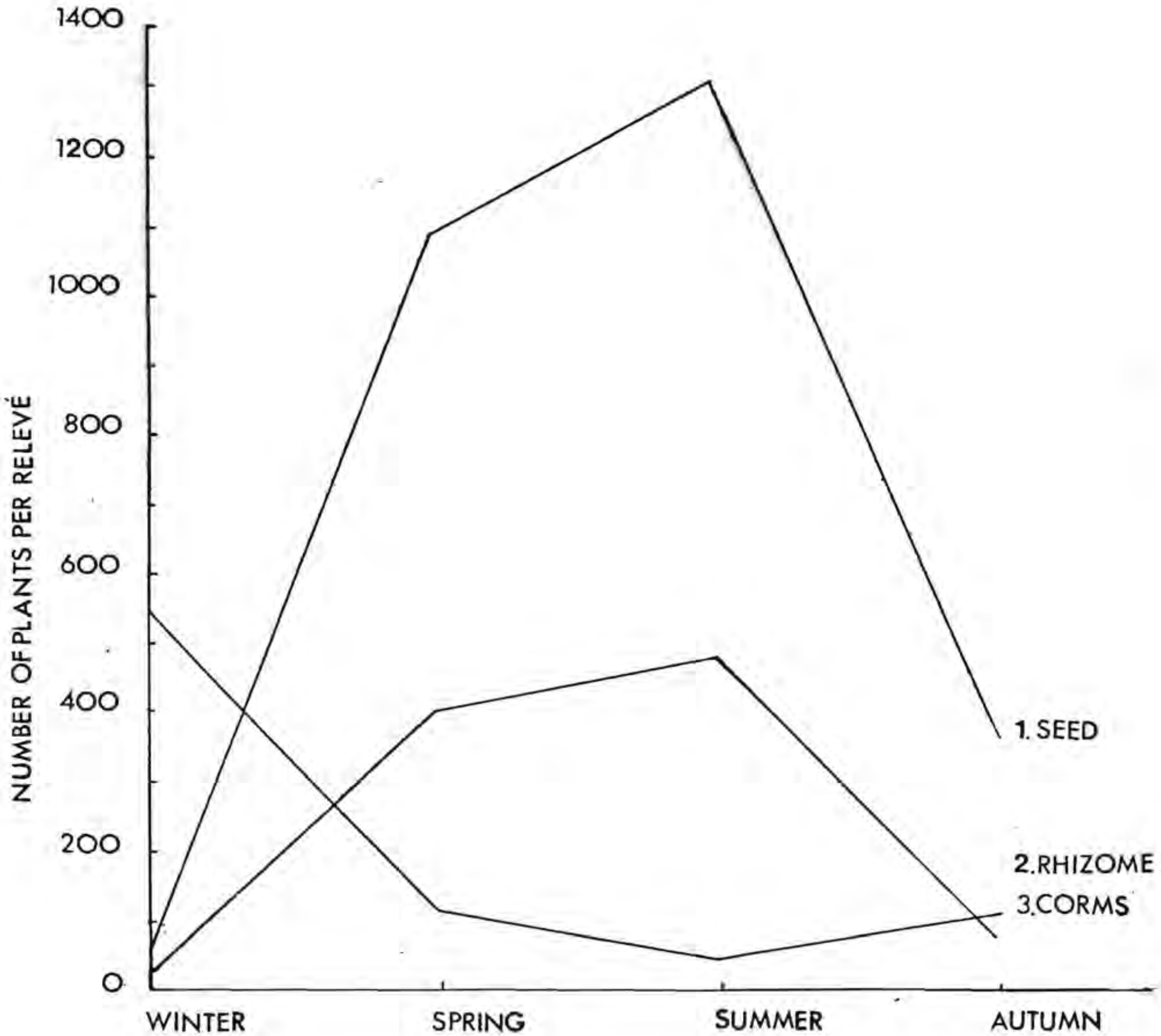


Fig. 11 Total number of plants regenerating in the five permanent relevés during the first year following the prescribed burn.

At Silver Mine the average survival rate, whether by seed, rhizomes or corms is below 100% which is in contrast to the finding of Van der Merwe (1966) at Swartboskloof and Kruger (1977a) at Jonkershoek. The regrowth from hemicryptophytes was fairly rapid within the first year after the fire when 800 kg/ha/yr above ground dry matter was produced (see Chapter 4). The phytomass result from the study area corresponds fairly closely with that obtained by Kruger (1977b) viz. between 1 000 - 4 000 kg/ha/yr. The canopy cover which was observed after a 24 month post-fire period was less than half of the canopy cover which was observed before the burn. Whereas at other experimental areas it was at least four-fifths of the original level (Kruger, 1972; 1977b).

The survival of seed regenerators in fynbos has been confirmed by Van der Merwe (1966) and Levyns (1935) who have indicated that the seeds of certain fynbos species survive on or in the soil. Circumstantial evidence indicated great longevity, more than 15 years (Boucher and McCann, 1975; Rourke, 1972), in fruits of certain members of fynbos, such as the Proteaceae, which remains dormant in the soil protected by a thick woody pericarp, until after a fire (Williams, 1972; Boucher and McCann, 1977; Rourke and Wiens, 1977). However, this was not the case at Silver Mine.

A number of fynbos species demonstrate the phenomenon of serotiny, the retention of seed in protective organs until either later in the season, or until certain other conditions are satisfied. An appropriate example being the genus Leucadendron (Williams, 1972). Achenes are retained in a woody receptacle and released either when the mother plant is killed by fire or other agencies, or after a period of three to five years, for example Leucadendron laureolum retains seed in cone-like fruiting heads for about three years. Williams (1972) records that in Leucadendron platyspermum the seed germinates after fire in the head "...... and is actually growing by the time it falls upon the ground". The rapid germination of Leucadendron spp. as noted in other areas (Williams, 1972) was not noted at Silver Mine. Only sparsely distributed L. laureolum plants of 20 mm were observed in the study area 14 months after the burn. Watsonia pyramidata, a typical fynbos geophyte which regenerates from a corm, was one of the species to appear 14 days after the burn, indicating a rapid response of this species to fire, a fact which has been mentioned by Hall (1959), Bean (1962) and Kruger (1979). Another species which was abundant 14 days after the fire was Wachendorfia paniculata. This species was not recorded in the area where the permanent plots were marked or when the Braun-Blanquet survey was conducted. This indicates that W. paniculata was present in the area but dormant: a typical strategy of a number of plants with underground storage organs (J. Rourke, *pers. comm.*).

*Tetraria compar* a rhizomatous regenerator appeared six weeks after the burn. *T. thermalis* performed similarly. This rapid resprouting of *Tetraria* spp. is common for a number of hemicryptophytes in the fynbos.

### 5.4.3 Community development: pyric succession

Pyric succession in fynbos viz. development of fynbos communities after a fire varies with pre-fire vegetation structure and the type of fire (Kruger, 1980). For instance, Levyns (1935) describes an unusual succession in transitional sclerophyllous scrub where each of the first three years saw dominance by one or a few reseeding species, each of which diminished thereafter: "a germinative species of *Aspalatus* dominated in the fifth year, but this was likely to decline and to be replaced by *Elytropappus rhinocerotis* this being a longer lived shrub in the Asteraceae" (Kruger and Bigalke, 1980 citing the finding of Levyns, 1935). Similarly, at Silver Mine it was found that *Wachendorfia paniculata* regenerated profusely after the fire, although the species was unnoticed prior to the burn. This indicates that the corms were dormant prior to the fire.

The first phase of succession viz. the immediate post-fire phase (Kruger, 1979) that has also been observed by Michell (1922), Levyns (1929), Adamson (1935), Wicht (1948), Martin (1966) and Taylor (1969) was not evident at Silver Mine. This difference was ascribed to the bush-cutting of the approximately 1,5 m tall vegetation six weeks prior to the burn. The fuel (bush-cut vegetation) was compressed and somewhat dry by the time it was burnt, so instead of the normal crown surface fire which is expected in fynbos a hot surface fire resulted (Mr. Venter, pers. comm.).

The bush-cutting before the prescribed burn appears to have contributed to the extremely poor regeneration of Leucadendron laureolum, seeds of which normally germinate within a few days after fire (Kruger, et. al. 1977c). This poor regeneration has been ascribed to the bush-cutting as some of the seeds were eaten by rodents (pers. obs.) and the remainder were probably killed by the fire. The first few, sparsely scattered plants were only observed some fourteen months after the burn, these plants could possibly be from soil stored seed or may have been blown in from adjacent unburned L. laureolum communities.

The initial recovery of the hemicryptophytes was as rapid as expected, and was similar to observations in other areas (Kruger, 1977a); see photo 4 for evidence of recovery of the various types of plant species. The Figs. 12 to 16 are not drawn to scale. The purpose of these figures is to help the reader to visualise the approximate location of the various species in each plot. From the permanently tagged species which regenerated after the fire, as indicated on Figs. 12 - 16, 50% regenerated by means of rootstocks and 50% by means of seeds. A striking feature observed in the regeneration of the permanently marked species is that no species in any of the permanently marked plots regenerated in the same position of the original plant. The regeneration of Erica multumbellifera in permanent plots 1 and 3 is 0,5 m from the original plant and in plots 4 and 5 the plant regenerated 1,75 m from the original. Similarly Erica pulchella regenerated 0,25 m away from the parent plant. Another seed regenerator viz. Helichrysum vestitum regenerated at distances between 0,1 to 0,25 m. Whereas the species which regenerated from rootstocks indicated a more variable distance of regeneration from each of the permanently tagged species. As a result of the distances of regeneration from the original tagged species, it does indicate that there is a shift in plants. It further appears that this shift of plants on regeneration has some form of pattern in seed regenerators, for instance as seen in Helichrysum vestitum, E. pulchella and E. multumbellifera.

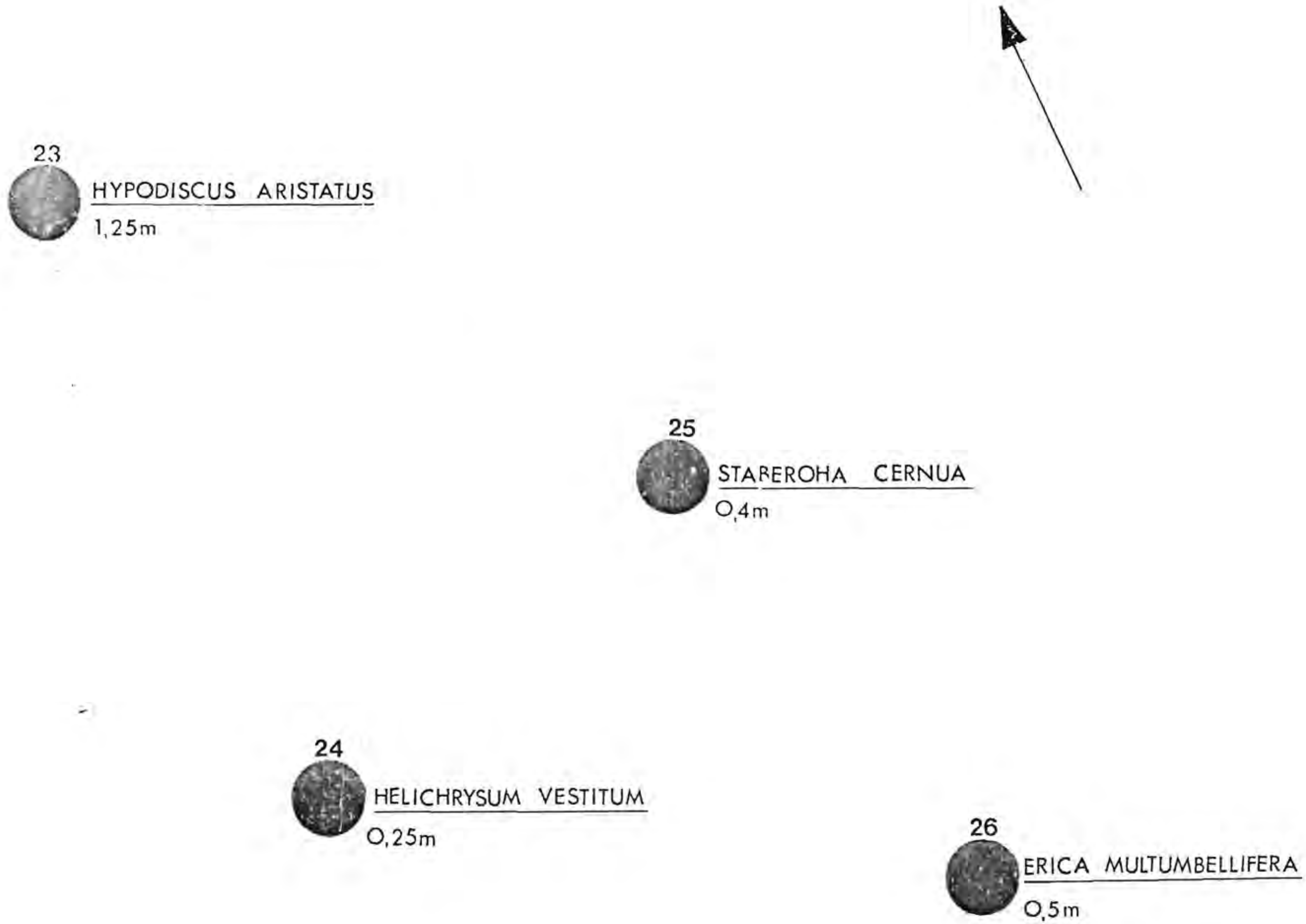


Fig. 12 Plot 1: Species regeneration after twelve months and their distances from marked plants of the same species prior to the prescribed burn.

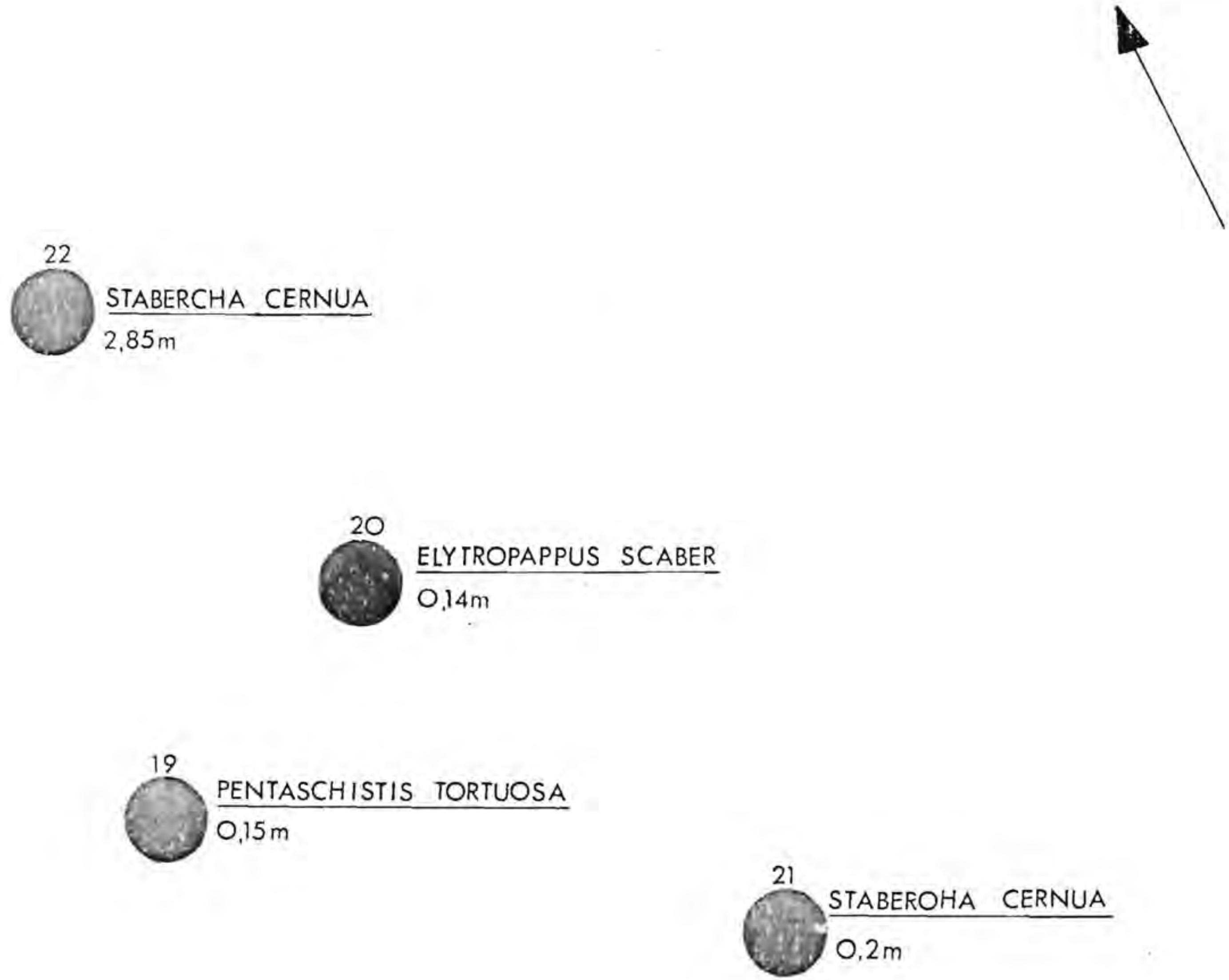


Fig. 13 Plot 2: Species regeneration after twelve months and their distances from marked plants of the same species prior to the prescribed burn.

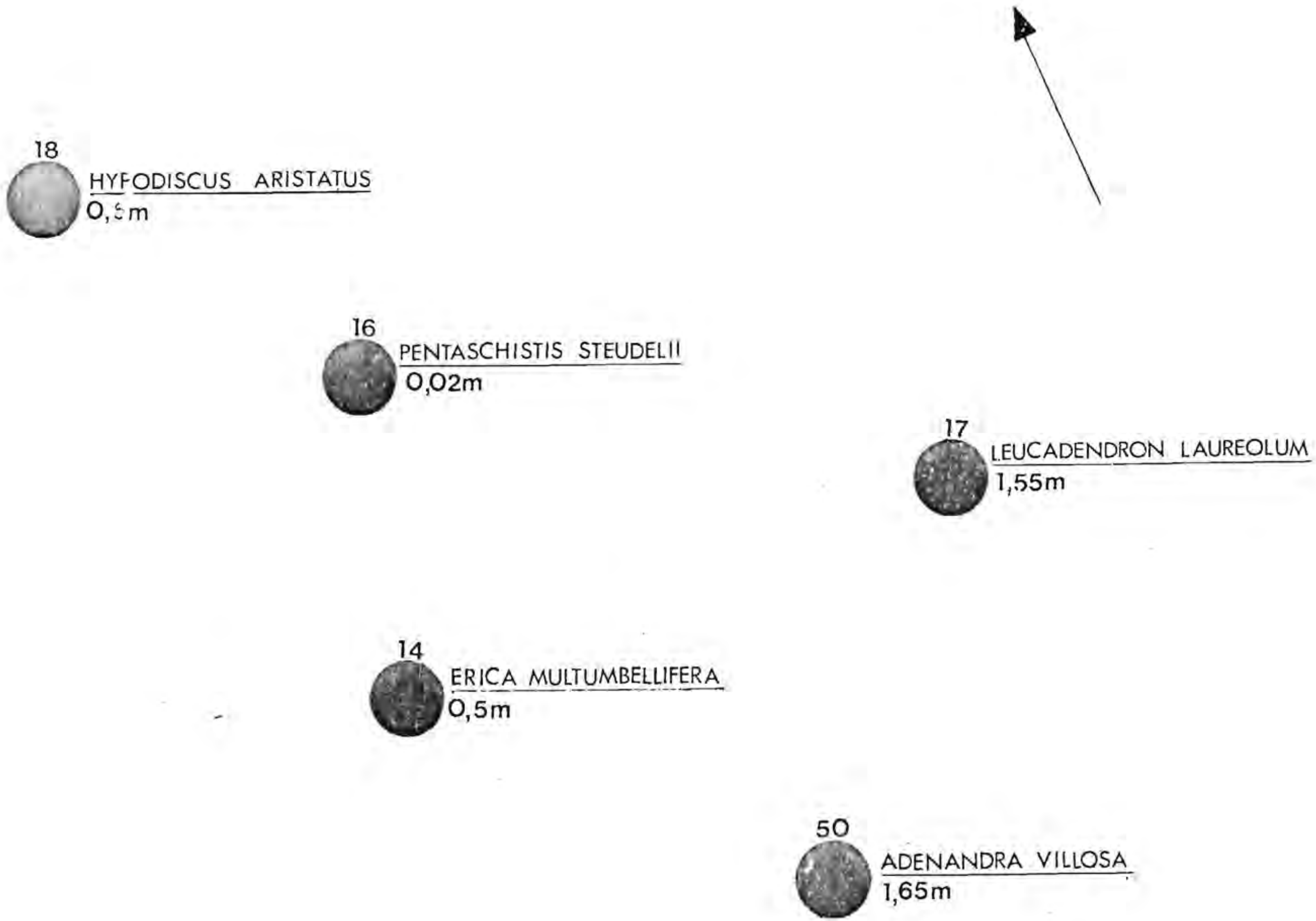


Fig. 14 Plot 3: Species regeneration after twelve months and their distances from marked plants of the same species prior to the prescribed burn.

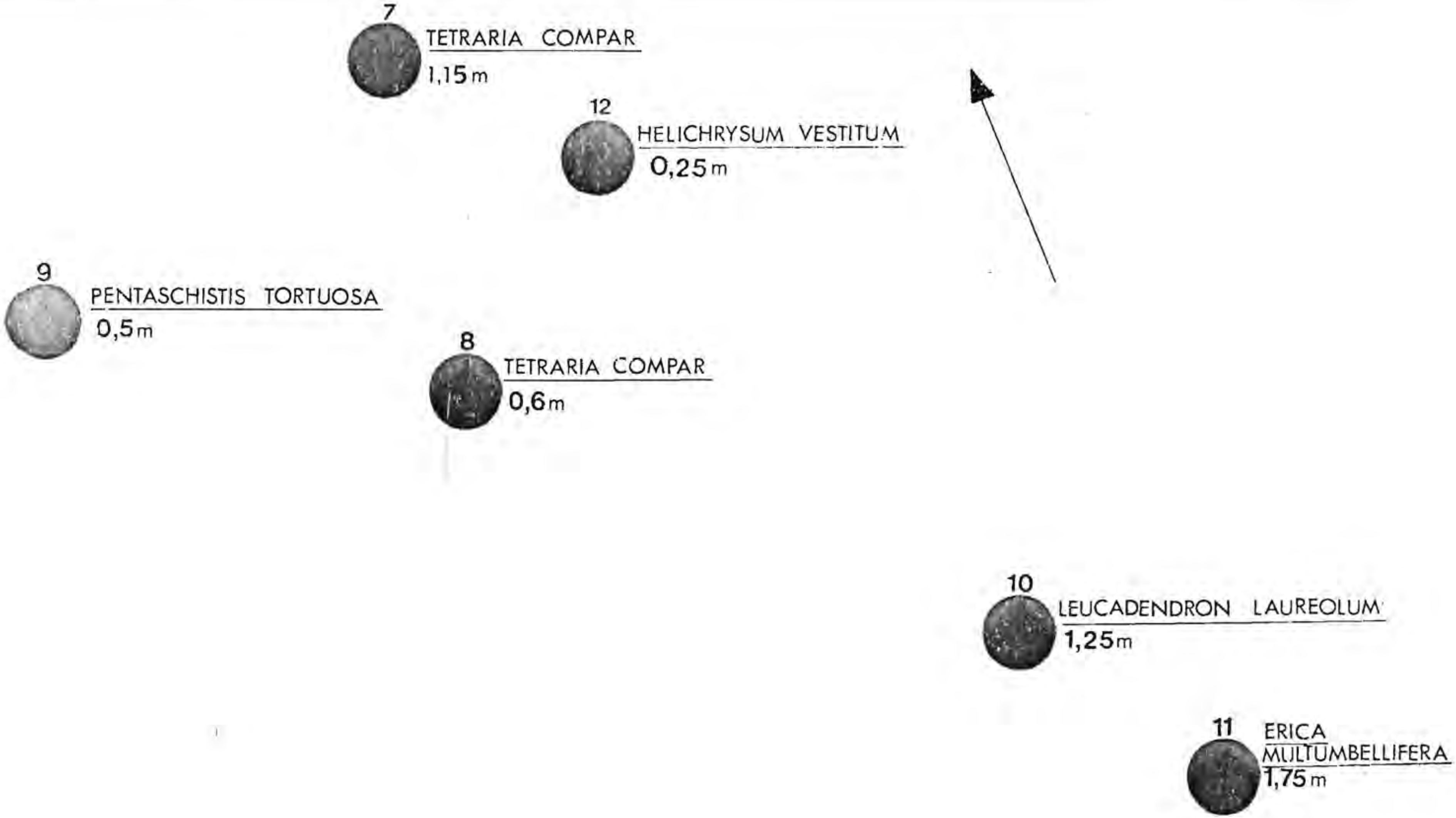




Fig. 15 Plot 4: Species regeneration after twelve months and their distances from marked plants of the same species prior to the prescribed burn.

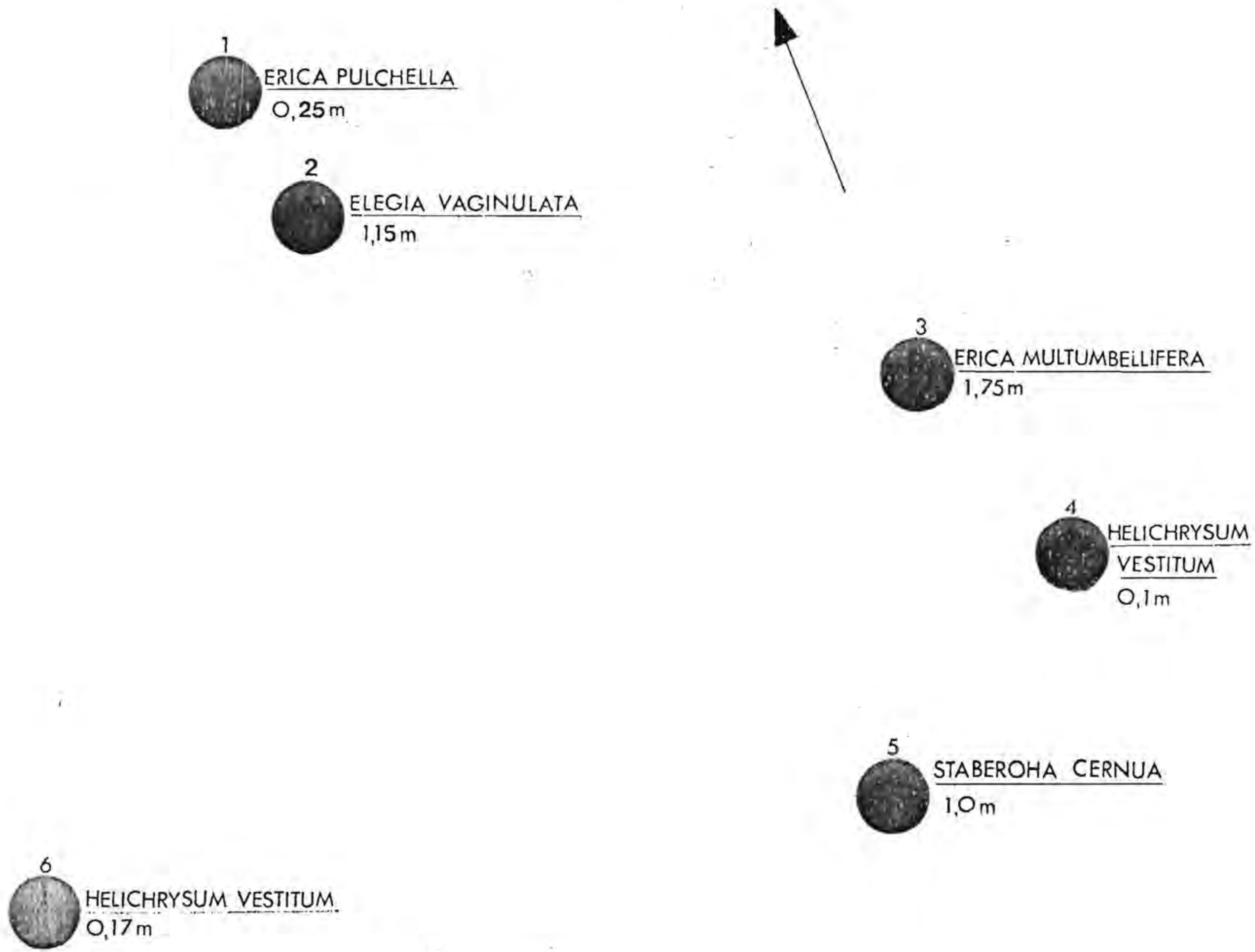


Fig. 16 Plot 5: Species regeneration after twelve months and their distances from marked plants of the same species prior to the prescribed burn.

Twelve months after the burn 34,9% of the species present were those that regenerated by means of seeds. See Table 8. A similar observation of the regeneration of plant species by means of seeds has been established by Kruger (1977a). Although in the study area the lower percentage of plant species that regenerated by means of seed could possibly also be explained by the pre-fire treatment of the vegetation which destroyed a portion of the seed store.

In Silver Mine Erica multumbellifera, which was fairly dense prior to the burn, was first observed about six months after the burn. This is in contrast to what is normally expected viz. that the Erica spp. make their appearance about 12 months after the burn (Adamson, 1935; Martin, 1966; Kruger, 1980). The early regeneration of the Erica spp. in the Silver Mine area could be ascribed to:

the enhanced viability of seed as a result of the pre-fire treatment of the vegetation;

the fairly dry spell which followed the burn (See Chapter 2 for the rainfall data).

Because the monitoring for the purpose of this dissertation was limited to the period of 12 months after the burn, no further aspects of the succession can be discussed at this stage.

### 5.4.4. The effect of fire on the soil

Another important effect is the impact of fire on the nutrient status of the soil. Soil samples from the top 200 mm were collected randomly from various permanent plots before the fire and on a seasonal basis after the fire. It was found that using the Bray No. 2 method for determining "plant available" phosphorus three months after the burn that the phosphorus level was 0,0004%, six months after the burn it diminished to 0,0002% and 12 months after the burn it had decreased to 0,0001 ppm, see Fig. 17. Before the burn the calcium content of the soil was noted to be 125 ppm whereas after the burn it increased to 140 ppm.

The low level of available P six months after the burn could be due to absorption by the vegetation (Low, 1978). Fig. 17 illustrates that there is a decrease in both the total, as well as the plant available phosphorus. This could reflect periods of mineralization and subsequent uptake and or leaching in the soil, by the plant system.

### 5.4.5 Conclusions

Fire is considered a natural factor of the fynbos environment (West 1965; and Kruger 1977a). In early times man used fire to manipulate his environment and today natural fires are not important as practically

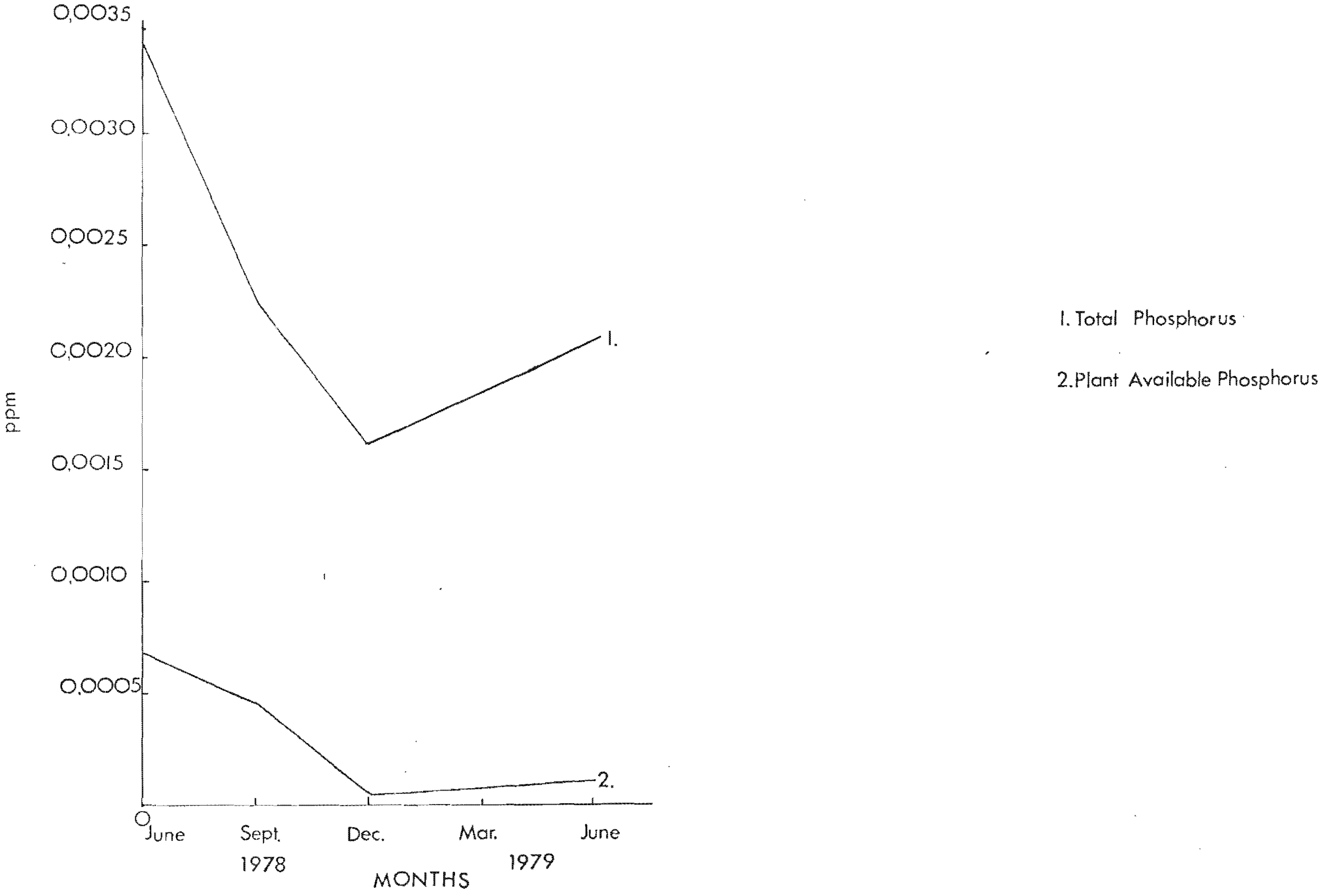


Fig. 17 Phosphorus content of the soil at the SILVER MINE NATURE RESERVE following a prescribed burn.

all fires are caused by man (Moll, 1971; Klein, 1974; Kruger, et. al., 1977c). Nevertheless, there are documented eye-witness accounts of fires of natural origin (Wicht, 1945). Fires due to lightning do occur throughout the fynbos zone, although in the study area there has been no definite proof of lightning causing fires (Venter, pers. comm.). Also the area is known to be a low risk lightning area.

Of the three methods of post-fire regeneration viz. seeds, rhizomes and corms - 34,9% regenerated by means of seed (see Table 8), with the highest percentage of seed-regenerators being found during summer with a gradually declining towards autumn (Fig. 11); 53,5% regenerated by means of rhizomes (see Table 9) with a maximum number of individuals in summer and the remaining 11,6% regenerated profusely during winter. Species regenerating by means of rhizomes belong mainly to the families Restionaceae and Cyperaceae and this is why the restioid element forms an important part of the fynbos especially in frequently burnt areas. Hence, 65,1% of the total species survived by regenerating from sub-surface tissue and these comprised about three-fifths of the total vegetation (pers. obs.).

In the mediterranean region there appears to exist an alternation between the dominance of various structural components after which could be summarised as follows:

geophyte $\underset{\text{fire}}{\overset{\text{time}}{\rightleftharpoons}}$ shrub. For example some geophytes such as Haemanthus spp. at Bettys Bay which flowers only after a fire. A possible explanation for this could be that the geophytes found in the fynbos are completely absent in the older stands but suddenly appear if the stands are burnt. This phenomenon is labelled by Rourke (*pers. comm.* 1980) as the "sleeping partner theory".

The analysis of various soil samples taken from the permanent plots revealed a decrease in the phosphorus content for the first six month period after the burn (Fig. 17), thereafter, on analysis an increase was found (Bray 2 extraction). Although the calcium content of the soil increased from 125 ppm before the burn to 140 ppm three months after the burn. A one molar ammonium acetate extraction of pH 7 was used, in a solution to liquid ratio of 1:25. The suppressing agent Lanthanum chloride was used. Measurement was done by atomic absorption. (A. Van Vuuren, Fedmis, *Pers. com.*). This endorses the finding of Lossaint (1977) that the aerial parts of the plant contains 69% calcium, hence after the fire the calcium content of the plant was deposited in the soil. To draw precise conclusions pertaining to the nutrient systems of the study area requires "knowledge of imports, exports and transfer rates within the system" (Westman and Rogers, 1977).

From Figs. 12-16, it is evident that the distance of the regenerated species indicates a shift, which varies from the position of the original tagged species from 0,02 m to approximately 2,85 m. This could be the result of nutrient cycling viz. at the original position of the plant the necessary nutrients had been exhausted, and regeneration took place in a site, where there was an adequate concentration of nutrients.

# CHAPTER 6

## GENERAL CONCLUSIONS

The present survey is the first detailed plant ecological investigation to be conducted in the Silver Mine Nature Reserve. The aim of the study was to gain knowledge of the vegetation of the area and to study the ecological effects of fire, since fire is regarded as a major factor in fynbos ecology.

From the floristic investigation in which the Braun-Blanquet phytosociological technique was used, it was concluded that two major fynbos communities dominated the landscape of the area of the Silver Mine Nature Reserve studied. Dominant fynbos formations vary considerably in structure (Taylor, 1978), but communities characteristically include growth forms of the restioid, ericoid and proteoid types. The study area has features typical of those described for fynbos by Taylor (1978) and Kruger (1980) viz:

The two major shrub communities occupy a wide variety of landscapes from flat surfaces to steep, rocky inclines on nutrient poor soils.

That precipitation by mist caused by orographic clouds on the mountain tops is appreciable in summer.

## The phytomass study

A comparison of the results obtained for the phytomass studies conducted at the Silver Mine Nature Reserve with other study sites within the fynbos biome and other mediterranean regions, increased our knowledge concerning the fuel components of the different post-fire ages, growth rates of the different elements of the fynbos biome (see Table 11), and the litter content (see Table 7).

Table 11. The phytomass of the fynbos community of the study area - the Silver Mine Nature Reserve. The data are for various ages of fynbos after fire and are given as a percentage for each of the major structural categories (namely proteoid, restioid and the "remainder").

| Post-fire age: Years | Proteoid: Percentage | Restioid Percentage | "Remainder" Percentage |
|---|---|---|---|
| 20 | 74 | 23 | 3 |
| 10 | 65 | 27 | 8 |
| 1 | 0 | 32 | 68 |

## The prescribed burn

The study area was burnt in June 1978, six weeks after being bush-cut. The compactness and partly dried nature of the bush-cut vegetation resulted in an intense, surface fire, which consumed all the available fuel.

The monitoring of the regeneration of the plant species for a period of 12 months was confined to five randomly selected permanent relevés. The plant species observed regenerated by means of: underground organs such as rhizomes, corms and bulbs, and from seed. It was found that a total of 65,1% regenerated from underground organs which comprised 53,5% from rhizomes, 11,6% from corms. The remaining 34,9% regenerated from seed. This rapid growth of sprouters from underground organs was also noted by Van der Merwe (1966); Rourke (1972); Taylor (1973) and Kruger (1977a).

It appears that a large percentage of the species in the earlier successional stages of fynbos re-sprout vegetatively (Taylor, 1978). In general these species form the bulk of the cover and thus act to reduce soil erosion during the period immediately after the burn as the species cover the ground quickly (Kruger, 1972).

It was observed that the rate of regeneration of Leucadendron laureolum, the dominant species prior to the burn, was extremely slow. After a period of 14 months only a few scattered L. laureolum plants were observed. The slow rate of regeneration of L. laureolum, the dominant species in the study area before the fire, and the sparseness of the vegetation after the fire could possibly be ascribed to:

(a) the bush-cutting of the vegetation before the prescribed burn which gave rise to an intense surface fire.

(b) a winter burn, which has been found unsuitable for Protea repens (Jordaan, 1949, 1965), may also be unsuitable for L. laureolum.

Another striking field observation was that the marked plant species in the various relevés show a change in position on regeneration. This movement of plant species has been mentioned by Deacon (1979).

From the phytomass and regeneration studies it appears that a suitable time interval for burning at the Silver Mine Nature Reserve would be from 15 to 18 years. This suggested interval is based on field observations viz. the dominant plant species - L. laureolum attains a maximum height of 1,75 m and the number of inflorescences produced begin to tail-off (senescence sets in) by the time it is 20 years old (pers. obs.). At this age the low shrubs, such as the Erica spp., begin to die and litter accumulates rapidly. The lower strata becomes reduced in importance and no germination of any existing species was observed.

It appears from the present research, as well as from other research conducted at the Swartboskloof (Van der Merwe, 1966) and Jonkershoek (Kruger, 1972), that the senescent vegetation should be burnt at approximate intervals of 15 years, which agrees with the finding of McLachlan and Moll (1976). The vegetation should be burnt during autumn or spring without being bush-cut.

Attitude of conservation

The study area is a part of the Fynbos Biome, classified as one of the six plant kingdoms of the world because of its diversity of species and high degree of endemism (Louw, 1979). Unfortunately the Fynbos Biome is generally threatened by injudicious burning (Kruger, 1977b; Taylor, 1978; Bigalke, 1979) and alien vegetation (Hall, 1979). The misuse of the mountain fynbos areas as places of recreation is an added problem and threat to the indigenous vegetation.

In order to preserve this heritage of plants John Citizen should be made aware of the biology and ecology of this unique biota. An awareness program based on the findings of research workers, which is aimed at the preservation of this unique flora of the south-western Cape, could be put into practice by:

The distribution of brochures and pamphlets at the entrances to nature reserves, such as the study area, which would help in the enlightenment and preservation program.

Schools and other educational institutions should be involved; not only to make a study of the theoretical aspects of nature conservation but also from a practical point of view, where pupils are given an opportunity to assist with conservation in the field.

It is clear that, the conservation of the fynbos becomes the duty of every citizen.

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Photo 1. Dense L. laureolum growing on a gentle sandy shallow slope in the foreground, with the dense orographic cloud in the background.

December 1978

Photo 2. Old L. laureolum stand showing distinct signs of senescence with a relative cover of Staberoha distachya in the foreground.

June 1977

Photo 3. Shows the twenty year old vegetation dominated by proteoid and restioid elements. The proteoid element shows clear signs of senescence.

June 1977

Photo 4. The one year old post-fire community showing the distinct absence of the proteoid element and a negligible presence of the restioid element. A clear indication of the presence of the nanophanerophytes represented by Helychrysum vestitum can be observed.

June 1979

Photo 5. The burnt study area showing charred vegetation as a result of an intense fire.

June 1978

Photo 6. Shows plant species consisting of those regenerated from seeds, rhizomes and corms twelve months after the fire.
June 1979

24 1981