MIST INTERCEPTION BY THREE SPECIES OF MOUNTAIN FYNBOS

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There it is, fog, atmospheric moisture still uncertain in destination, not quite weather and not altogether mood, yet partaking of both.

Hal Borland : Sundial of the Seasons

ABSTRACT

The objective of the present study was to investigate mist interception by Mountain Fynbos under non-rainfall conditions. Quantitative measurements and qualitative observations of plant-drip and stem-flow from selected plant species were recorded at five experimental sites on the Back Table of Table Mountain, Cape Province. Plant-drip and stem-flow catching devices were designed and installed in order to collect the moisture intercepted by plants. The results indicated that mist interception by the vegetation was influenced by wind speed, density of mist and by the morphological characteristics of the plants. Greater interception occurred when dense mist was accompanied by high wind speeds. The interception ability was found to increase with plant size. Interception efficiency depended on the leaf morphology of the plants. Narrow-sclerophylls (e.g. *Psoralea pinnata*) were found to be more effective in intercepting mist droplets than broad-sclerophylls (e.g. *Leucadendron salignum*). The portioning of intercepted water into plant-drip and stem-flow was largely influenced by the shape of the plant. The mean rate of water yield per plant observed during five periods of rainfree, misty conditions, was 71 ml hr^{-1}.

Rainfall is, therefore, not the sole source of moisture contributing to the water balance. The additional moisture intercepted by vegetation should, therefore, be taken into consideration in studies of water balance and hydrology.

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CHAPTER 1

INTRODUCTION

This investigation is primarily concerned with the interception of mist by indigenous mountain vegetation. The study was conducted under non-rainfall conditions at an altitude of between 680 to 760m above sea level on the lower plateau of Table Mountain, Cape Town. Five sites were selected and three fynbos species were monitored at each site. The investigation was carried out during 1984 under varying weather conditions.

It has often been recognized that in many mountainous areas the frequent occurrence of mist and orographic cloud accounts for a significant contribution to the total moisture budget through the interception of mist droplets by vegetation (Barry 1981; Kruger 1979; Geiger 1965; Ekern 1964; Nagel 1962; Twomey 1957; Marloth 1903 & 1905). Mist precipitation (which is not recorded in standard raingauges) should, therefore, be taken into consideration in all studies of the water balance and hydrology of catchment areas, and for the compilation of climatic records (Fuggle 1979; King, Day & Van der Zel 1979; Kruger 1979; Nagel 1962). Although the importance of mist precipitation has been acknowledged as being beneficial to plants and also contributing to the overall water balance, it has, however, not been satisfactorily measured (Kerfoot 1968).

Mist interception by vegetation is closely related to rainfall interception and the processes of plant-drip and stem-flow.

In order to clarify this discussion the following terminology has been adopted:

Mist precipitation is the process in which cloud (mist) droplets are deposited on or intercepted by the vegetation and redistributed as plant-drip and stem-flow, although no rainfall has occurred in the open.

Plant-drip is that portion of the mist which, having been intercepted by the canopy, reaches the ground as drip from the leaves and branches.

Stem-flow is that portion of intercepted mist which reaches the ground by running down the stem.

1.1 OBJECTIVE

The objective of this study was to investigate by direct observation the extraction of moisture from the atmosphere by fynbos vegetation.

This entailed the investigation of the moisture catching ability of fynbos species under non-rainfall conditions in order to determine whether specific plant species have the ability to extract moisture preferentially from

(i) mountain-top cloud, and
(ii) an unsaturated atmosphere with high relative humidity.

1.2 APPROACH

Direct observations of moisture extraction by plants under non-rainfall conditions were made at the onset of, and during, misty weather on the Back Table of Table Mountain.

The quantities of intercepted mist moisture reaching the ground via plant-drip and stem-flow from selected fynbos species was measured. The species selected for these measurements were *Leucadendron salignum*, *Berzelia lanuginosa* and *Psoralea pinnata*. Catching devices were designed and placed beneath the plants for purposes of measurement. These three species were monitored at each of five selected sites.

The basic weather parameters; air temperature, relative humidity, and wind speed and direction were recorded whenever interception of moisture by plants was observed. Rainfall and mist precipitation in the study area was measured by means of standard 127mm raingauges and fog-catchers respectively.

1.3 STUDY AREA

1.3.1 Location

The area chosen for this study was the Back Table of Table Mountain, Cape Peninsula. The area is located 34°59' south and 18°24' east (Fig. 1). At this location the mountain range has a north-south orientation with the Atlantic Ocean to the west, the Cape Flats to the east and False Bay to the south-east. The elevation of the study area ranges from 680 to 760m above sea level and stretches from the southeasterly edge to the northwesterly edge of the plateau.

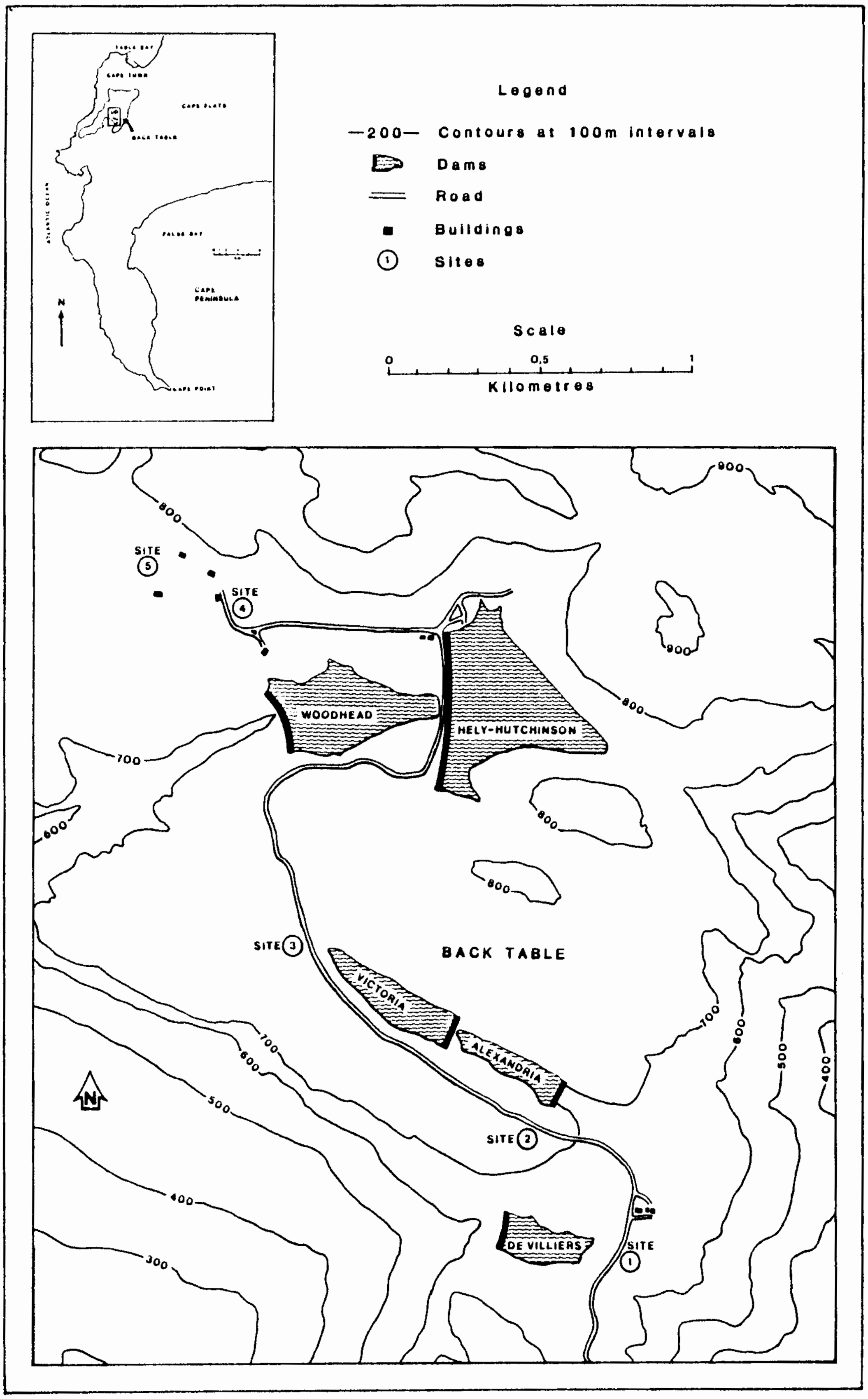

Fig. 1 : Contour plan of the Back Table of Table Mountain showing locations of experimental sites.

This area was selected because it provided suitable mountain-top weather conditions, was accessible by road, and has relatively undisturbed fynbos vegetation.

1.3.2 Climate

The study area falls within a Mediterranean climate, characterized by hot, dry summers and cool, wet winters.

Climatic data for the study area and for mountainous areas in general are scarce. Although there are no doubt micro-climatic variations within the area, these variations are, however, not marked. The documented observations of the overseer at Table Mountain House for the year 1984 show that rainfall was recorded on 125 days and cloud or mist cover (without rainfall) on 73 days. The total number of occasions on which cloud cover was recorded, irrespective of rainfall, was, therefore, 198. This provides an indication of the incidence of cloud occurrence in the study area.

Precipitation is principally in the form of rain which falls mainly during the winter months and occurs in association with northwesterly pre-frontal winds (Jackson & Tyson 1971). The 30 year mean annual rainfall figures (1921-1950) at Table Mountain House and Woodhead Dam, which are situated within the area of study on the Back Table, are 1780mm and 1611mm respectively. Seventy-four percent (74%) of the rainfall at Table Mountain House occurs in winter and 26% in summer. At Woodhead Dam, 74,3% occurs in winter and 25,7% in summer (Nagel 1961). During anti-cyclonic south-easter weather considerable orographic cloud is induced, normally without rain. These clouds often envelop the summit plateau as well as the Back Table plateau of Table Mountain and provide an added source of precipitation in the form of mists, particularly in summer. Reliable data on mist precipitation are, however, not available.

Snow is infrequent and falls are light, and is not an important source of moisture in the study area.

Frosts are rare.

Solar radiation data are not available for the study area. Values for Cape Town, however, show a radiant flux density of slightly over 30 MJ m^{-2} day^{-1} (Fuggle 1981).

The mean annual sunshine at Table Mountain House is 6,4 hours per day. The mean hours of sunshine in summer and in winter are 8,6 and 4,5 hours per day respectively (Fuggle 1981).

The annual mean daily temperature for the area is 12,8^{o}C. The seasonal mean daily temperatures range between 15,6°C in summer to 9,8°C in winter (Fuggle 1981). The mean daily maximum and minimum temperatures are 20,1°C and 6,8°C respectively.

Although evaporation data are not available specifically for the study area, the mean annual evaporation for the southwestern Cape mountain complex is close to 2000mm per year. Over 40% of the annual evaporation total for this area occurs in summer (Fuggle 1981).

The entire coastal area is characterized by strong winds. The summer winds are dominantly southeast to southerly, while winter winds dominate from the northwest and southwest. Southeast and south winds prevail for about 60% of the time in summer. The summer sea breeze over False Bay reinforces the southerly gradient winds and gives rise to maximum wind velocities in the early afternoon. Hot, dry, gusty winds (Berg winds) occassionally occur along the coast, especially in winter. The mean annual wind speed for Cape Town is 17,4 km hr^{-1} (Specht & Moll 1983; Nagel 1961).

The mean annual relative humidity recorded for Cape Town at 0700 hours is 83% and at 1300 hours 60% (Pearce & Smith 1984).

1.3.3 Vegetation

The vegetation of the study area has been classified as Mountain Fynbos by Taylor (1978), Kruger (1979) and Boucher & Moll (1981). Mountain Fynbos corresponds to Macchia (Veld Type 69) as classified by Acocks (1975). Detailed descriptions of the vegetation have been compiled by Taylor (1978) and Kruger (1979).

The vegetation of the area is dominated by evergreen sclerophyllous species representing the three characteristic fynbos elements; the restioid, ericoid and proteoid (Kruger 1979; Taylor 1978). These fynbos elements contain plants that resemble typical members of the Restionaceae, Ericaceae and Proteaceae respectively, in growth form, but do not necessarily belong to these families (Taylor 1978).
The restioid element comprises wiry, aphyllous evergreen Hemicryptophytes of the Restionaceae and some Cyperaceae. The ericoid element contains dwarf and low evergreen Phanerophytes, with hard, narrow, rolled leaves (ericoid leaves). Typical plants representing this category include families such as Ericaceae, Ru~~s~~taceae, Bruniaceae, Polygalaceae and Thymelaeaceae. The proteoid element comprises medium to tall broad-sclerophyllous Phanerophytes with hard, leathery

leaves, usually of the Proteaceae.

Three layers may be distinguished in mature Mountain Fynbos plant communities: an upper stratum of proteoid shrubs, usually discontinuous; a dense middle layer of ericoids, lower proteoids with smaller leaves and some larger restioids; and a ground layer of small shrubs, herbs, many geophytes and low restioids, often wiry and matted (Taylor 1978). The upper shrub stratum is generally absent from communities at higher elevations. The dense middle stratum contains a great diversity of species and life forms except where suppressed by taller plants.

Taylor (1978) recognized two broad Mountain Fynbos zones, the proteoid zone of the lower mountain slopes and foothills, and the ericoid-restioid zone of higher elevations. A third category, the azonal hygrophilous fynbos, cuts across these two zones in habitats with perennial soil moisture.
The proteoid zone, characterized by the predominance of broad-sclerophyllous proteoid shrubs (usually about 1,5 - 2,5 m high), is restricted largely to the foothills, lower slopes and plateaus. This zone is not a dominant feature in the study area and the larger proteoids are scarce and confined to sheltered places.

The ericoid-restoid zone is distinguished by the relative scarcity of the proteoid form. The vegetation is generally two layered in which ericoids and restioids are prominent, either separately or as a mixture of both. The ericoid and other leptophyllous shrubs range in height from 20 cm to 1,5 m. Where the shrubs are sparse the vegetation is normally dominated by Restionaceae. This zone is found on upper slopes, ridges, plateaus and summits of the mountain. Cool habitats of this zone are usually one layered in which a dense shrub community, only 25-50 cm tall, is dominated largely by Ericaceae, particularly *Erica hispidula*.

The hygrophilous fynbos includes a wide range of communities in a diversity of habitats, each of which has soils that are permanently wet or moist. These habitats along high level drainage lines or seepage zones are dominated by narrow-sclerophyllous *Berzelia lanuginosa*, broad-sclerophyllous *Osmitopsis asteriscoides* and emergent *Chondropetalum mucronatum* in the upper stratum. The lower stratum is dominated by short Restionaceae and Ericaceae. *Psoralea pinnata* often dominates the upper stratum in some of these wet areas. The middle layer is then composed of *Berzelia lanuginosa* and *Leucadendron salignum* with Restionaceae and Ericaceae forming the lower stratum.

Glyphis (1976) has presented a detailed survey of the vegetation on the Back Table of Table Mountain. He recognized two major plant communities for the area: (i) a *Cunonia capensis* forest community, which contains all the typical members of wet kloof forests in the southwestern Cape; and (ii) an *Erica hispidula* fynbos community, containing four sub-communities. These sub-units of the community are: (i) Wet *Hypolaena crinatus* - *Elegia thyrsiflora* sub-association, (ii) *Hypodiscus aristatus* - *Tetraria thermalis* sub-association, (iii) *Cliffortia ruscifolia* - *Lampranthus falciformis* sub-association, and (iv) woody proteoid sub-association. The sub-units of this community all contain one or more of the following five species: *Erica hispidula*, *Penaea mucronata*, *Aristea macrocrapa*, *Aristea thyrsiflora*, *Berzelia lanuginosa* and *Villarsia ovata*.

The classification of the vegetation by Glyphis (1976) conforms to the broad description of Mountain Fynbos presented by Taylor (1978) and Kruger (1979).

The descriptions above provide an accurate account of the vegetation and the habitats found in the present study.

1.4 PREVIOUS RESEARCH

Numerous investigations of mist interception have been conducted in forest communities but relatively few have concentrated on heathlands. Adequate reviews of studies in forests have been compiled by Kittredge (1948), Geiger (1965), Kerfoot (1968) and Rutter (1975). Of more direct interest to this study are the investigations by Marloth (1903, 1905), Nagel (1956, 1962) and Moll & Romoff (1983).

Marloth (1903, 1905) observed that considerable quantities of water were deposited on the vegetation of Table Mountain in the absence of rain, when the mountain was covered with its 'Table Cloth'. He placed two raingauges on the upper plateau, one of which had a bundle of Restionaceae reeds inserted into a wire framework mounted over the gauge, while the other was left open on top. After the occurrence of cloud on the plateau he noted a considerable quantity of water in the gauge with reeds, while the ordinary raingauge collected a negligible quantity. Although Marloth's work has been criticized (Stewart 1903; Fourcade 1942), it nevertheless demonstrated the influence that mist might have on the water availability on the mountain.

Throughout the world mist interception studies have usually been made using fog-catchers and various screen collectors. Reviews of some of the earlier investigations have been compiled by Geiger (1965) and Kerfoot (1968).

On Table Mountain Nagel (1956) measured fog precipitation with two standard raingauges, one of which was equipped with a fog-catcher. He found that fog precipitation, measured over a year amounted to 3294mm against 1940mm of rain. The value of the results is, however, restricted because they include periods when rain and drizzle were falling. If wind is present on such occasions,'rainfall' intercepted by the fog-catcher augments the vertical rainfall and erroneous measures are obtained. Nagel (1962) also derived an empirical equation to determine the quantity of mist precipitation (especially during the occurrence of rain) on Table Mountain and the Back Table. His calculations for a five year period (1957-1961) showed that mist precipitation amounted to 2398mm yr^{-1} and rainfall to 1544mm yr^{-1}, at Table Mountain House on the Back Table. He found the ratio of mist to rain to be 2,40 in summer, 1,25 in winter and 1,55 for the year as a whole. At McLear's Beacon (Table Mountain), mist precipitation was calculated to be 5664mm yr^{-1} and rainfall 1904mm yr^{-1}, with a ratio of mist to rain of 4,7 in summer, 2,4 in winter and 3,0 for the year. These results show that mist precipitation on mountains exceeds actual rainfall several fold. Nagel attributed this to the fact that clouds on mountain summits last much longer than rainfall events and that rainfall seldom occurs from southeasterly orographic cloud.

The ability of fynbos vegetation to intercept and trap mist droplets has been observed by Moll & Romoff (1983). The authors, while investigating the seasonal change in water potentials of selected fynbos plants at Pella in the southwestern Cape, obtained some unexpected results which they concluded could only have been attributed to mist trapping by *Thamnochortus punctatus* (a member of the Restionaceae).

Went (1955) has suggested that small, narrow leaf surfaces (leptophyllous or needle-like leaves) of plants such as that of the chaparral in California (similar in structure to the fynbos vegetation of South Africa) are more effective in straining droplets from passing mist than broad-leafed species. Went's explanation for this is that "A fog consists of very small (0,01 - 0,1 milli-meter) water droplets, which are far enough apart that they do not fuse, are suspended in saturated air so that they do not evaporate, and are light enough not to settle. Furthermore, in a fog there is usually enough air movement to stir up droplets about to settle. When such a fog moves past solid surfaces, it is deflected, and the water droplets flow with the air around the surface and prevent contact with it. If the surface is small or narrow enough, the air is hardly deflected, and the inertia of the water droplets is sufficient to carry them against the surface, where they fuse with it. That means that small or narrow surfaces will act as strainers for the fog droplets." This would appear to be confirmed by Costin & Wimbush (1961). These authors, although investigating the interception of rain, cloud and fog by forests, observed (though without measurement) that fine-leafed grassland and heath vegetation accumulated considerable quantities of cloud water, and considered that their leaves might be more efficient in this respect than a community of broad-leafed species.

A study of the previous research shows that attention has in the past been directed mainly towards the interception of rainfall or rainfall and mist by forest communities. A number of studies have measured mist precipitation by means of mechanical collectors.

No detailed studies have been made to obtain observations and direct measurements of moisture interception by vegetation under purely non-rainfall conditions. Furthermore, no detailed mist interception studies have been conducted in fynbos vegetation. This study seeks to fill these gaps in knowledge,and investigates mist interception by selected fynbos plants under non-rainfall conditions. The Back Table of Table Mountain was chosen as a site to conduct the study as it afforded relatively undisturbed indigenous vegetation and suitable mountain-top weather conditions. The study was, therefore, conducted in order to establish, through direct observations and quantitative measurements, whether specific fynbos plants have the ability to intercept significant quantities of moisture from mountain-top cloud.

CHAPTER 2

METHODOLOGY

2.1 OVERALL DESIGN

In planning the overall design of the methodology consideration was given to the following:

(i) A literature survey of relevant previous research.

(ii) The selection of a study area favourable to mist interception.

(iii) Accessibility to the area for monitoring purposes.

(iv) The availability of indigenous vegetation.

(v) The selection of suitable catching devices for interception quantities.

(vi) A pilot study.

2.2 STUDY AREA

The Back Table of Table Mountain was selected for the investigation because it provided suitable mountain-top weather conditions, was accessible by road, and has relatively undisturbed fynbos vegetaion.

2.3 SITES

Five experimental sites were selected on the Back Table for purposes of (i) direct observations of moisture interception by particular plants, and (ii) quantitative measurements of plant-drip and stem-flow from three selected plant species.

The reasons for selecting different sites were:

(i) To cover representative areas of the plateau; stretching from the southeast edge to the northwest edge.

(ii) To include different elevations of the area.

(iii) To allow for repetitions in observations and measurements.

The following criteria were employed for selecting each site:

(i) The plants at each site had to be representative of the vegetation of the study area.

(ii) Each site had to contain the same plant species used for quantitative measurements of moisture interception.

(iii) Each site had to be exposed to the prevailing mist formations.

Five sites which satisfied the above criteria were then established on the Back Table (Fig.1). The sites are situated at various elevations and lie along a northwest-southeast axis. This accords with the direction of the predominant winter (NW) and summer (SE) winds, and the axis along which mist is blown. The approximate elevations of the sites,as well as their horizontal distance from the southeast edge of the mountain are:

Site 1 : 680m and 25m respectively, situated on the southeast side of the study area.

Site 2 : 720m and 540m respectively.

Site 3 : 720m and 1500m respectively.

Site 4 : 760m and 2440m respectively.

Site 5 : 750m and 2750m respectively, situated on the northwest side of the plateau.

Each experimental site is approximately 15 x 35 m in extent.

2.4 PLANT SELECTION

2.4.1 Plants Selected for Observations

The plants selected for mist interception observations were chosen so as to represent the three characteristic fynbos elements; the restioid, ericoid and proteoid. These elements contain plants that resemble typical members of the Restionaceae, Ericaceae and Proteaceae respectively, in growth form, but do not necessarily belong to these families (Taylor 1978). The plants common to all five sites and representative of the vegetation of the study area are: *Berzelia lanuginosa* (Bruniaceae), *Leucadendron salignum* (Proteaceae), *Psoralea pinnata* (Fabaceae), *Cliffortia ruscifolia* (Rosaceae), *Watsonia tabularis* (Iridaceae), *Stoebe cinerea* (Asteraceae), and members of Ericaceae and

Restionaceae. These plants were selected at each site for observational purposes. Broad-sclerophyllous (e.g. Proteaceae) and narrow-sclerophyllous (e.g. Bruniaceae) plants were considered for selection in order to determine the effectiveness of different leaf sizes in intercepting mist droplets. No distinction was made between different species of Restionaceae and Ericaceae unless observations indicated differing interception abilities. The dominant species together with species representative of the plant community at each site may be found in Chapter 3.

2.4.2 Plants Selected for Mist Interception Measurements

The plant species selected for quantitative measurements of plant-drip and stem-flow were *Leucadendron salignum* (Proteaceae), *Berzelia lanuginosa* (Bruniaceae) and *Psoralea pinnata* (Fabaceae). These three species were selected because they satisfied the following criteria:

(i) The plants readily intercepted mist droplets from the atmosphere.

(ii) The plants were suitable for the positioning of plant-drip and stem-flow catching units (see 2.5.4).

(iii) The plants were present at each of the five sites.

These species were selected at each of the sites in such a manner that they were not isolated from, but formed part of the plant community of each area. The size and shape, and the exposure of the plants to the wind at each site are presented in Table 1.

2.5 DESIGN OF EQUIPMENT

In order to measure the amount of mist precipitation in the form of plant-drip and stem-flow, it was necessary to design catching devices which could be placed directly beneath plant canopies and also round the stems of plants.

Many studies of mist precipitation have been conducted in forests where large catching trays or raingauges have been positioned beneath the canopy; large stem-collars being used to catch stem run-off.

As fynbos is a shrub type vegetation, smaller catching devices for plant-drip and stem-flow needed to be constructed.

TABLE 1 : Description of the experimental plants at each site and their exposure to the prevailing winds.

Site	*Leucadendron salignum* Broad-sclerophyll (nanophyll)		*Berzelia lanuginosa* Narrow-sclerophyll (leptophyll)		*Psoralea pinnata* Narrow-sclerophyll (leptophyll)	
	Plant height & crown shape	Sheltered or exposed to winds	Plant height & crown shape	Sheltered or exposed to winds	Plant height & crown shape	Sheltered or exposed to winds
1	1,1 m Spreading, Branching	Sheltered from NW & SE winds	1,1 m Narrow, Funnelling	Sheltered from NW & SE winds	1,3 m Narrow, Funnelling	Exposed to NW & SE winds
2	0,9 m Spreading, Branching	Sheltered from NW & Exposed to SE	0,7 m Narrow to Spreading	Sheltered from NW Exposed to SE	1,1 m Narrow, Funnelling	Exposed to NW & SE winds
3	0,8 m Narrow to Spreading	Exposed to NW & SE winds	0,9 m Spreading, Branching	Sheltered from SE Exposed to NW	1,4 m Spreading	Exposed to SE & NW winds
4	0,9 m Spreading, Branching	Sheltered from NW Exposed to SE	0,9 m Spreading, Branching	Sheltered from NW & SE winds	1,2 m Narrow, Funnelling	Sheltered from NW Exposed to SE
5	0,8 m Spreading, Branching	Sheltered from SE Exposed to NW	1,0 m Spreading	Sheltered from NW Exposed to SE	1,4 m Spreading	Exposed to NW & SE winds

2.5.1 Plant Drip Trays (Fig.2)

Plant-drip trays were designed so that they could be positioned beneath the canopies of plants in order to catch water dripping from the leaves and branches. Aluminium sheeting was selected for constructing the trays. This material proved easy to work with, yet rigid and strong enough to withstand wind buffeting. The trays were constructed to a standard size rather than varying the size to suit the different plants. This simplified the manufacture of the trays. As fynbos plants are relatively small, it was easy to select suitably sized plants for the trays.

The trays were constructed from 1 m^2 sheets of aluminium (0,9mm thick). Each sheet was cut in half, the two halves were overlapped along the cut median strip by 20mm, and four 4mm diameter holes drilled at equal distances through the overlapping strips. A hole of 25mm diameter was cut through the centre of the positioned halves. This ensured that each half of the tray could be positioned beneath a plant with the stem fitting through the centre hole. The outer 20mm of each sheet was then turned up to form a rim. To channel water falling onto the tray

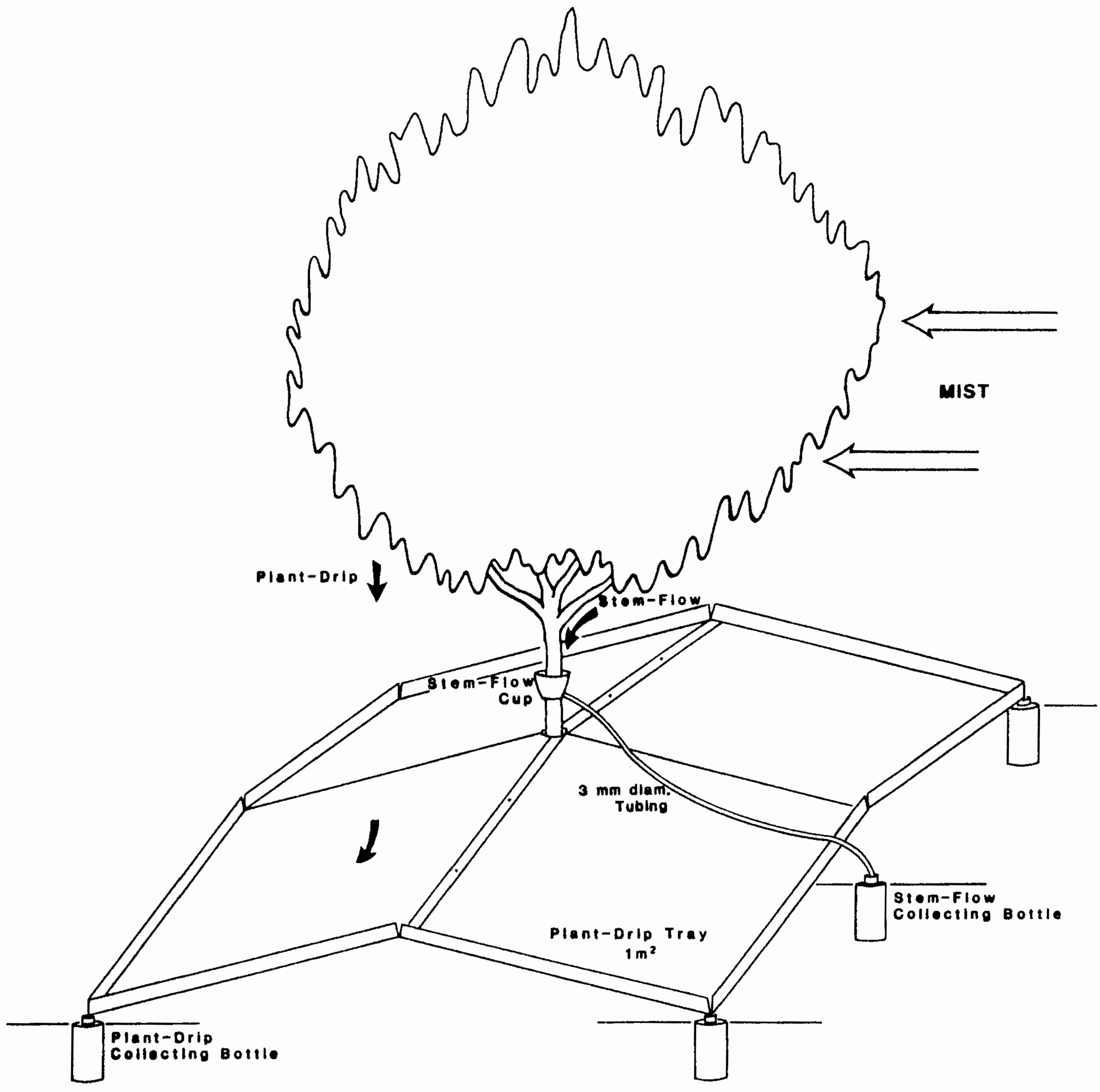

Fig. 2 : Diagram of plant-drip tray and stem-flow cup.

towards the corners, each half sheet was slightly bent along its short centre length. Holes of 5mm diameter were drilled through each corner to allow for drainage into collecting bottles.

2.5.2 Positioning of the Plant-Drip Trays
(Figs. 6, 7 & 8)

Plastic insulation tape was wrapped round the edge of the centre hole before positioning the halves of the tray round the stem of the plant. This was done to prevent the sharp aluminium edge cutting into the stem and so injuring the plant. It was, however, found that the insulation tape did not provide adequate protection, as the centre hold edge eventually cut through the tape and into the stem, particularly when the plant was buffeted by the wind. Semi-circular polythene strips were subsequently fitted round the stem. This proved to be more effective.

The two halves of the tray were positioned beneath the plant, with the stem protruding through the centre hole. Where necessary, the centre hole was enlarged. The halves were then bolted together on the overlapping mid-section.

Fig 3: Typical mist conditions studied

Fig 4: *Psoralea pinnata* intercepting mist droplets

Fig 5: Stem-flow cup in position

Fig 6: Spreading branching habit of *Leucadendron salignum* with plant-drip tray in position

Fig 7: Funnel shaped habit of *Psoralea pinnata*

Fig 8: Tufted habit of *Berzelia lanuginosa*

Each half of the tray was set at an angle sloping away from the stem of the plant. Adequate slope on each quarter of the tray was allowed so that water could flow towards the corners. Where necessary a short length of wood was used to prop up the centre section of the tray, the wooden piece being placed next to the stem and secured to the underside of the tray by a small screw.

The mid rib of the tray was aligned in a northwest - southeast direction (the direction of the prevailing winds). This ensured windward and leeward side collection of plant-drip water.

The tray was secured to the ground by means of tent pegs placed near each corner.

A hole was made in the soil beneath each corner of the tray and a polythene collecting bottle placed in each hole. The neck of each bottle was positioned directly beneath the drainage holes of the tray.

The set up of the tray thus ensured that any water falling onto it would flow towards the corners, through the holes and into the collecting bottles. Drainage was checked by sprinkling water onto the trays.

The rate of water evaporation was reduced by utilizing narrow necked bottles and by sinking them into the soil.

Control trays, without a centre hole, were placed in the open, away from shrub vegetation, at each site.

2.5.3 Stem-Flow Catching Devices (Figs. 2 & 5)

The stem-flow catching device (stem-flow cup) was constructed from a polythene bottle with the top and bottom cut off and split down the one side. This was fitted round the stem about 5 cm above the centre hole of the plant-drip tray and secured by wire. The positioning of the cup immediately above the centre hole of the tray ensured that water could not flow down the stem through the hole. The gaps between the stem and the cup and also the split side were sealed with silicone marine sealant. The sealant was found to be ideal; when dry it was sufficiently pliable to prevent cracking while at the same time providing a permanent seal. A hole was made in the one side of the cup, directly above where it embraces the stem, and into which a length of 3mm diameter polythene tubing was fitted. The tube was led from the cup to a stem-flow collecting bottle, which was placed into a hole in the ground next to the tray. Adequate head was allowed to enable water, caught by the cup, to flow down the tube and into the collecting bottle. The flow was checked by pouring water into the cup.

The stem-flow catching device thus ensured that water caught by the cup would pass into the collecting bottle.

Bottles of varying capacity were tested in order to determine which were most suitable for the experiment. The shallow rocky soils created difficulty in digging holes for large capacity bottles.

The following plant-drip and stem-flow collecting bottles were used for the study:

Site 1 :	Plant-drip	-	220 ml
	Stem-flow	-	550 ml; 1100 ml
Site 2 :	Plant-drip	-	220 ml
	Stem-flow	-	220 ml; 550 ml
Site 3 :	Plant-drip	-	220 ml
	Stem-flow	-	220 ml; 550 ml; 3300 ml
Site 4 :	Plant-drip	-	220 ml
	Stem-flow	-	220 ml; 550 ml; 1100 ml
Site 5 :	Plant-drip	-	220 ml
	Stem-flow	-	220 ml; 1100 ml; 3300 ml

2.5.4 Problems Encountered in Setting up Plant-Drip and Stem-Flow Units

Plants best suited for the catching devices were those with fairly straight, slender stems. Multiple stemmed plants such as Restionaceae and some Ericaceae were unsuitable.

It was necessary to choose plants with canopy areas not extending beyond the catching surfaces of the trays. Furthermore, plants had to be selected so as to ensure that their height did not result in foliar droplets being deflected beyond the tray by wind.

The trays could not be placed beneath plants which were situated close to large rocks as it proved most difficult to position the tray correctly and to dig holes for the collecting bottles.

Plants in close proximity to taller vegetation were also found to be unsuitable for placing trays as droplets from the surrounding plants could fall or be blown onto the tray and so spoil results.

2.6 OBSERVATIONS AND MEASUREMENTS

2.6.1 Qualitative Observations

Direct observations of moisture intercepted by the plants, selected at the sites, were made whenever mist occurred on the mountain. Observations commenced in March 1984 and continued through to December 1984.

Specific observations made included:

(i) The interception of moisture droplets from the atmosphere by selected plant species.

(ii) Which species first intercepted moisture.

(iii) Whether intercepted droplets initially formed on the windward side of the plants.

(iv) The degree of moisture intercepted by the plants.

(v) The occurrence of plant-drip and stem-flow.

(vi) Whether taller plants intercepted more moisture than shorter ones.

(vii) The influence of different leaf sizes in intercepting mist droplets.

(viii) The influence of different plant shapes in directing intercepted water to plant-drip and stem-flow.

(ix) The weather conditions under which interception occurred.

The above observations were made whenever weather conditions favourable for interception occurred in the study area. One of two observational sequences were carried out:

(i) At the onset of mist the site on the windward side of the study area was monitored, as it was first to receive mist. Each selected plant at the site was visually checked in order to establish which of the plants intercepted moisture first. This procedure was continued for each site in turn, until all the sites had been monitored. All the selected plants which intercepted mist droplets were recorded and listed in the order in which they first intercepted moisture. In monitoring the sites consecutively it was found that by the time the last few sites were visited, the mist had already covered them. It was, therefore, impossible to determine which plants had intercepted moisture first. The sites were, therefore, visited in rotation and monitored according to whether mist occurred from the southeast or northwest.

(ii) When mist was already present in the study area, or after the onset of mist, each site in turn was monitored. The degree of moisture intercepted by the selected plants was observed on the following basis: (a) whether the plants were dry; (b) whether they contained visible droplets on the foliage; (c) whether they were wet, without evidence of stem-flow and plant-drip; and (d) whether they were saturated with moisture, exhibiting plant-drip and stem-flow.

The observational sequences ensured that all the abovementioned specific observations were documented. Observational circuits were continued until such time as the plants became saturated and no distinction between the plants could be made on the basis of intercepted moisture.

Observations were aborted whenever rainfall occurred at the time of monitoring. Rainfall was recorded on 120 days during the period March to December 1984.

Observations were not made at night due to the impracticality of successful monitoring. Ninety-four visits were made to the study area. Twenty-seven observational sequences were obtained of which 15 were complete, the rest being influenced by rainfall or mist dissipating during the observational sequence.

2.6.2. Quantitative Measurements

(a) Weather Conditions

Measurements of air temperature, relative humidity and wind speed and direction were recorded whenever observations of moisture interception by the selected plants were made. A visual estimation of the degree of mist cover was also made. The measurements were taken at each site and repeated for each observational circuit until such time as the observations were abandoned. The purpose of these measurements was to establish the conditions under which mist interception by the plants occurred.

Air temperature was measured with a dry-bulb thermometer, relative humidity with a whirling psychrometer and wind speed with a hand held cup anemometer. Because of the difficulty in obtaining accurate mean wind speeds, the speed at the time of measurement was, therefore, related to the Beaufort Wind Scale in which the limits of wind speed could be incorporated. Wind direction was estimated. This proved to be sufficiently accurate as the predominant winds were either north-west or southeast or slight variations of these directions.

Rainfall and mist precipitation in the study area were recorded by means of standard 127mm raingauges and fog-catchers respectively. Values were taken on each visit and compared in order to distinguish occurrences of rainfall from mist.

(b) Mist Interception

The quantities of moisture intercepted by *Leucadendron salignum*, *Berzelia lanuginosa* and *Psoralea pinnata* were measured by means of plant-drip trays and stem-flow cups. These catching units were placed beneath each plant at each site (Figs. 6, 7 & 8). A control tray was also set up at each site.

A visual observation of the mountain was made each day to determine whether mist cover was present in the study area. With the occurrence of mist on the plateau, each site in turn was visited and the quantities of moisture collected by the experimental and control trays, measured to the nearest millilitre (Appendix 1). The quantities of plant-drip moisture were separated into windward and leeward side measurements in order to determine whether the windward or leeward side of the plants intercepted a greater quantity of moisture.

The design, manufacture and installation of the catching units was completed by the end of April 1984. From May to December 1984, 20 significant quantitative results were obtained from each site. Fifty-five percent of these were obtained during the months of October and November. This indicates the frequency of rainfree mist periods on the mountain during summer months.

Rainfall occurred on 107 days during the measurement period. The collecting bottles had to be emptied after each period of rainfall. Five results were lost due to rainfall occurring at the time of measurement.

Rainfall and fog catch measurements were recorded on each visit. The respective measurements were compared in order to distinguish occurrences of rainfall from mist.

The quantities of mist precipitation from the experimental plants were not converted into millimetres for comparison with standard ranfall measurements, as it was not horizontal area catch which was measured but moisture intercepted by the plants.

The possible effects of condensation contributing to the quantities measured was recognized. However, for purposes of this study the role played by condensation was considered to be irrelevant.

In planning the methodology consideration was given to the following: selection of sites; selection of plants; design of equipment; and the documentation of observations and measurements. The overall design needed to satisfy the objective of mist interception by specific fynbos plants under non-rainfall conditions. The overriding factor influencing the methodology was weather. The method of investigation proved to be adequate. However, a noteworthy problem was enountered in anticipating suitable weather conditions for observations and measurements.

CHAPTER 3

VEGETATION AND MIST CONDITIONS

This chapter comprises a general description of the vegetation at each site and the mist conditions observed in the study area.

3.1 **VEGETATION**

Identification of the plants encountered at each site was based on dominance and conspicuousness. The identification was conducted by purely visual means and verified with the aid of standard texts (Kidd 1983; Jackson 1982; Kruger 1979; Taylor 1978; Moll & Campbell 1976; Levyns 1966; Adamson & Salter 1950). All the plants which were identified were representative of the vegetation of the area. Individual Restionaceae and Ericaceae species were not identified. However, certain species, which were observed to differ in their interception abilities, were noted.

The plants selected for purposes of the investigation into mist interception are shown below.

Site 1 (elevation : 680 m)

The upper stratum is dominated by tall *Psoralea pinnata*. The middle stratum is dominated by *Berzelia lanuginosa*, *Leucadendron salignum*, *Erica hispidula* and other members of Ericaceae. Restionaceae and low growing Ericaceae dominate the lower stratum. Other species which occur include *Cliffortia ruscifolia*, *Watsonia tabularis*, *Stoebe cinerea*, *Tetraria thermalis* and various members of Asteraceae.

Site 2 (elevation : 720 m)

The site is dominated by Restionaceae. Species which form part of the community but not visually dominant include *Berzelia lanuginosa*, *Psoralea pinnata*, *Leucadendron salignum*, *Cliffortia ruscifolia*, *Watsonia tabularis*, *Stoebe cinerea*, *Tetraria thermalis* and members of Ericaceae and Asteraceae.

Site 3 (elevation : 720 m)

The southeastern side of the site is dominated by an upper stratum of *Psoralea pinnata* and a lower stratum of *Stoebe cinerea*. The middle layer at this side of the site is absent. The central and northwestern areas of the site are dominated by a middle stratum of *Berzelia lanuginosa*, *Leucadendron salignum* and emergent *Chondropetalum mucronatum*. Ericaceae (mainly *Erica hispidula*) and Restionaceae dominate the lower layer. *Hypolaena crinatus* and *Restio perplexus* form matted hummocks in wet areas. Also present are *Osmitopsis asteriscoides*, *Tetraria thermalis*, *Watsonia tabularis* and *Cliffortia ruscifolia*.

Site 4 (elevation : 760 m)

Berzelia lanuginosa, *Leucadendron salignum* and taller Ericaceae and Restionaceae dominate the middle stratum. The upper stratum is absent at the site. The lower layer contains low Ericaceae and Restionaceae. Other species within the community include *Cliffortia ruscifolia*, *Osmitopsis asteriscoides*, *Stoebe cinerea*, *Psoralea pinnata*, *Watsonia tabularis* and various members of Asteraceae.

Site 5 (elevation : 750 m)

The dominant species of the middle stratum include *Leucadendron salignum* and *Berzelia lanuginosa*. The lower layer is dominated by Restionaceae, Ericaceae and Coleonema album. *Cliffortia ruscifolia, Watsonia tabularis* and *Stoebe cinerea* are present.

The plants common to each site, viz. *Psoralea pinnata, Cliffortia ruscifolia, Watsonia tabularis, Leucadendron salignum, Stoebe cinerea, Berzelia lanuginosa* and Ericaceae and Restionaceae were selected for observational purposes of mist interception. The same plants were selected at each site to ensure repetitive observations.

3.2 MIST CONDITIONS

The northwest-southeast axis along which mist is blown corresponds with the direction of the prevalent winter (NW) and summer (SE) winds. The elevations of the sites vary from approximately 680 m at Site 1 on the southeastern side of the study area to 760 m at Site 4,and 750 m at Site 5 on the northwestern side; a horizontal distance of approximately 2725 m.

The gradual increase in elevation between the sites resulted in the entire plateau being enveloped under dense mist conditions. The denseness of the mist occurring in the study area varied from dense mist in which the visibility was estimated at 20-100 m (Fig.3) to light mist with visibility estimated at 100-300 m. Patches of mist were associated with gusty wind conditions. Continuous, driving mist was observed to occur under steady wind conditions. Mist was also observed to occur at night subsequent to mist-free days. Quantities of moisture intercepted by selected plants under varying mist conditions are considered in the following chapter at 4.1.1.

CHAPTER 4

RESULTS AND DISCUSSION

In dealing with the results a distinction has been made between quantitative measurements and qualitative observations. The quantitative measurements incorporate all the results which have been supported by data whereas the qualitative observations deal with visual observations and observations which are not wholly supported by data owing to variable factors.

4.1 QUANTITATIVE MEASUREMENTS

Raw data of moisture intercepted by the three selected plants, at each of the five sites, were obtained and are recorded in Appendix 1. These measurements were then translated into total quantities for each site, Table 2. The quantities in Table 2 were in turn transformed into ratios of leeward and windward side, stem-flow to plant-drip and plant-drip plus stem-flow to control values, as presented in Table 3.

TABLE 2 : Total quantities (ml) of mist precipitation collected by the experimental and control trays at each site.

PD : Plant-drip quantities
SF : Stem - flow quantities

WWS : Windward side measurement from trays
LWS : Leeward side measurement from trays

Site	*Leucadendron salignum*					*Berzelia lanuginosa*					*Psoralea pinnata*					Control		
	Plant-Drip					Plant-Drip					Plant-Drip							
	WWS	LWS	TOT PD	SF	TOT PD +SF	WWS	LWS	TOT PD	SF	TOT PD +SF	WWS	LWS	TOT PD	SF	TOT PD +SF	WWS	LWS	TOT
1	1508	946	2454	4622	7076	921	931	1852	4526	6378	1193	1135	2328	4603	6931	776	780	1556
2	2891	2460	5351	3645	8996	2364	2345	4709	4656	9365	1583	1549	3132	4615	7747	1222	1296	2519
3	1856	1775	3631	4125	7756	1182	1247	2429	4250	6679	1238	1276	2514	6377	8891	1290	1324	2614
4	2638	2893	5531	6052	11583	2095	2588	4683	3892	8575	1730	1658	3388	6756	10144	1526	1570	3096
5	1629	1596	3225	4938	8163	1428	2115	3543	7586	11129	1429	1671	3100	17087	20187	1082	1206	2288
Totals	10522	9670	20192	23382	43574	7990	9226	17216	24910	42126	7173	7289	14462	39438	53900	5896	6177	12073
Average per Site	2104	1934	4038	4676	8715	1598	1845	3443	4982	8425	1435	1458	2892	7888	10780	1179	1235	2415

TABLE 3 : Ratios of leeward side (LWS) to windward side (WWS); stem-flow (SF) to plant-drip (PD); and plant-drip (PD) + stem-flow (SF) to control quantities

SITE	*Leucadendron salignum*			*Berzelia lanuginosa*			*Psoralea pinnata*			CONTROL
	RATIOS			RATIOS			RATIOS			RATIO
	LWS/WWS	SF/PD	PD+SF/CONTROL	LWS/WWS	SF/PD	PD+SF/CONTROL	LWS/WWS	SF/PD	PD+SF/CONTROL	LWS/WWS
1	0,6	1,9	4,5	1,0	2,4	4,1	1,0	2,0	4,5	1,0
2	0,9	0,7	3,6	1,0	1,0	3,7	1,0	1,5	3,1	1,1
3	1,0	1,1	3,0	1,1	1,7	2,6	1,0	2,5	3,4	1,0
4	1,1	1,1	3,7	1,2	0,8	2,8	1,0	2,0	3,3	1,0
5	1,0	1,5	3,6	1,5	2,1	4,9	1,2	5,5	8,8	1,1
RATIOS FOR STUDY AREA	0,9	1,2	3,6	1,2	1,4	3,5	1,0	2,7	4,5	1,0

4.1.1 Mist Interception

A greater number of interception results were obtained under southeasterly wind conditions (14 results) than from northwesterly conditions (6 results) (Appendix 1). This was due to the southeasterly generated clouds normally not producing rain (i.e. fair weather orographic clouds) whereas the northwesterly clouds were usually accompanied by rainfall.

(a) Total Intercepted Qantities

The quantities of intercepted moisture, in the form of plant-drip and stem-flow from the selected plants; and also that caught by the control trays, are presented in Appendix 1. The quantities collected by the trays were separated into leeward and windward side measurements. On a number of occasions the quantities intercepted by the plants exceeded the holding capacity of the collecting bottles, especially the stem-flow bottles. This is indicated by the plus sign (+) in Appendix 1. The bottle capacities were subsequently increased after quantities collected were established. The overflow from some of the collecting bottles thus caused an underscore of the results in these particular cases.

Table 2 sets out the total quantities of moisture intercepted by *Leucadendron salignum, Berzelia lanuginosa* and *Psoralea pinnata* at each site. In comparing the overall quantity collected by these plants, it can be seen that *Psoralea pinnata* collected the largest quantity. The quantity collected by *Psoralea pinnata* being 28% and 24% greater than that collected by *Berzelia lanuginosa* and *Leucadendron salignum* respectively. The high overall quantity collected by *Psoralea pinnata* compared with the other two species revealed the efficiency of the plant in intercepting mist moisture.

On a number of occasions quantities were only measured over a specified period of time in order to avoid rainfall interfering with the results. This was especially the case for the rainbearing northwesterly clouds (Appendix 1). These results were used to calculate the rate of intercepted water collected by the catching devices (ml hr^{-1})(Table 4). The interception efficiency of *Psoralea pinnata* can also be seen when comparing the rates of water collected by the three species (Table 4). The rate for *Psoralea pinnata* being roughly twice that of the other plants.

TABLE 4 : Rate of mist precipitation collected by the experimental trays (plant-drip (PD) + stem-flow (SF)) and the control trays at each site (ml hr^{-1}). The ratios of the rate collected by the experimental trays to that caught by the control trays are shown. Values taken from Appendix 1.

Site	Time period (hrs)	*Leucadendron salignum*			*Berzelia lanuginosa*			*Psoralea pinnata*			Control	
		Total PD+SF (ml)	Rate PD+SF (ml hr^{-1})	Ratio of rate PD+SF to rate control	Total PD+SF (ml)	Rate PD+SF (ml hr^{-1})	Ratio of rate PD+SF to rate control	Total PD+SF (ml)	Rate PD+SF (ml hr^{-1})	Ratio of rate PD+SF to rate control	Total (ml)	Rate (ml hr^{-1})
1	14,75	445	30	2,0	612	41	2,7	623	42	2,8	215	15
2	12,50	354	28	2,5	351	28	2,5	732	59	5,4	139	11
3	15,80	596	38	5,4	583	37	5,3	375	24	3,4	115	7
4	13,50	1261	93		935	69		1240	92		447	33
5	9,50	932	104	52,0	780	87	43,5	4128	459	229,5	21	2
Total and ratios for study area	65,55	3588	55	3,9	3261	50	3,6	7098	108	7,7	937	14

(b) Plant-Drip and Stem-Flow

Plant-drip and stem-flow values for each experimental plant at each site are reflected in Table 2. Figure 9 depicts the quantities and percentages of intercepted water directed to plant-drip and stem-flow for each of the three species. Stem-flow quantities were greater than plant-drip values for all three species (Table 2; Fig. 9). Table 3 shows the ratios of stem-flow to plant-drip and clearly indicates the extent to which stem-flow exceeded plant-drip.

From Table 3 it can be seen that the ratio of plant-drip plus stem-flow to control quantities is 3,6 for *Leucadendron salignum*, 3,5 for *Berzelia lanuginosa* and 4,5 for *Psoralea pinnata*. The high value for *Psoralea pinnata* indicates the efficiency of the plant in intercepting moisture.

The portion of intercepted moisture directed to plant-drip and stem-flow was largely influenced by the shape of the plant. Table 1 provides details of the shape of each experimental plant. *Leucadendron salignum* exhibited almost equal plant-drip and stem-flow values. The ratio of stem-flow to plant-drip being 1,2 (Table 3). This can be explained by the spreading, branching

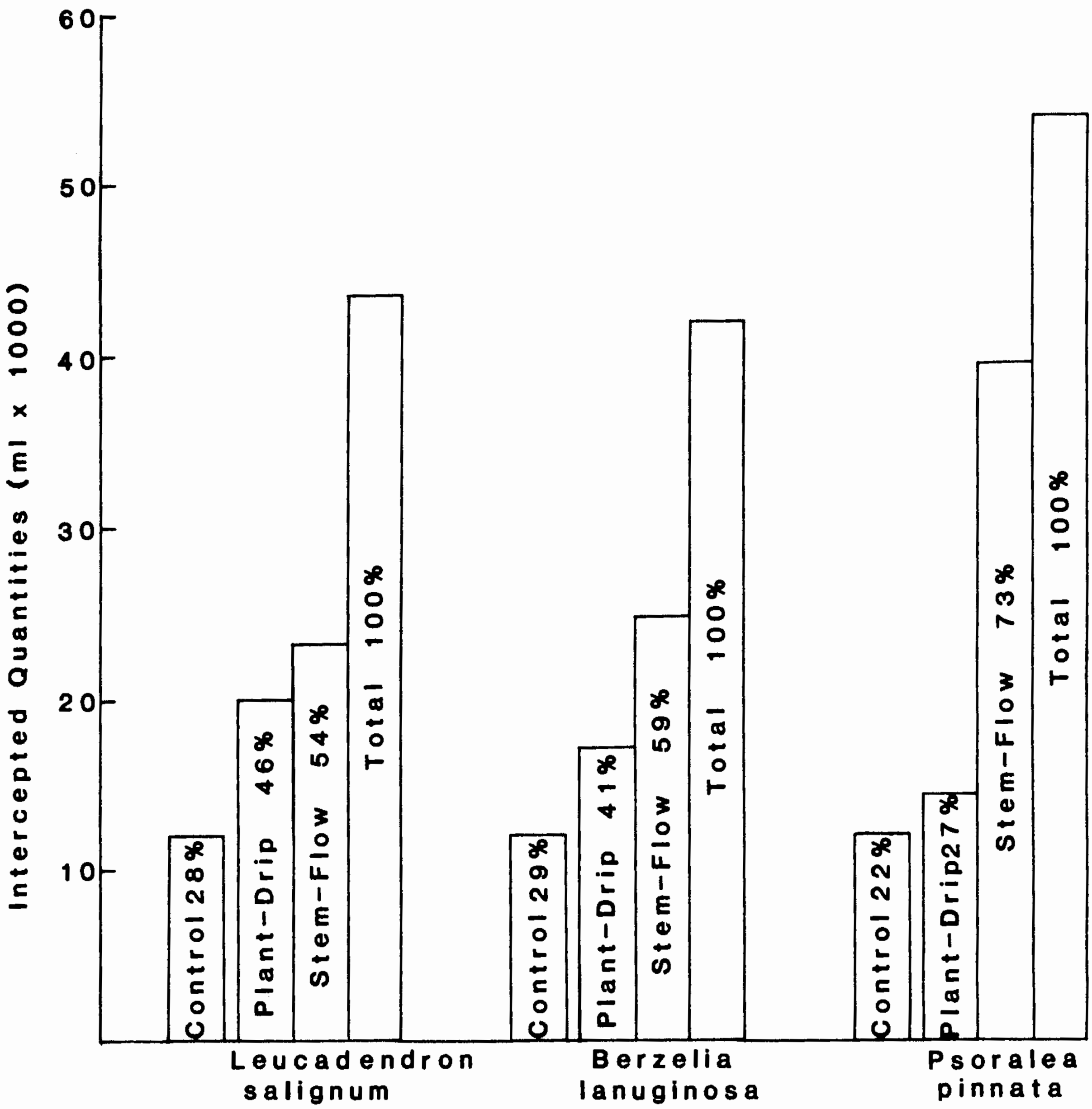

Fig.9 : Quantities and percentages of plant-drip and stem-flow for the experimental plants.

habit of the plant being conducive to plant-drip (Fig. 6). *Leucadendron salignum* showed the highest plant-drip value; 15% greater than *Berzelia lanuginosa* and 28% greater than *Psoralea pinnata* (Table 2; Fig. 9). These results indicate how conducive the spreading branching nature of the plant is in directing intercepted moisture to plant-drip.

Berzelia lanuginosa have erect, slender stems with relatively small, tufted canopies of fine shoots and short pinnoid leaves (Fig. 8). Intercepted droplets are readily conducted from the leaves to the branches and stem, hence the higher stem-flow to plant-drip ratio of 1,4 (Table 3).

The high stem-flow to plant-drip ratio of 2,7 for *Psoralea pinnata* (roughly twice that of *Leucadendron salignum* and *Berzelia lanuginosa*)(Table 3) is due to the funnel shaped habit of the plant (Table 1; Fig. 7). The steeply inclined branches and leaves readily channel intercepted water downwards towards the stem. Seventy-three percent (73%) of the water intercepted by the plant was portioned to stem-flow. Stem-flow for the plant being 69% and 58% greater than the stem-flow values for *Leucadendron salignum* and *Berzelia lanuginosa* respectively (Fig. 9).

The value of stem-flow for *Psoralea pinnata* at Site 5 was found to be greater than, and inconsistent with, the values obtained for the plant at the other sites (Table 2). This may be attributed to the large size of the plant and it being situated at the highest altitude resulting in exceptional exposure to the north-west and southeast mist bearing winds (Table 1). The large size of the plant presented a greater area for interception of mist droplets. The major portion of the intercepted moisture was channelled down the stem. The ratio of stem-flow to plant-drip being 5,5 (Table 3). The collecting rate of the plant was found to be high (Table 4). For example, the stem-flow collecting bottle overflowed after only 1,5 hours (1100 ml bottle) on 2 August 1984. On 17 December 1984 the highest quantity of stem-flow was recorded (3300 ml) from the plant (Appendix 1). These values reveal the remark-able ability of the plant in intercepting and directing water down the stem.

(c) Windward and Leeward Side Tray Measurements

The ratios of leeward to windward side plant-drip quantities are very similar for the three species and also for the sites (Table 3). Although more moisture was observed to be intercepted by the windward side of the plants, many of the droplets were, however, blown towards the leeward side as they fell, thereby balancing out the quantities collected from either side of the trays (Table 2).

(d) Relationships between Control and Plant Interception Quantities

Relationships between control and plant interception values (plant-drip and stem-flow) for the three selected species were investigated. Graphs were constructed by plotting the quantities of plant-drip, stem-flow and plant-drip plus stem-flow against control values. The objective of this was to develop equations from which plant-drip, stem-flow and plant-drip plus stem-flow values could be predicted from control measurements alone. The wide scattering of plotted points for these graphs, however, indicated that these variables are not directly or clearly related. The graph of plant-drip plus stem-flow against control values is shown in Figure 10. This serves chiefly to illustrate the wide scattering of plotted points, from which no clear relationship could be made. Similar results were obtained for the graphs of plant-drip against control and stem-flow against control. It was, therefore, considered unnecessary to include these graphs.

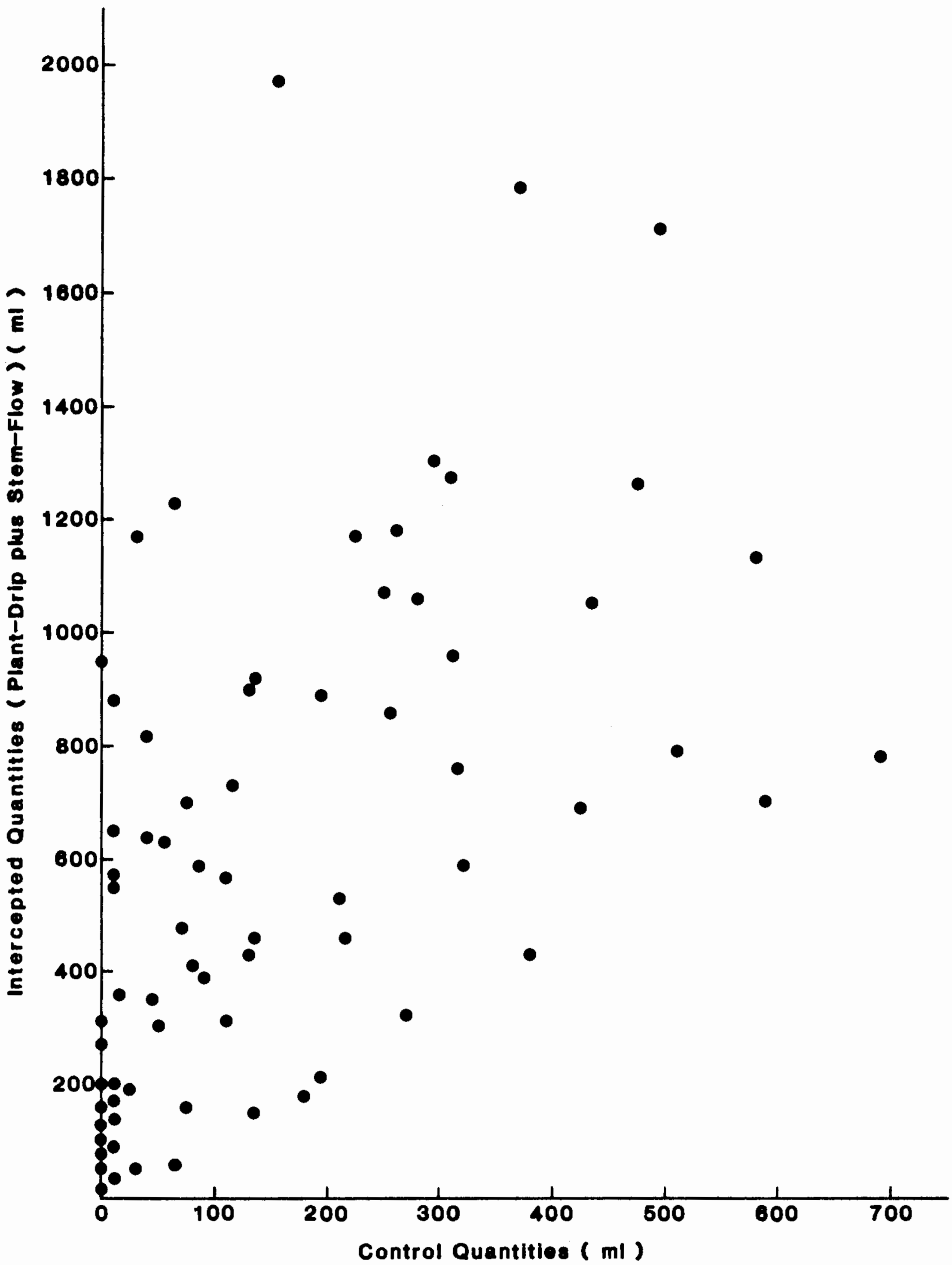

Fig. 10 : Plant-drip plus stem-flow quantities against control quantities.
Intercepted quantities are mean values for the three experimental plants; *Leucadendron salignum*, *Berzelia lanuginosa* and *Psoralea pinnata*.

4.1.2 Weather Conditions

The average weather conditions under which interception occurred were high relative humidities (95-100%), dense mist and relatively high wind speeds (34 km hr^{-1} : fresh breeze)(Appendix 1).

(a) Wind Speed and Mist Density

Relevant data extracted from Appendix 1 are presented in Tables 5 and 6 to illustrate how interception quantities differ under varying wind speeds and varying mist densities. Table 5 sets out mist interception quantities of the three selected plants at Site 1 under varying wind speeds. The quantities selected for the table were recorded under observed dense mist conditions. From Table 5 it can be seen that greater quantities of moisture were generally obtained when dense mist was accompanied by strong winds.

Table 6 sets out mist interception quantities of the three selected plants at Site 1 under varying densities of mist. The values selected for the table were recorded under the same wind speeds. From Table 6 it can be seen that greater quantities of moisture were intercepted by the plants under dense mist

TABLE 5 : Mist interception quantities recorded under varying wind speeds at Site 1.

Date	Wind speed and Direction	Mist Density	Intercepted Quantities (Plant-drip + Stem-flow) *Leucadendron salignum*	*Berzelia lanuginosa*	*Psoralea pinnata*	Mean Value per Plant	Mean Value per Wind Speed
841026	Light breeze(SE)	Dense mist	183	147	189	173	173
841024	Gentle breeze(SE)	"	708	558	456	574	519
841030	"	"	528	427	436	464	
841025	Moderate breeze(SE)	"	887	842	951	893	605
841102	"	"	303	315	330	316	
841110	Fresh breeze(SE)	"	424	298	346	356	698
841112	"	"	944	798	1030	924	
841129	"	"	746	608	595	650	
841217	"	"	962	855	768	862	
841119	Strong breeze(SE)	"	759	635	709	701	701

TABLE 6 : Mist interception quantities recorded under varying mist densities at Site 1.

Date	Wind Speed and Direction	Mist Density	Intercepted Quantities (Plant-drip + Stem-flow) *Leucadendron salignum*	*Berzelia lanuginosa*	*Psoralea pinnata*	Mean Value per Plant	Mean Value per Wind Speed
840724	Gentle breeze(SE)	Patches	5	14	23	14	14
841024	"	Dense	708	558	456	574	519
841030	"	Dense	528	427	436	464	
840723	Fresh breeze(SE)	Patches	113	135	214	154	100
841105	"	Patches	31	51	53	45	
841110	"	Dense	424	298	346	356	698
841112	"	Dense	944	798	1030	924	
841120	"	Dense	746	608	595	650	
841217	"	Dense	962	855	768	862	
841111	Strong breeze(SE)	Patches	22	51	194	89	89
841110	"	Dense	759	635	709	701	701

conditions at constant wind speeds. Low quantities were obtained when light mist or patches of mist occurred. Most of the droplets intercepted under these conditions evaporated whenever the mist lifted, i.e. very little moisture accumulated on the plants to produce high quantities of plant-drip and stem-flow. Interpretation of the data recorded in Tables 5 and 6 reveals that greater interception occurred when dense mist was accompanied by relatively high wind speeds. The stronger the wind, the greater the volume of mist passing through the vegetation and hence the more moisture available for the plants to intercept.

(b) Rainfall and Fog-Catch

Rainfall and mist precipitation in the study area were recorded by standard 127mm raingauges and fog-catchers respectively. The total monthly rainfall and fog-catch measurements for each site for the period May to December 1984 appear in Table 7.

The values were taken on each visit and compared in order to distinguish occurrences of rainfall from mist. Only measurements excluding rainfall were regarded for purposes of this study (Appendix 1). The overall ratio of fog-catch to rainfall in the study area was 3,0 for the 8 month period.

This ratio is very similar to the ratios of plant-drip plus stem-flow to control for the three experimental species, viz. 3,6 for *Leucadendron salignum*, 3,5 for *Berzelia lanuginosa* and 4,5 for *Psoralea pinnata* (Table 3).

TABLE 7 : Monthly rainfall and fog-catch totals (mm) for each site for the period May to December 1984

MONTH	SITES							
	1		2		3		4 & 5	
	Rain	Fog	Rain	Fog	Rain	Fog	Rain	Fog
May	321,6	747,8	293,4	604,8	341,1	625,5	332,9	780,1
June	100,6	229,0	99,5	273,0	95,5	315,6	82,2	266,5
July	219,0	497,5	199,5	580,2	207,6	610,8	187,7	561,4
August	121,7	337,2	116,0	452,0	125,3	525,0	119,9	480,1
September	221,1	599,7	223,0	724,8	168,8	694,5	167,6	677,8
October	94,7	315,4	94,0	397,4	107,4	387,9	111,7	397,0
November	14,5	153,0	4,0	234,6	4,0	177,2	3,2	200,9
December	187,7	428,5	165,0	460,5	156,5	496,5	155,5	437,6
Totals per Site	1281,9	3348,1	1194,4	3727,3	1206,2	3833,0	1160,7	3801,4
Ratio Fog-catch to rainfall per site	2,6		3,1		3,2		3,3	

(c) Screen Catch

In order to clarify the observation that taller plants intercept more moisture than shorter ones, measurements of mist interception were recorded from three mesh screens (500 x 500 mm each) at different heights above the ground. The quantities of moisture collected by the screens are presented in Table 8.

TABLE 8 : Mist interception quantities from three screen collectors at different heights above the ground. Quantities measured to nearest 5 millilitres.

Date	SCREEN CATCH (ml)		
	Screen 1 750mm Above Ground	Screen 2 1250mm Above Ground	Screen 3 1750mm Above Ground
840926	65	80	110
841009	2510	2915	3205
841024	1760	1840	2100
841025	3150	3100	3485
841026	975	1140	1155
841030	1360	1520	1550
841102	460	590	690
841105	390	475	505
841110	200	260	375
841111	90	240	290
841112	3885	5230	5250
841119	2025	2120	2245
841129	3035	3065	3395
841217	2310	2650	3315
Total per Screen	22215	25225	27670
Mean Values	1587	1802	1976
% Increase	-	13.5	24.5

These values confirm that interception increases with height above the ground. Visual observations of moisture intercepted by the plants indicated that the degree of interception was height dependent. It can, therefore, be deduced that taller plants intercept more moisture than shorter ones.

4.2 QUALITATIVE OBSERVATIONS

4.2.1 Mist Interception

Observations, concerned with mist interception by the selected plants at the sites, concentrated on the morphological characteristics of the species concerned, the order in which the plants first intercepted moisture, and the trapping of moisture beneath the plants.

(a) Morphological Characteristics

The values from Table 2 show a variation of interception abilities for the three species; *Leucadendron salignum*, *Berzelia lanuginosa* and *Psoralea pinnata*. *Psoralea pinnata* being more efficient in intercepting mist droplets than *Leucadendron salignum* and *Berzelia lanuginosa* (Table 2; Section 4.1.1). It, therefore, appears that the interception ability of the plants was greatly influenced by the morphological characteristics of plant size, leaf size and shape, and whether the leaves contained hairs or not.

(i) Height of Plant

Table 8 (screen catch) confirmed that interception increases with height above the ground. It was deduced that taller plants intercept more moisture than shorter ones (Section 4.1.2(c)). The taller plants such as *Psoralea pinnata, Berzelia lanuginosa* and *Chondropetalum mucronatum* were observed to intercept mist droplets more readily than low growing species (e.g. Ericaceae and Restionaceae). The taller plants of the same species (e.g. *Psoralea pinnata)* also appeared to intercept moisture more readily than shorter ones, i.e. the degree of interception appeared to be height dependent. The increase in interception with height has been noted by Means (1927), Phillips (1928), Kittredge (1948) and Vogelmann *et al.* (1968).

(ii) Leaves

Plants with small or narrow leaf surfaces (pinnoid or needle-like leaves) such as *Psoralea pinnata* and *Berzelia lanuginosa* (narrow-sclerophylls) were observed to intercept moisture more effectively than broad-leafed plants such as Protea and *Leucadendron salignum* (broad-sclerophylls). The values in Table 2 indicate how effectively the small narrow leaves of *Psoralea pinnata* intercept mist droplets (Fig. 4). Although Ericaceae plants are low growing, their small, narrow leaves were, however, observed to be effective in collecting droplets under low, dense mist conditions. The efficiency of small, narrow leafed plants in straining out mist droplets from the atmosphere has been noted by Went (1955) and Costin & Wimbush (1961). Many of the Restionaceae which have dense tussocks of wiry stems (culms) were noted to effectively intercept droplets. This has been observed by Moll & Romoff (1983) while working on *Thamnochortus punctatus* (a member of the Restionaceae). *Restio perplexus* and *Hypolaena crinatus* which form dense, matted hummocks were also noted to effectively screen out droplets from the mist. It can, therefore, be concluded that narrow-sclerophylls present an effective screening surface for mist droplets.

Psoralea pinnata have small fine hairs covering the leaves whereas *Berzelia lanuginosa* lack such leaf hairs. Interception would appear to be enhanced by plants having small or narrow leaves with hairs (Table 2; Section 4.1.1(a)). It was observed that the leaves and leaf hairs of *Psoralea pinnata* became more erect under cool, misty conditions. This increase in effective straining area might be the reason for *Psoralea pinnata* being more efficient in intercepting mist droplets than *Berzelia lanuginosa* and *Leucadendron salignum* (Table 2).

Many of the fynbos plants have leaves covered with fine hairs, e.g. *Psoralea pinnata, Cliffortia ruscifolia,* and many Asteraceae and Ericaceae. These fine leaf hairs would appear to increase the intercepting surface of the plants and therefore are effective in straining out moisture from passing mist. Some of the broader leafed species such as *Leucadendron coniferum* and some *Protea spp.,* have fine hairs situated around the margins of the leaves. These leaf margin hairs were noted to be the primary areas for intercepting mist droplets.

It can therefore be concluded that the morphological characteristics of different plant species have a definite effect on mist interception efficiencies.

(b) Order in which Plants First Intercepted Moisture

The order in which selected plants at the sites were observed to intercept mist droplets was as follows: *Psoralea pinnata* (Fabaceae), *Cliffortia ruscifolia* (Rosaceae), *Berzelia lanuginosa* (Bruniaceae), *Leucadendron salignum* (Proteaceae) and *Chondropetalum mucronatum* (Restionaceae).

(c) Trapping of Moisture Beneath Plants

It was noted that the soil and undergrowth beneath plants remained wet for a number of days after the interception of mist. This would appear to be due to the spongy mass of undergrowth, leaf litter, and also the shading effect of overhanging branches and leaves inhibiting the rate of evaporation. The tangled hummocks of *Restio perplexus* and *Hypolaena crinatus* were noted to retain moisture for a number of days after interception of mist had occurred. The dense, funnel shaped tussocks of Restionaceae have been found by Moll & Romoff (1983) to be most effective in trapping intercepted moisture at the base of the plant.

4.2.2 Weather Conditions under which No Interception Occurred

Observations were made in order to establish whether the selected plants at the sites extracted moisture from an unsaturated atmosphere with high relative humidity, and under stagnant mist conditions.

On eleven occasions relative humidities between 85-95% were recorded. During these unsaturated periods of high relative humidities no interception or moisture extraction by the plants was observed to occur.

No interception was observed under stagnant mist conditions. This is confirmed by Went (1955) who stated that "Stagnant mists cannot serve as a source of water because the condensation occurs only when a sufficient volume of air with fog droplets is carried over the condensing surface. Therefore the ground mist developed through rapid cooling at night of the air nearest the soil is ineffective for condensation of the fog particles. But coastal fogs formed by moisture-laden air rising against coastal ranges, or clouds forming against the mountain ranges by lateral air movement which forces air up against the mountain slopes, are ideal for fog condensation". Twomey (1956) and Vogelman *et al.* (1968) also noted that interception of mist droplets is greatly accelerated with an increase in air movement (wind speed).

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

The study was conducted in order to investigate :

1. The moisture interception ability of fynbos vegetation under non-rainfall conditions.

2. The weather conditions under which interception occurred.

3. The interception efficiencies of selected plant species.

4. The quantities of induced mist precipitation measured in the form of plant-drip and stem-flow from three selected species.

Interception of moisture by the vegetation occurred under average conditions of high relative humidities (95-100%), dense mist and relatively high wind speeds (Fresh breeze : 34 km hr^{-1}).

The extent to which the plants intercepted mist droplets was influenced by:

1. The density of mist.

2. The wind speed.

3. The size and height of the plant.

Greater interception occurred when dense mist was accompanied by high wind speeds, i.e. the stronger the wind, the greater the volume of mist passing through the vegetation and hence the more moisture available for interception.

The interception ability increased with size and height of the plant.

The interception efficiencies of the plants depended on the leaf morphology of the species concerned.

Psoralea pinnata yielded the highest overall quantity of intercepted water. *Psoralea pinnata* (53400 ml) collected 24% more water than *Leucadendron salignum* (43754 ml) and 28% more than *Berzelia lanuginosa* (42126 ml).

The portioning of intercepted water into plant-drip and stem-flow was largely influenced by the shape of the experimental species. All three species exhibited greater stem-flow than plant-drip.

Plant-drip and especially stem-flow water was observed to be effectively retained by the soil and undergrowth beneath the plants.

No direct relationship between control and intercepted quantities were found, due to the large number of inter-related variables involved.

The mean rate of water yield per plant, observed during five periods of rainfree, misty conditions, was 71 $ml\,hr^{-1}$. Rainfall is, therefore, not the sole source of moisture contributing to the water balance of the area. The additional moisture available to the mountain catchment should be taken into consideration in all studies of water balance, hydrology and for the compilation of climatic records.

5.2 RECOMMENDATIONS

In order to obtain a better understanding of the mist interception process, continuous monitoring of the plant-climate interaction is required.

The use of a data logger for recording parameters such as solar radiation, air temperature, relative humidity, wind speed and direction, leaf temperature, leaf moisture and stem moisture, together with automatic raingauges and fog-catchers is recommended.

This will determine:

1. whether intercepted moisture is due to rainfall or mist;

2. the duration of rainfall or mist precipitation;

3. when moisture is intercepted by the plant (leaf moisture detector);

4. when stem-flow occurs (stem moisture detector).

The use of a drop size recorder and transmissometer in conjunction with the above apparatus will help to distinguish between high and low interception quantities.

In order to avoid the overflowing of plant-drip and stem-flow collecting bottles, self-emptying containers should be used.

APPENDIX 1 : Mist precipitation quantities (ml) collected by experimental and control trays.

PD : Plant-drip quantities
SF : Stem-flow quantities
WWS : Windward side measurements from trays
LWS : Leeward side measurements from trays

+ Sign : Collecting bottles overflowed
Wind Speed : Based on Beaufort Wind Scale
Fog (mist) catch : Measured at time of taking tray quantity

Site and Date	Previous Day's Weather	Fog Catch (mm)	*Leucadendron salignum* Plant-drip					*Berzelia lanuginosa* Plant-drip					*Psoralea pinnata* Plant-drip					Control			Present Day's Weather	Remarks
			WWS	LWS	TOT PD	SF	TOT PD+ SF	WWS	LWS	TOT	SF	TOT PD+ SF	WWS	LWS	TOT	SF	TOT PD+ SF	WWS	LWS	TOT		
Site 1																						
840510	Light breeze (NW) Patches of mist	1,6	0	1	1	7	8	2	3	5	5	10	0	0	0	4	4	0	0	0	Light breeze (NW) Clear	
840628	Moderate breeze (NW) Clear		27	117	144	283	427	148	203	351	225	576	161	168	329	257	586	97	114	211	Moderate gale(NW) Dense mist from 10h00 No rain	Bottles empty at 10h00 Quantities after 3,75 hrs
840629	Moderate gale(NW) Rain & dense mist		2	2	4	3	7	2	2	4	17	21	3	3	6	18	24	2	2	2	Moderate gale(NW) Patches of mist No rain	Emptied bottles at 14h00 Quantities after 3 hrs

840723	Fresh breeze (SE) Patches of mist	2,8	43	31	74	39	113	52	46	98	37	135	88	85	173	41	214	67	69	136	Gentle breeze (SE) Patches of mist	
840724	Gentle breeze (SE) Patches of mist	1,6	2	2	4	1	5	3	2	5	9	14	2	3	5	18	23	0	0	0	Calm Clear	
840801	Light breeze (NW) No mist		0	3	3	1	4	1	2	3	2	5	0	2	2	2	4	0	0	0	Strong breeze (NW) Patches of mist from 13h00	Quantities after 4 hrs
840802	Strong breeze (NW) Patches of mist		0	1	1	7	8	0	1	1	21	22	1	3	4	6	10	0	0	0	Moderate breeze (NW) Patches of mist	
840926	Fresh breeze (NW) Rain & dense mist		0	2	2	5	7	3	4	7	3	10	3	3	6	3	9	0	0	0	Fresh breeze (NW) Patches of mist	Emptied bottles at 09h00 Quantities after 4 hrs

841024	Gentle breeze (SE) Mist at night	16,5	144	14	158	550+	708	22	12	34	524	558	12	8	20	436	456	3	3	6	Moderate breeze (SE) Dense mist	
841025	Moderate breeze (SE) Dense mist	28,3	193	98	291	596+	887	102	94	196	646+	842	101	108	209	742+	951	114	80	194	Light breeze (SE) Clear	
841026	Light breeze (SE) Mist at night	6,7	13	25	38	145	183	7	10	17	130	147	7	9	16	173	189	1	3	4	Strong breeze (NW) Patches of mist	
841030	Gentle breeze (SE) Mist at night	8,3	163	74	237	291	528	100	83	183	244	427	113	98	211	225	436	110	105	215	Gentle breeze (SE) Moderate mist	
841102	Moderate breeze (SE) Mist	2,4	118	104	222	81	303	108	117	225	90	315	136	139	275	55	330	134	137	271	Light breeze (SE) Clear	
841105	Fresh breeze (SE) Patches of mist	3,1	6	0	6	25	31	1	0	1	50	51	0	0	0	53	53	0	0	0	Strong breeze (SE) Clear	

841110	Fresh breeze (SE) Mist at night	9,8	88	12	100	324	424	26	9	35	263	298	25	21	46	300	346	8	9	17	Strong breeze (SE) Patches of mist	
841111	Strong breeze (SE) Patches of mist	5,5	8	2	10	12	22	15	12	27	24	51	17	27	44	150	194	13	6	9	Fresh breeze (SE) Clear	
841112	Fresh breeze (SE) Mist at night	73,6	249	145	394	550+	944	123	125	248	550+	798	260	220	480	550+	1030	61	74	135	Strong breeze (SE) Patches of mist	
841119	Strong breeze (SE) Mist	31,5	151	58	209	550+	759	50	35	85	550+	635	85	74	159	550+	709	40	35	75	Calm Clear	
841129	Fresh breeze (SE) Mist at night	17,3	170	26	196	550+	746	43	15	58	550+	608	27	18	45	550+	595	5	8	13	Moderate breeze (SE) Patches of mist	
841217	Fresh breeze (SE) Mist at night	10,6	131	229	360	602	962	113	156	269	586	855	152	146	298	470	768	121	135	256	Fresh breeze (NW) Patches of mist	

<u>Site 2</u>																						
840510	Light breeze (NW) Patches of mist	1,2	2	0	2	8	10	4	8	12	12	24	34	9	43	14	57	10	4	14	Light breeze (NW) Clear	
840628	Moderate breeze (NW) Clear		32	87	119	220+	339	31	83	114	220+	334	233	240	473	220+	693	56	80	136	Moderate gale(NW) Dense mist from 10h00	Bottles empty at 10h00 Quantities after 3 hrs
840629	Moderate gale(NW) Rain & dense mist		2	0	2	2	4	1	0	1	3	4	2	2	4	2	6	2	0	2	Moderate gale(NW) Patches of mist No rain	Emptied bottles at 14h15 Quantities after 3 hrs
840723	Fresh breeze (SE) Patches of mist	8,7	89	64	153	65	218	102	72	174	220+	394	204	75	279	150	429	29	15	44	Gentle breeze (SE) Patches of mist	
840724	Gentle breeze (SE) Patches of mist	1,2	3	3	5	1	6	4	1	5	17	22	5	4	9	1	10	1	0	1	Calm Clear	

840801	Light breeze (NW) No mist		0	2	2	2	4	0	1	1	1	2	4	1	5	7	12	1	0	1	Strong breeze (NW) Patches of mist from 13h00	Quantities after 3 hrs
840802	Strong breeze (NW) Patches of mist		1	3	4	16	20	0	0	0	20	20	1	31	32	53	85	0	0	0	Fresh breeze (NW) Patches of mist	
840926	Fresh breeze (NW) Rain & dense mist		2	2	4	3	7	3	2	5	6	11	2	2	4	17	21	0	0	0	Fresh breeze (NW) Patches of mist No rain	Emptied bottles at 09h15 Quantities after 3,5 hrs
841024	Gentle breeze (SE) Mist at night	26,4	284	157	441	220+	661	161	129	290	220+	510	22	30	52	220+	272	35	35	70	Moderate breeze (SE) Dense mist	
841025	Moderate breeze (SE) Dense mist	36,6	369	299	668	420	1088	238	287	525	429	954	146	150	296	533	829	152	160	312	Light breeze (SE) Clear	

841026	Light breeze (SE) Mist at night	9,1	7	14	21	115	136	11	22	33	112	145	5	13	18	137	155	0	2	2	Strong breeze (NW) Patches of mist	
841030	Gentle breeze (SE) Mist at night	15,4	274	144	418	214	632	257	156	413	488	901	143	146	289	456	745	157	155	316	Gentle breeze (SE) Moderate mist	
841102	Moderate breeze (SE) Mist	4,8	183	154	337	33	370	185	146	331	79	410	184	182	366	129	495	186	193	379	Light breeze (SE) Clear	
841105	Fresh breeze (SE) Patches of mist	5,3	30	8	38	49	87	22	4	26	123	149	1	0	1	60	61	0	0	0	Strong breeze (SE) Clear	
841110	Fresh breeze (SE) Mist at night	15,4	184	134	318	352	670	105	87	192	469	661	36	40	76	367	443	41	46	87	Strong breeze (SE) Patches of mist	
841111	Strong breeze (SE) Patches of mist	9,1	5	2	7	12	19	9	10	19	37	56	24	23	47	22	69	19	13	32	Fresh breeze (SE) Clear	

841112	Fresh breeze (SE) Mist at night	104,7	440+	440+	880	550+	1430	427	440+	867	550+	1417	175	223	398	550+	948	121	190	311	Strong breeze (SE) Patches of mist	
841119	Strong breeze (SE) Mist	46,1	385	344	729	550+	1279	314	318	632	550+	1182	86	111	197	550+	747	126	125	251	Calm Clear	
841129	Fresh breeze (SE) Mist at night	33,1	357	290	647	381	1028	224	246	470	550+	1020	50	61	111	550+	661	60	68	128	Moderate breeze (SE) Patches of mist	
841217	Fresh breeze (SE) Mist at night	16,9	242	314	556	432	988	266	333	599	550+	1149	226	206	432	577	1009	226	211	437	Fresh breeze (NW) Patches of mist	
<u>Site 3</u>																						
840628	Moderate breeze (NW) Clear		78	73	151	220+	371	13	51	64	220+	284	21	44	65	220+	285	46	66	112	Moderate gale (NW) Dense mist from 10h00 No rain	Bottles empty at 10h00 Quantities after 3,5 hrs

840629	Moderate gale(NW) Rain & dense mist		40	22	62	104	166	2	2	4	168	172	1	1	2	61	63	0	0	0	Moderate gale(NW) Dense mist	Emptied bottles at 14h30 Quantities after 2,25 hrs
840723	Fresh breeze (SE) Patches of mist	2,4	51	48	99	35	134	41	35	76	102	178	75	41	116	115	231	94	88	182	Gentle breeze (SE) Patches of mist	
840724	Gentle breeze (SE) Patches of mist	0,2	2	2	4	1	5	2	2	4	1	5	3	2	5	2	7	1	1	2	Calm Clear	
840801	Light breeze (NW) No mist		2	2	4	5	9	1	2	3	10	13	2	3	5	2	7	0	0	0	Strong breeze (NW) Patches of mist from 13h00	Quantities after 2,5 hrs
840802	Strong breeze (NW) Mist		6	43	49	165	214	4	13	17	220+	237	2	2	4	105	109	14	11	25	Fresh breeze (NW) Mist	
	"		1	33	34	1	35	2	2	4	80	84	0	1	1	7	8	1	2	3	Strong breeze (NW) Patches of mist	Quantities after 4,5 hrs

840926	Fresh breeze (NW) Rain & dense mist		3	2	5	10	15	1	2	3	27	30	2	2	4	8	12	0	0	0	Fresh breeze (NW) Patches of mist No rain	Emptied bottles at 09h30 Quantities after 3 hrs
841024	Gentle breeze (SE) Mist at night	14,6	112	140	252	145	397	23	34	57	220+	277	10	7	17	220+	237	73	26	49	Moderate breeze (SE) Dense mist	
841025	Moderate breeze (SE) Dense mist	20,5	293	170	463	254	717	114	137	251	230	481	151	153	304	270	574	154	167	321	Light breeze (SE) Clear	
841026	Light breeze (SE) Mist at night	12,6	20	47	67	143	210	21	31	52	116	168	8	17	25	161	186	0	1	1	Strong breeze (NW) Dense mist	
841030	Gentle breeze (SE) Mist at night	10,2	266	211	477	292	769	247	204	451	225	676	256	232	488	428	916	249	261	510	Gentle breeze (SE) Moderate mist	

841102	Moderate breeze (SE) Mist	4,7	304	286	590	132	722	285	248	533	203	736	191	205	396	231	627	280	310	590	Light breeze (SE) Clear	
841105	Fresh breeze (SE) Patches of mist	5,5	5	0	5	82	87	1	1	2	67	69	4	3	7	318	325	0	0	0	Strong breeze (SE) Clear	
841110	Fresh breeze (SE) Mist at night	3,5	47	36	83	294	377	13	24	37	178	215	41	37	78	550+	628	40	39	79	Strong breeze (SE) Patches of mist	
841111	Strong breeze (SE) Patches of mist	2,0	16	14	30	43	73	7	11	18	9	27	15	12	27	358	385	39	36	75	Fresh breeze (SE) Clear	
841112	Fresh breeze (SE) Mist at night	94,5	285	360	645	550+	1195	208	241	449	550+	999	203	245	448	550+	998	155	125	280	Strong breeze (SE) Patches of mist	
841119	Strong breeze (SE) Mist	23,6	115	107	222	550+	772	52	69	121	550+	671	89	96	185	550+	735	67	49	116	Calm Clear	

841129	Fresh breeze (SE) Mist at night	34,3	78	56	134	550+	684	19	27	46	550+	596	34	41	75	550+	625	17	25	42	Moderate breeze (SE) Patches of mist	
841217	Fresh breeze (SE) Mist at night	18,9	132	123	255	549	804	126	111	237	524	761	130	132	262	1671	1933	110	117	227	Fresh breeze (NW) Patches of mist	
<u>Site 4</u>																						
840510	Light breeze (NW) Patches of mist	0,9	18	24	42	12	54	30	35	65	9	74	27	28	55	1	56	33	33	66	Light breeze (NW) Clear	
840628	Moderate breeze (NW) Clear		185	301	486	220+	706	110	269	379	220+	599	256	299	555	220+	775	216	211	427	Moderate gale(NW) Dense mist from 10h00 No rain	Bottles empty at 10h00 Quantities after 4 hrs
840629	Moderate gale(NW) Rain & dense mist		28	40	68	177	245	6	27	33	104	137	15	21	36	187	223	5	6	11	Moderate gale(NW) Dense mist	Emptied bottles at 15h00 Quantities after 1 hr

840723	Fresh breeze (SE) Patches of mist	4,9	70	51	121	24	145	69	66	135	76	211	83	67	150	118	268	106	90	196	Gentle breeze (SE) Patches of mist	
840724	Gentle breeze (SE) Patches of mist		2	2	4	1	5	2	2	4	2	6	2	2	4	2	6	1	1	2	Calm Clear	
840801	Light breeze (NW) No mist		16	15	31	68	99	2	16	18	46	64	5	6	11	65	76	1	0	1	Moderate gale(NW) Dense mist from 13h00	Quantities after 2 hrs
840802	Moderate gale(NW) Dense mist		117	110	227	220+	437	33	131	164	220+	384	53	56	109	220+	329	47	43	90	Strong breeze (NW) Dense mist	
	"		34	25	59	117	176	6	28	34	77	111	5	4	9	135	144	4	4	8	Strong breeze (NW) Patches of dense mist	Quantities after 4 hrs

840926	Fresh breeze (NW) Rain & dense mist		6	1	7	28	35	2	7	9	15	24	4	2	6	16	22	0	0	0	Fresh breeze (NW) Patches of mist No rain	Emptied bottles at 09h45 Quantities after 2,5 hrs
841024	Gentle breeze (SE) Mist at night	21,3	85	219	304	389	693	101	113	214	373	587	21	19	40	569	609	32	24	56	Moderate breeze (SE) Dense mist	
841025	Moderate breeze (SE) Dense mist	37,4	226	333	559	709	1268	216	277	493	536	1029	124	139	263	975	1238	115	145	260	Light breeze (SE) Clear	
841026	Light breeze (SE) Mist at night	7,5	102	25	127	105	232	5	34	39	105	144	9	19	28	190	218	0	1	1	Strong breeze (NW) Dense mist	
841030	Gentle breeze (SE) Mist at night	15,4	388	344	732	462	1194	401	263	664	363	1027	300	254	554	615	1169	291	287	578	Gentle breeze (SE) Patches of mist	

841102	Moderate breeze (SE) Mist	5,5	392	184	576	135	711	353	309	662	124	786	348	342	690	156	846	328	362	690	Light breeze (SE) Clear	
841105	Fresh breeze (SE) Patches of mist	6,0	1	2	3	32	35	1	1	2	27	29	2	1	3	55	58	0	0	0	Strong breeze (SE) Clear	
841111	Strong breeze (SE) Patches of mist	2,4	0	1	1	5	6	0	1	1	4	5	1	1	2	7	9	0	0	0	Fresh breeze (SE) Clear	
841112	Fresh breeze (SE) Mist at night	107,1	440+	440+	880	1100+	1980	440+	440+	880	550+	1430	343	285	628	1100+	1728	240	254	494	Strong breeze (SE) Patches of mist	
841119	Strong breeze (SE) Mist	26,0	69	301	370	828	1198	32	95	127	435	562	49	28	77	632	709	21	20	41	Calm Clear	
841129	Fresh breeze (SE) Mist at night	35,4	203	365	568	1100+	1668	192	296	488	402	890	45	34	79	1041	1120	31	33	64	Moderate breeze (SE) Patches of mist	

841217	Fresh breeze (SE) Mist at night	20,1	256	110	366	320	686	94	178	272	204	476	38	51	89	452	541	55	56	111	Fresh breeze (NW) Patches of mist	
<u>Site 5</u>																						
840510	Light breeze (NW) Patches of mist	0,9	2	2	4	2	6	3	3	6	36	42	2	2	4	22	26	2	3	5	Light breeze (NW) Clear	
840801	Light breeze (NW) No mist		2	9	11	35	46	4	7	11	62	73	5	5	10	207	217	3	2	5	Moderate gale(NW) Dense mist from 13h00	Quantities after 0,25 hrs
	"		4	17	21	38	59	3	3	6	57	63	5	4	9	220	229	2	2	4	"	Quantities after 1,25 hrs
840802	Moderate gale(NW) Dense mist		36	250	286	220+	506	71	126	198	220+	417	65	86	151	220+	371	71	62	133	Strong breeze (NW) Dense mist	
	"		8	51	59	220+	279	10	20	30	220+	250	12	13	25	1100+	1125	5	6	11	"	Quantities after 1,5 hrs
	"		2	5	7	20	27	2	2	4	42	46	1	2	3	269	272	0	1	1	"	Quantities after 2 hrs

840820	Gentle breeze (NW) Patches of mist		0	0	0	9	9	0	0	0	14	14	0	6	6	169	175	0	0	0	Gentle breeze (NW) Patches of mist	
840926	Fresh breeze (NW) Rain & dense mist		2	6	8	39	47	3	3	6	46	52	3	2	5	195	200	0	0	0	Fresh breeze (NW) Mist No rain	Emptied bottles at 10h00 Quantities after 2 hrs
841024	Gentle breeze (SE) Mist at night	21,3	73	23	96	220	316	22	163	185	251	436	34	40	74	1100+	1174	16	25	41	Moderate breeze (SE) Dense mist	
841025	Moderate breeze (SE) Dense mist	37,4	201	131	332	325	657	114	253	367	1100+	1467	126	154	280	1495	1775	146	151	297	Light breeze (SE) Clear	
841026	Light breeze (SE) Mist at night	7,5	7	9	16	54	70	6	1	7	59	66	3	29	32	770	802	2	0	2	Strong breeze (NW) Dense mist	
	"		4	124	128	346	474	13	13	26	270	296	2	28	30	2055	2085	0	0	0	"	Quantities after 2 hrs

841030	Gentle breeze (SE) Mist at night	15,4	259	141	400	281	681	263	288	551	950	1501	255	241	496	1100+	1596	222	251	473	Gentle breeze (SE) Patches of mist	
841102	Moderate breeze (SE) Mist	5,5	377	267	644	234	878	358	260	618	172	790	341	325	666	883	1549	376	368	744	Light breeze (SE) Clear	
851105	Fresh breeze (SE) Patches of mist	6,0	11	3	14	32	46	0	6	6	138	144	1	0	1	613	614	0	0	0	Strong breeze (SE) Clear	
841111	Strong breeze (SE) Patches of mist	2,4	0	3	3	5	8	0	7	7	13	20	5	7	12	69	81	2	3	5	Fresh breeze (SE) Clear	
841112	Fresh breeze (SE) Mist at night	107,1	305	209	595	1100+	1695	206	440+	646	1100+	1746	360	440+	800	1100+	1900	141	230	371	Strong breeze (SE) Patches of mist	
841119	Strong breeze (SE) Mist	26,0	63	19	82	381	463	8	75	83	923	1006	15	45	60	1100+	1160	2	9	11	Calm Clear	

841129	Fresh breeze (SE) Mist at night	35,4	156 70 226 494 720	50 356 406 1100+1506	95 89 184 1100+1284	10 22 32	Moderate breeze (SE) Patches of mist	
841217	Fresh breeze (SE) Mist at night	20,1	117 176 293 883 1176	292 89 381 813 1194	99 153 252 3300+3552	82 71 153	Fresh breeze (NW) Patches of mist	

REFERENCES

Adamson, R.S. & Salter, T.M. 1950. *Flora of the Cape Peninsula*. Juta, Cape Town. 889pp.

Acocks , J.P.H. 1975. Veld Types of South Africa. *Mem. Bot. Surv. S. Afr. 40* : 1-128.

Barry, R.G. 1981. *Mountain Weather and Climate.* Methuen, London. 313pp.

Boucher, C. & Moll, E.J. 1981. South African Mediterranean Shrublands. In: *Ecosystems of the World. Vol. 11, Mediterranean-Type Shrublands* (eds. F. Di Castri, D.W.Goodall & R.L.Specht). Elsevier, Amsterdam. pp.233-248.

Costin, A.B. & Wimbush, D.J. 1961. Studies in catchment hydrology in the Australian Alps. IV, Interception by trees of rain, cloud and fog. *Division of Plant Industry Technical Paper No. 16*. C.S.I.R.O, Melbourne, pp.1-16.

Ekern, P.C. 1964. Direct interception of cloud water at Lanaihale, Hawaii. *Proc. Soil Sci. Soc. Am. 28* : 419-421.

Fourcade, H.G. 1942. Some notes on the effects of the incidence of rain on the distribution of rainfall over the surface of unlevel ground. *Trans. R. Soc. S. Afr. 29* : 235-254.

Fuggle, R.F. 1981. Fynbos Biome Project. Macro-Climatic Patterns within the Fynbos Biome. Final Report, December, 1981. *National Programme for Environmental Sciences, Co-operative Scientific Programmes*, C.S.I.R., Pretoria. 116pp.

Geiger, R. 1965. *The Climate Near the Ground.* Harvard University Press, Cambridge. 611pp.

Glyphis, J. 1976. A phytosociological survey of the Back Table of Table Mountain. In: *The Ecological Status of Table Mountain* (eds. E.J.Moll & B.M.Campbell). Department of Botany, University of Cape Town. Appendix.

Jackson, W.P.U. 1982. *Wild Flowers of Table Mountain.* Howard Timmins, Cape Town. 120pp.

Jackson, S.P. & Tyson, P.D. 1971. Aspects of weather and climate over Southern Africa. In: *The Standard Encyclopaedia of Southern Africa 3.* Nasou, Cape Town. pp.258-269.

Kerfoot, O. 1968. Mist precipitation on vegetation. *For. Abstr. 29*(1) : 8-20.

Kidd, M.M. 1983. *Cape Peninsula. South African Wild Flower Guide 3.* Botanical Society of South Africa, Cape Town. 239pp.

King, J.M., Day, J.A. & Van der Zel, D.W. 1979 Hydrology and hydrobiology. In: Fynbos Ecology: A Preliminary Synthesis (eds. J. Day, W.R.Siegfried, G.N. Louw & M.L.Jarman). *South African National Scientific Programmes Report No. 40.* pp.27-42.

Kittredge, J. 1948. *Forest Influences.* McGraw Hill, New York. 394pp.

Kruger, J.F. 1979. South African heathlands. In: *Ecosystems of the World. Vol. 9A, Heathlands and Related Shrublands. Descriptive Studies.* (ed. R.L.Specht). Elsevier, Amsterdam. pp. 19-80.

Levyns, M.R. 1966. *A Guide to the Flora of the Cape Peninsula.* Juta, Cape Town. 310pp.

Marloth, R. 1903. Results of experiments on Table Mountain for ascertaining the amount of moisture deposited from the south-east clouds. *Trans. S.Afr. Philos. Soc. 14* : 403-408.

Marloth, R. 1905. Results of further experiments on Table Mountain for ascertaining the amount of moisture deposited from the south-east clouds. *Trans. S.Afr. Philos. Soc. 16* : 97-105.

Means, T.H. 1927. Fog precipitation by trees. *J.For.25*: 1015-1016.

Moll, E.J. & Campbell, B.M. 1976. *The Ecological Status of Table Mountain.* University of Cape Town. 59pp.

Moll, E.J. & Romoff, N. 1983. Evidence of mist trapping *Thamnochortus punctatus* Pillans at Pella in the southwestern Cape Province. *S.Afr. J. Sci. 79* : 432.

Nagel, J.F. 1956. Fog precipitation on Table Mountain. *Q.J.R. Met. Soc. 82*: 452-460.

Nagel, J.F. 1961. Rainfall on the Table Mountain area with special reference to orographic effects. *Notos 10* : 59-73.

Nagel, J.F. 1962. Fog precipitation measurements on Africa's southwest coast. *Notos 11* : 51-60.

Pearce, E.A. & Smith, C.G. 1984. *The World Weather Guide*. Hutchinson, London. 480pp.

Phillips, J. 1928. Rainfall interception by plants. *Nature 121* : 354-355.

Rutter, A.J. 1975. The hydrological cycle in vegetation. In: *Vegetation and the Atmosphere. Vol. 1, Principles* (ed. J.L. Monteith). Academic Press, London. pp. 111-154.

Specht, R.L. & Moll, E.J. 1983. Mediterranean-type heathlands and sclerophyllous shrublands of the world: an overview. In: *Mediterranean-Type Ecosystems. The Role of Nutrients* (eds. F.J.Kruger, D.T.Mitchell & J.U.M.Jarvis). Springer-Verlag, Berlin. pp.41-65.

Stewart, C.M. 1903. A note on the quantities given in Dr. Marloth's paper on "The moisture deposited from the south-east clouds". *Trans. S.Afr. Philos. Soc. 14* : 413-417.

Taylor, H.C. 1978. Capensis. In: *Biogeography and Ecology of Southern Africa* (ed. M.J.A. Werger). Junk, The Hague. pp.171-229.

Twomey, S. 1957. Precipitation by direct interception of cloud water. *Weather 12* : 120-122.

Vogelmann, H.W., Siccama, T., Leedy, D. & Ovitt, D.C. 1968. Precipitation from fog moisture in the Green Mountains of Vermont. *Ecology 49* (6) : 1205-1207.

Went, F.W. 1955. Fog, mist, dew and other sources of water. In: *Yearbook of Agriculture, U.S. Department of Agriculture.* pp.103-109.