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The vegetation ecology of the Eastern Transvaal Escarpment in the Sabie area. 1. Physical environment

G. B. DEALL*, J. C. SCHEEPERS* and C. J. SCHUTZ**

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ABSTRACT

The physiography, geology, soil and climate of a broad transect of the Eastern Transvaal Escarpment in the Sabie area are described. The transect extends from Hazyview (530 m elevation) to Mount Anderson (2 280 m elevation). The description provides a contextual framework for the subsequent vegetation classification.

UITTREKSEL

Die fisiografie, geologie, grond en klimaat van 'n breë lynopname van die Oos-Transvaalse platorand in die Sabie-gebied word beskryf. Die lynopname strek vanaf Hazyview (530 m bo seespieël) tot Mount Anderson (2 280 m bo seespieël). Die beskrywing verskaf 'n koördinerende raamwerk vir die daaropvolgende plantegroeiklassifikasie.

INTRODUCTION

The Eastern Transvaal Escarpment, representing Acocks's (1975) Veld Types 8 (North-Eastern Mountain Sourveld) and 9 (Lowveld Sour Bushveld), is an area subject to land-use conflict. The need to produce food and timber comes into increasing conflict with the need to protect mountain catchments, to conserve natural ecosystems, and to preserve scenic landscapes. Rational land-use planning is required to resolve such conflict (Ferrar *et al*. 1988).

The relevance of plant-ecological studies to land-use planning and management is well known (cf. Pentz 1938, 1945; Bayer 1970; Walker 1976; Edwards 1967; Müller 1983).

In the past, Acocks's (1975) veld types have provided useful information at the scale of broad landscape types. However, to meet the present needs for regional and subregional planning, attention must be focused on sections of these landscapes (Van der Meulen & Scheepers 1978). A more detailed classification of vegetation into ecologically interpretable vegetation units is therefore necessary. A description of the physical environment is fundamental to this task.

STUDY AREA

This study is confined to a broad transect located in the Sabie area of the Eastern Transvaal Escarpment. The transect is situated between the Olifants River in the north and the Crocodile River in the south. Spanning both the Pilgrims Rest and the Nelspruit Districts, it is bounded by latitudes 25°00′ and 25°10′ south and longitudes 30°30′ and 31°10′ east (Figure 1). It is 65 km long and 20 km broad, covering approximately 1 300 km². The village of Sabie (1 050 m) is centrally situated in the transect, whilst Hazyview (530 m) and Mount Anderson (2 280 m) are situated at the eastern and western extremities respectively. Its orientation is perpendicular to that of the Escarpment, which has a roughly north-south orientation in this area.

PHYSIOGRAPHY

Following the rationale of Scheepers (1978) and with certain modifications, the study area may be divided into the following broad physiographic belts (Figure 2):

1, the Subalpine Belt consisting of the rolling plains, level terraces and prominent peaks of the mountain summits (above 1 900 m);

2, the steeply sloping Montane Belt of the mountain slopes to the west of the Escarpment Plateau (± 1 200–1 900 m);

3, the steeply sloping, much dissected Submontane Belt of the escarpment slopes to the east of the Escarpment Crest, and including the Escarpment Plateau (± 900–1 400 m);

4, the gently sloping, undulating Upland Belt of the foothills (± 500–900 m).

A finer subdivision of these physiographic belts leads to the identification of ten physiographic zones (Figure 2). The main criteria for physiographic zonation are geomorphology and altitude.

Since geomorphology does not always vary consistently with altitude, the altitudinal limits of the physiographic zones are arbitrary.

(a) *Summit* (above 1 900 m). It can be divided into Summit Plateau (± 1 900–1 950 m), Summit Slopes (± 1 950–2 100 m), and Summit Peaks (more than 2 100 m).

(b) *Mountain Slopes* (± 1 200–1 900 m). This zone is found between the Escarpment and Summit. Altitudinal subdivision facilitates the recognition of Lower (± 1 200–1 500 m) and Upper (± 1 500–1 900 m)

* Botanical Research Institute, Private Bag X101, Pretoria 0001, RSA.

** D. R. de Wet Forestry Research Centre, Private Bag X520, Sabie 1260, RSA.

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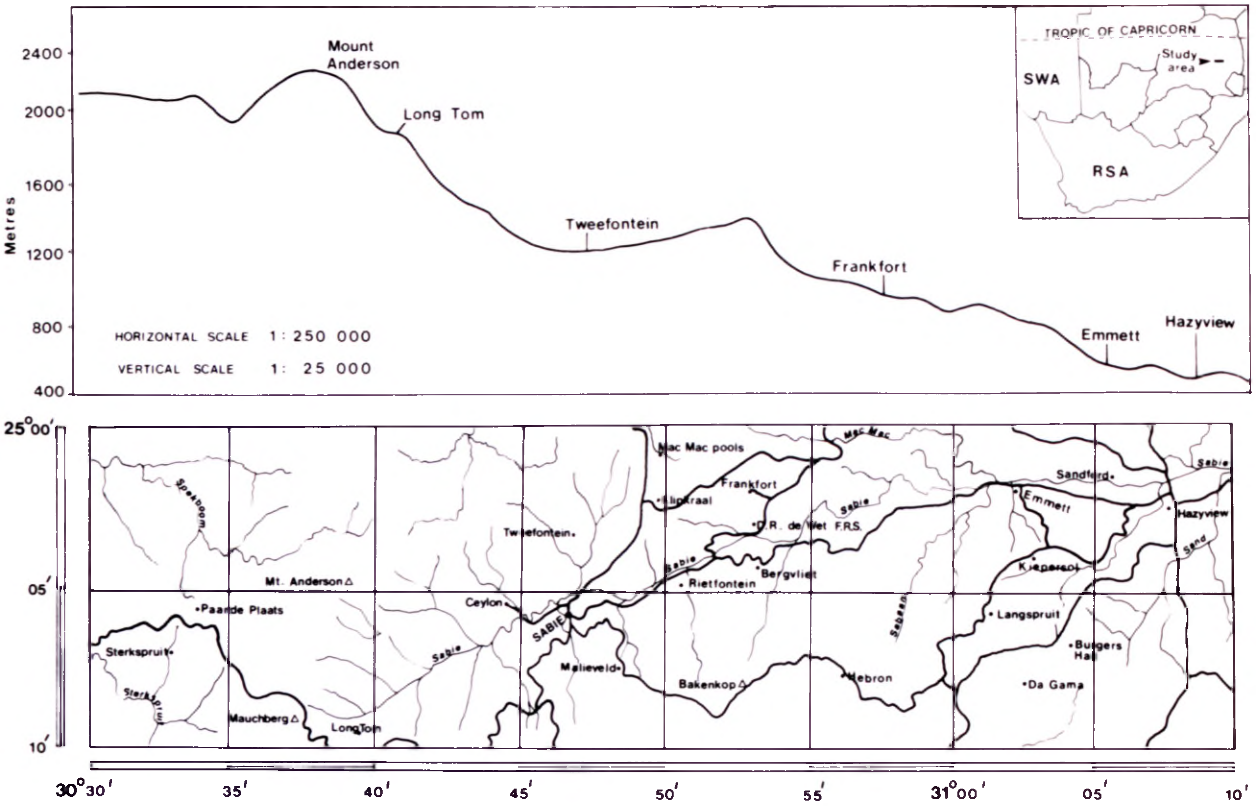

FIGURE 1.—Location of the study area (inset), showing a hypothetical profile (above) and the detailed topography (below). Based on S.A. 1:250 000 Topographical Sheet 2530 Barberton.

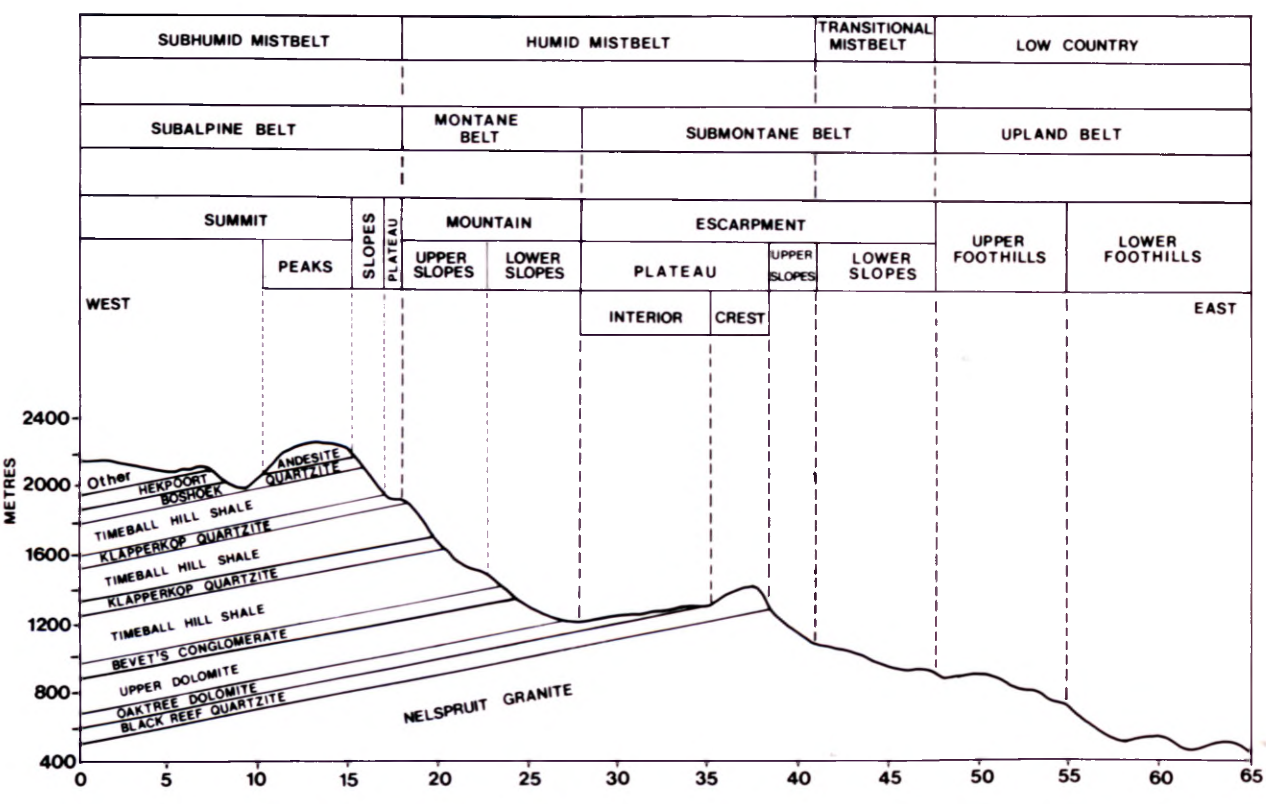

FIGURE 2.—Hypothetical profile of the study area showing physiographic and climatic zonation in relation to geology.

Slopes. Generally, this is a zone of steeply east-sloping hills intersected by valleys and rivulets.

(c) *Escarpment Plateau* (±1 200–1 400 m). This is a flat, gently west-sloping zone forming a shelf or plateau immediately west of, and including, the main Escarpment Crest. The Escarpment Plateau may be divided into the Plateau Interior (± 1 200–1 300 m) and the Plateau Crest (± 1 300–1 400 m).

(d) *Escarpment Upper Slopes* (± 1 100–1 300 m). This is a steeply sloping zone immediately below, and to the east of the main Escarpment Crest. The slopes are intersected by numerous deeply-incised gorges, kloofs and valleys.

(e) *Escarpment Lower Slopes* (± 900–1 100 m). This zone is due east of the Escarpment Upper Slopes. Valleys are wider and less deeply incised.

(f) *Upper Foothills* (± 700–900 m). This and the following zone represent a transition from the Escarpment Slopes to the Lowveld. The Upper Foothills are characterized by broken undulating terrain.

(g) *Lower Foothills* (± 500–700 m). This zone lies between the Upper Foothills and the Lowveld. Valleys are wide and flat-bottomed, and slopes are gentle.

In Kayser's (1983) morphogenetic classification of south-eastern Africa our Foothills and Escarpment Slopes would be described as comprising 'peneplains, clusters of residual peneplains, regions with mountains and knobs'. His concept of 'peneplains on the lower escarpment level with moderate degree of dissection' finds equivalence in our Lower Foothills, whereas 'peneplains on the upper escarpment level with high degree of dissection' corresponds to our Escarpment Slopes and Upper Foothills. The Escarpment Plateau matches 'marginal zones on the inland plateau level with strong relief' (Kayser 1983). The Plateau Crest Zone is identified as a particularly high benchland scarp, steep and divided into sections (presumably co-incident with the Black Reef Quartzite Formation). The transition from Escarpment Plateau to Mountain Slopes is marked by a medium-height single benchland scarp (presumably co-incident with the Rooihoogte Formation). The Mountain Slopes and Summit would be described as 'high, closed benchland highland' (Kayser 1983).

The main drainage systems eastward are the Sabie and Mac-Mac Rivers (Figure 1). The Sabie River has its source in the Mount Anderson range and flows east-north-east to the Lowveld. The Mac-Mac River drains the dolomite country southwards from Driekop near Graskop until it swings abruptly east at Mac-Mac Falls and then continues its course to the Lowveld.

GEOLOGY

A major geological survey resulted in the publication of a map of the area south of Sabie in 1960 (Visser & Verwoerd 1960). Since then surveys and lithostratigraphic studies have been undertaken on the Transvaal Supergroup (Zietsman 1964; Button 1973a), the Wolkberg Group (Button 1973b), the Malmani Subgroup (Button 1973c), the Timeball Hill Formation (Eriksson 1973) and the Archaean granite basement (Robb 1978; Lageat & Robb 1984). A great deal of confusion surrounding the lithostratigraphy of the area was cleared up by the recent handbook published by the Geological Survey (SACS 1980).

The whole Escarpment region forms the eastern rim of the Bushveld Igneous Complex of the central Transvaal. The stratigraphy and field nomenclature are shown in Table 1. The varying relief of the Escarpment is determined largely by the underlying geological structure. Essentially, four different geological systems are represented. They are traversed by a network of diabase intrusions. Contacts between the systems are roughly parallel and in a north-south direction.

Nelspruit Granite

Nelspruit Granite, an intrusive of Swazian age, is the oldest rock formation (Table 1). It comprises the biotite-bearing gneissose granites and migmatites forming the undulating terrain of the Escarpment Slopes and Foothills (Figure 2).

Overlying the granite, and reaching from the Escarpment Plateau to the Summit, are the stratified rocks of Vaalian age, namely the Transvaal Sequence, represented mainly by the Wolkberg, Chuniespoort and Pretoria Groups (Table 1; Figure 2).

The Wolkberg Group

In the study area, the Wolkberg Group is represented mainly by the Sekororo, Selati Shale and Black Reef Quartzite Formations (Table 1). The Black Reef Quartzite Formation, with its extreme resistance to weathering, is largely responsible for the formation of the Escarpment Plateau with its numerous associated waterfalls, viz. Sabie, Mac-Mac, Lisbon and Berlin Falls. Accelerated weathering along joints results in the characteristic 'pillar and passage' topography with its weird weathering forms ('gendarmes'). The Black Reef Quartzite Formation rarely exceeds 10 m in thickness south of Sabie, but reaches nearly 100 m near Mariepskop in the north. It has a westerly dip of 5°. Shale is always present, particularly near the top, close to the contact with the overlying dolomite (SACS 1980) (Table 1). North-south flowing streams often follow the course of this shale, thus forming a natural division between the Black Reef Quartzite and the dolomites.

The Chuniespoort Group

Overlying the Black Reef Quartzite Formation and rising into the Mountains from the Escarpment Plateau, are the chemical sediments of the Chuniespoort Group, including dolomite, shale, limestone and chert (Table 1; Figure 2). The dolomite is mostly fine-grained and blue-grey in colour with a black weathered surface (owing to manganese oxides) and a wrinkled texture resembling the skin of an elephant, thus deriving the name 'Olifantsklip'.

The incorporation of carbonaceous shale and quartzite with the overlying dolomite produces the dark dolomite of the Oaktree Formation. The Monte Christo, Lyttelton, Eccles and Frisco Formations are characterized on the basis of chert content (Table 1).

Dolomite rock is not often exposed within the high rainfall zone owing to the solubility of the limestone. Exceptions are Spitskop and the cliff line of the Eccles Formation, more resistant to weathering because of the high chert content. The solubility of the limestone has resulted in the formation of caves, usually more visible within the Eccles Formation.

The Pretoria Group

The dolomites mark the transition to the overlying Pretoria Group, which consists predominantly of quartzite and shale in the Rooihoogte, Timeball Hill and

TABLE 1.—Chronostratigraphic and lithostratigraphic divisions in the Sabie area of the Eastern Transvaal Escarpment (adapted from SACS 1980)

Erathem	Sequence	Group	Formation	Member	Lithology	Field nomenclature	Thickness (m)
Mokolian			Transvaal Diabase (intrusive rock)			Transvaal Diabase	
Vaalian	TRANSVAAL	PRETORIA	Hekpoort Andesite		Andesite, quartzite, shale	Hekpoort Andesite	0–200
			Boshoek		Siltstone, shale, quartzite, conglomerate	Boshoek Quartzite	0–90
			Timeball Hill	Klapperkop Klapperkop	Shale Quartzite Shale Quartzite Shale	Timeball Hill Shale/ Klapperkop Quartzite	900–1 600
			Rooihoogte	Bevet's Conglomerate	Quartzite, conglomerate	Bevet's Conglomerate	0–50
		CHUNIESPOORT (MALMANI SUBGROUP)	Frisco		Chert-free dolomite, 1° limestone; carbonaceous shale	Upper Dolomite	300
			Eccles		Chert-rich dolomite		300
			Lyttelton		Chert-free dolomite		120
			Monte Christo		Chert-rich dolomite		200
			Oaktree		Dark dolomite—incorporates carbonaceous shale and quartzite	Oaktree Dolomite	10
		WOLKBERG	Black Reef Quartzite		Quartzite, minor shale, conglomerate	Black Reef Quartzite	0–100
			Selati Shale		Shale Argillaceous quartzite		0–400
			Sekororo		Arkose, shale, quartzite		0–240
			Godwan (Witwatersrand Supergroup: Button 1973a)		Lava, tuff, conglomerate, quartzite, shale		
Swazian			Nelspruit Granite (intrusive rock)			Nelspruit Granite	

Boshoek Formations, and of prominent volcanic elements in the Hekpoort Andesite Formation (SACS 1980) (Table 1; Figure 2). The Rooihoogte Formation consists of a conglomerate/breccia base with quartzite above, forming a clearly visible cliff line from Ceylon State Forest southwards. Waterfalls such as Bridal Veil, Lone Creek and Horseshoe originate on the brow of this cliff line. The conglomerate is distinguished as the Bevet's Conglomerate Member.

The Timeball Hill Formation comprises a shale zone up to 1 600 m thick. Two bands of quartzite, the Klapperkop Quartzite Member, run through the middle of the zone, giving rise to broken cliff faces with waterfalls. The lower band averages 10 m in thickness whereas the upper band reaches up to 60 m. Its resistance to weathering has resulted in the formation of the Summit Plateau (e.g. at Hartebeestvlakte).

The shales and mudstones of the Timeball Hill Formation are carbonaceous, thinly bedded, highly jointed, fissile and dark in colour. They weather to pale colours. In the Sabie area there are anomalous dips due to slumping into solution cavities in the dolomite beneath, and further tilting of the strata sometimes occurs in the vicinity of diabase dykes.

The Boshoek Formation forms a small, prominent cliff above the Timeball Hill Shale. It consists mostly of quartzite, conglomerate, shale and pyroclastics.

In the Hekpoort Andesite Formation flows of basaltic andesite are the most prominent rock types. The Formation reaches a thickness of 200 m.

Transvaal Diabase

Transvaal Diabase, an intrusive of Mokolian age, criss-crosses the entire area in the form of dykes and interbedded sills (Table 1). It is rare in the Wolkberg Group, but most common in the Pretoria Group, particularly in the form of sills. Other basic rocks also make up these sills, those in the upper Chuniespoort Group and Pretoria Group being composed of pyroxenitic material. Sills occur most frequently between the two bands of Klapperkop Quartzite and within the Boshoek Formation. Dykes run mostly in a north-north-easterly direction.

SOILS

Von Christen (1959, 1964) studied 40 soil profiles in the Escarpment area in an attempt to gain insight into nutrient cycling and podzolization processes under pine stands. Subsequently a land type survey was conducted by Schoeman *et al*. (1980), which included the samples of 10 profiles.

The description which follows is based largely on the study of 439 profiles covering the widest possible range in soil and site conditions (Schutz in prep.). Soil properties are strongly influenced by parent material and geological substrate (Table 2).

Nelspruit Granite. The soils derived from the granites are deep, well drained, apedal, red, ferrallitic, and highly leached. Well decomposed granite saprolite is quite frequently encountered within the soil profile below a depth of 800 mm. Quartz grit, often in the form of a broken stoneline, is commonly found in the upper B horizon. Coarse sand is prevalent, mainly towards the surface, whereas the subsoil, or decomposed saprolite is siltier. Although the clay content of the B horizons of these soils is usually high (sandy clay loam to sandy clay), the water-holding capacity of the topsoil is low. In bottom-land positions and river terrace areas, hydromorphic soils tend to develop. These soils can be extremely wet during summer.

Organic carbon content in the topsoil of granitic soils is far lower than that of other soils in the area (2,3 %). This is probably owing to accelerated decomposition of organic substances occasioned by high temperatures (Fränzle 1984). Some pockets of organic rich or humic topsoils (Oakleaf Form) do occur in narrow drainage lines or concave footslopes. Otherwise topsoils are relatively pale in colour (usually Hutton soils).

Selati Shale. Soils derived from Selati shale are not extensive, occurring in a narrow band along the Escarpment Crest, where the Black Reef Quartzite Formation has been eroded. Parent materials are shale and quartzite.

These are the shallowest of all the soils in the area (740 mm) and the bedrock is usually overlain by a layer of hardpan ferricrete. In summer, the water table is generally high. In winter, however, slow but efficient drainage is facilitated both by the sandy texture of the soil and by the slight westerly dip of the strata (Figure 2). These soils can thus be particularly dry in winter. Such fluctuations of the water table together with eluviation are conducive to the formation of bleached E horizons.

Soils derived from Selati shale are usually sandy clay loams with a coarse sandgrade in the A horizon. Stonelines are common when the parent material is shale. On the shallow soils of the Escarpment Crest the dominant soil form is the Glenrosa. Profiles of the Hutton, Oakleaf and Griffin Forms develop on the deeper soils.

Black Reef Quartzite. Soils on the Black Reef Quartzite Formation extend further south than Selati soils, but are also not extensive. South of Sabie all sandy soils along the Escarpment Crest are derived from Black Reef material. North of Sabie they occur in a band parallel with Selati soils, but generally further west down the dipslope.

Soils on Black Reef Quartzite are mostly very shallow over solid bedrock. Under grassland, however, fairly deep soils have developed. Of all soils in the area they have the deepest A horizons (450 mm).

Soils on Black Reef Quartzite are sandy loams, with the highest percentage sand (78 %) of all the soils. They also have the darkest surface soils, with lowest values and chromas. Organic, peaty topsoils are common, reaching a maximum of 9,3 % organic carbon.

The dominant soil form is the Hutton, but Mispah, Clovelly, Inanda and Oakleaf Forms are also common. Less common soil forms include Champagne (under marshy conditions) and Houwhoek and La Motte (under highly leached conditions).

Oaktree. Towards the Plateau Interior, the Oaktree soils begin to appear. They are distinguished from Black Reef sands by an increase in clay content of the subsoil.

TABLE 2.—Summary of mean soil properties of 439 sites covering six geological formations in the Sabie area of the Eastern Transvaal Escarpment (after Schutz in prep.)

Soil property	Nelspruit Granite (n = 139)	Selati Shale (n = 27)	Black Reef Quartzite (n = 20)	Oaktree (n = 35)	Dolomite (n = 111)	Timeball Hill (n = 107)
A hor. depth (mm)	300	240	450	200	200	180
B hor. depth (mm)	1 000	520	660	880	1 020	690
Solum depth (mm)	1 290	740	1 040	1 090	1 220	870
A1 hor. sand (%)	58	57	78	43	33	36
B21 hor. clay (%)	39	29	9	42	45	43
B hor. stone (%)	14	29	10	11	17	47
A1 hor. colour	dark reddish brown	dark brown (black)	dark brown (black)	yellow-brown	dark reddish brown	dark reddish brown
B21 hor. colour	red	yellow	dark yellowish brown	(dark) red	(yellowish) red	red
A1 hor. organic C (%)	2,3	5,3	3,5	5,2	3,5	4,3
A1 hor. pH (water)	4,9	4,5	4,8	4,6	5,0	4,6
A1 hor. exch. acidity (m.e./100 g)	1,2	2,2	1,3	1,4	1,0	2,2
P (mg/kg)	6,7	6,3	6,2	3,4	3,9	6,0
K (mg/kg)	38,0	34,0	18,0	25,0	46,0	32,0
Ca (mg/kg)	117,0	43,0	13,0	16,0	132,0	39,0
Mg (mg/kg)	34,0	12,0	6,0	9,0	37,0	15,0
A1 (m.e./100 g)	0,58	1,37	0,66	0,93	0,43	1,58
B21 hor. K + Ca + Mg/100 g clay	1,5	0,7	1,6	0,3	0,9	0,7
Dominant soil forms	Hutton	Glenrosa	Hutton Clovelly	Griffin	Hutton Griffin	Hutton Glenrosa

A horizons are shallow but the solum is moderately deep (about 1 090 mm). The topsoils have the highest percentage of fine sand of all the soils (together with Timeball Hill Formation). They are generally clay loams except in cases where B horizons are overlain with a colluvial, dark sandy A horizon derived from Black Reef Quartzite. B horizons are classified as clay. Some of the wetter B horizons tend to have massive structure. Stone content of the B horizon is low (11 %).

Surface horizons are usually dark when associated with Black Reef Quartzite soils. Yellow-brown apedals over red apedals abound. The B horizon has the highest colour value of all the soils.

Dolomite. Soils derived from dolomite are deep, and well drained. Only on ridge tops and steep slopes does the unweathered rock come close to the surface. The presence of many chert stones and manganese concretions suggests that these soils are transported.

Of all soils in the area, dolomite soils have the highest pH and lowest exchange acidity, probably owing to their limestone origin. Although P levels are low, the sum of basic cations is high, making them the most fertile of soils in the area. Often, there is such colluvial mixing of unconsolidated rock with the red soil matrix that classification of the soil becomes difficult. Otherwise, Hutton and Griffin Forms are usually dominant.

Timeball Hill. Because they are developed in the dissected terrain and steep slopes of the Mountain and Summit Zones, the soils derived from the Timeball Hill Formation tend to be shallow, except on terraces and valley bottoms. The A horizons are shallower than those of other soils in the area. Pockets of silty clay loam 400–500 mm deep are nevertheless prevalent on the slopes, and root penetration is further facilitated by cracks in the shale. Where the shale strata dip (in association with diabase intrusions), weathering is usually deeper than where strata are horizontal.

Soils are well drained clay loams with a fine sand-grade in the topsoil. Subsoils are high in clay content, but can be quite sandy in areas below the two Klapperkop Quartzite cliff lines. The high subsurface stone content (47 %) is typical of these soils. The stones may be loose, or compacted into stonelines, particularly where there is shale colluvium over diabase.

Transvaal Diabase. Soils derived from Transvaal Diabase are not easily recognizable as they are always buried below colluvial topsoil from the adjacent country rock, from which they are separated by a stoneline at 300 to 500 mm depth.

Diabase soils therefore exist only as subsoils and their position as an important subdivision of soils is questionable.

CLIMATE

The Eastern Transvaal Escarpment lies in a seasonally arid, subtropical region, with hot wet summers and cool dry winters. It forms a transition area between the warmer Lowveld to the east and the climatically more extreme Highveld plateau to the west. Summer to winter shifts in the position of the high pressure system of the southern hemisphere play a major role in the constitution of weather (Fabricius 1988).

A climatic gradient facilitates the recognition of two major climatic belts based on altitudinal distribution of mist. These belts are especially meaningful for identifying gross climatic variability. Following Scheepers (1978), there is the Mistbelt of the high, cooler altitudes as opposed to the Low Country of the low, warmer altitudes (Figure 2). The boundary between these two belts is irregular and poorly defined in the study area, but appears to fluctuate between 900 and 1 100 m elevation. This zone of fluctuation may constitute a third climatic belt, namely Transitional Mistbelt. Its range conforms to Scheepers's (1978) arbitrary lower limit of about 1 050 m elevation. A fourth climatic belt, derived from the subdivision of Mistbelt into 'moist' and 'dry' sectors (Humid and Subhumid Mistbelt respectively, Figure 2), may also be justified (Deall 1985). The Subhumid Mistbelt (represented by the Summit Zone), is a distinctly cooler and drier sector of the Mistbelt (Figures 3 & 4). It is frequently misty up to about 1 800 m elevation and completely clear on the Summit above. The boundary between Humid and Subhumid Mistbelt is therefore assumed to co-incide with the transition from Montane to Subalpine Belt (Figure 2).

Fabricius's (1984, 1988) hygric classification of south-eastern Africa, based on a humidity index (the ratio of precipitation to potential evapotranspiration—Papadakis 1966), concurs fairly well with the climatic

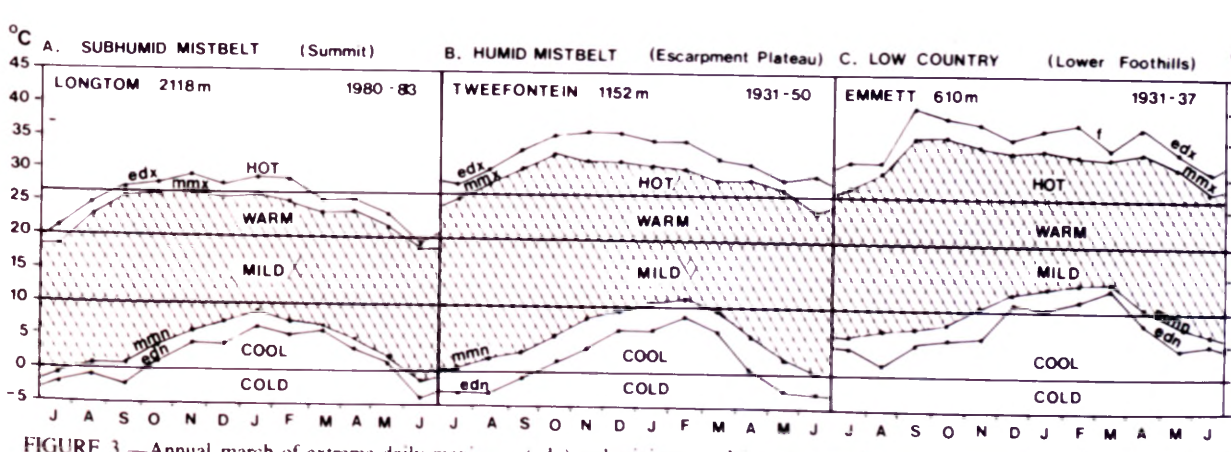

FIGURE 3.—Annual march of extreme daily maximum (edx) and minimum (edn) temperatures and mean monthly maximum (mmx) and minimum (mmn) temperatures for three stations in the Sabie area of the Eastern Transvaal Escarpment. Compiled from Weather Bureau, S.A. (1954a) and from climatological reports of the Soil and Irrigation Research Institute, Private Bag X79, Pretoria 0001.

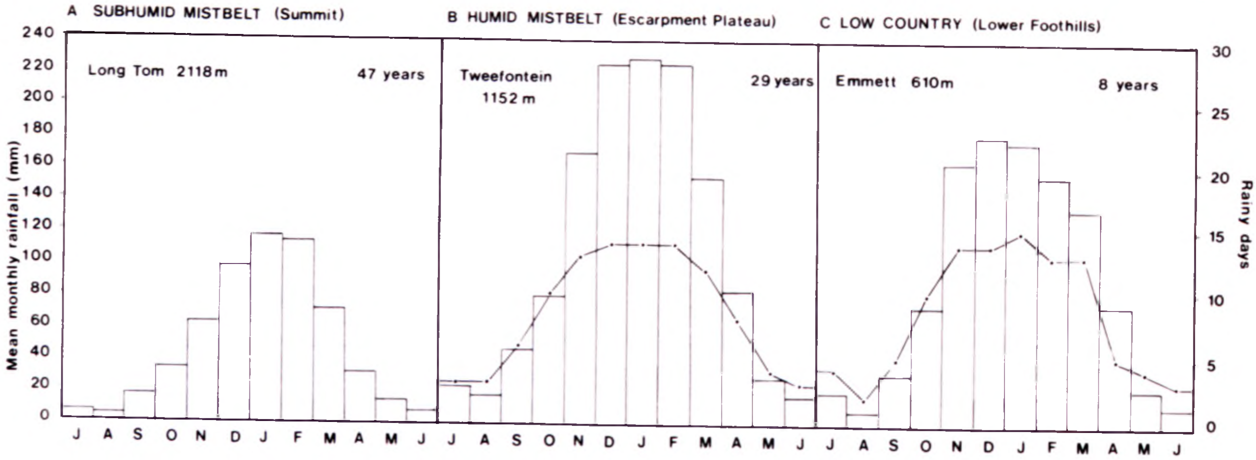

FIGURE 4.—Annual march of mean monthly rainfall (histogram) and mean rainy days per month (graph) for three stations in the Sabie area of the Eastern Transvaal Escarpment. Compiled from Weather Bureau, S.A. (1965b) and from climatological reports of the Soil and Irrigation Research Institute, Private Bag X79, Pretoria 0001.

belt concept outlined above. Low Country and Mistbelt correspond to 'subhumid' and 'humid' types respectively. Transitional and Humid Mistbelts together correspond to 'humid' and 'perhumid' types. The Subhumid Mistbelt peculiar to the Summit is inferred on Fabricius's (1984) map to be 'perhumid'. Insolation, temperature, rainfall, and humidity records (Tables 3, 4, 7 & 8) for Long Tom on the Summit (25°08′ south and 30°37′ east), however, suggest a 'subhumid' rather than a 'perhumid' climatic type. Moreover, the humidity index for Long Tom is calculated as 0,698, a 'subhumid' category in Fabricius' (1984, 1988) classification.

According to Schulze & McGee (1978), light (insolation), temperature, and moisture (precipitation) are the most significant climatic factors in vegetation development. These operate together to produce 'homogeneous environments in which certain plant communities attain importance'.

INSOLATION

Insolation may be measured directly in terms of the quantity of incoming solar radiation, and indirectly by means of sunshine duration. Maps of incoming solar radiation patterns based on solar radiation measurements in southern Africa have been compiled by Schulze & McGee (1978). In addition, the Weather Bureau (1950) has compiled maps showing broad, countrywide patterns of sunshine duration and cloud cover based on a number of stations in South Africa.

Schulze & McGee's (1978) maps show that incoming radiation is subject to seasonal variation. For instance, radiant flux densities for the study area in summer are apparently 80 × 10^5 Jm^{-2} day^{-1} higher than in winter. The magnitude of seasonal variation is supposedly tempered by the interposing effect of cloud cover which, during summer in the study area, reduces the average duration of bright sunshine by 20–30 % (Weather Bureau 1950).

There is also geographic variation of sunshine duration within the study area. For instance, the average annual duration of bright sunshine in the Mistbelt is less than 60 % of the possible sunshine, whereas it is 60–70 % in the Low Country. Similarly, the Mistbelt experiences less 'bright' days (days with 90–100 % of possible sunshine) than the Low Country (Weather Bureau 1950).

This trend of increasing cloudiness is broken in places on the Summit (Subhumid Mistbelt) however, where, owing to rain-shadow effects, the duration of daily sunshine may be greater than in the Low Country. Thus throughout the year, Long Tom (2 118 m) in the Subhumid Mistbelt experiences more sunshine than Hazyview (530 m) in the Low Country (Table 3).

Besides seasonal and geographic variability, there is also physiographic variability of insolation owing to slope and aspect. Daily incoming radiant flux densities on sloping terrain as a function of slope, aspect, and season have been presented for cloudless days in South

TABLE 3.—Annual march of mean daily sunshine (hours) for two stations in the Sabie area of the Eastern Transvaal Escarpment*

	Jan.	Feb.	March	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Long Tom (2 118 m) 1980–1983	6,6	7,4	7,2	7,5	8,3	8,7	8,4	8,6	8,2	7,4	6,2	7,0
Hazyview (530 m) 1973–1983	6,0	6,5	6,2	6,6	6,6	7,1	7,5	7,2	7,1	6,2	5,9	6,5

* Based on climatological reports of the Soil and Irrigation Research Institute, Private Bag X79, Pretoria 0001.

TABLE 4.—Annual march of temperature extremes, ranges and means (°C) for six stations in the Sabie area of the Eastern Transvaal Escarpment*

Climatic belt	SMB	HMB		TMB	LC	
Station	Long Tom	Tweefontein	Sabie	Bergvliet	Emmett	Hazyview
Altitude (m)	2 118	1 152	1 108	983	610	530
Period	1980–1983	1931–1950	1914–1928	1934–1950	1931–1937	1971–1983
A. Extreme daily maximum						
Jan.	29.0	35.0	34.6	35.1	37.1	42.8
Feb.	28.6	35.0	34.8	35.0	37.8	38.5
Mar.	25.5	32.5	34.1	33.3	34.1	39.5
Apr.	25.5	31.7	32.9	31.7	37.4	38.4
May	23.5	29.4	29.0	30.6	33.4	35.2
Jun.	19.0	30.0	28.1	30.6	30.7	31.5
Jul.	21.2	28.3	28.9	29.4	32.3	34.5
Aug.	25.0	30.6	31.6	32.8	32.2	36.4
Sep.	27.2	33.6	36.0	33.9	40.4	39.8
Oct.	28.1	35.6	37.5	38.3	39.1	41.8
Nov.	29.1	36.1	37.2	37.8	38.2	40.0
Dec.	27.9	36.1	35.6	37.8	35.7	40.6
Year	29.1	36.1	37.5	38.3	40.4	42.8
B. Extreme daily minimum						
Jan.	6.5	6.7	7.9	10.0	10.1	11.8
Feb.	5.2	8.9	10.1	10.6	11.4	12.2
Mar.	5.9	6.7	6.1	9.4	13.3	10.4
Apr.	3.2	1.1	2.4	7.2	8.4	6.8
May	1.2	–2.2	–2.0	3.9	4.6	4.2
Jun.	–4.0	–2.5	–3.1	2.8	5.0	1.7
Jul.	–2.1	–2.8	–4.2	0.0	4.4	1.3
Aug.	–1.0	–2.8	–2.9	1.7	1.8	1.3
Sep.	–2.3	–0.6	–1.5	3.3	5.0	3.2
Oct.	1.3	1.7	4.4	5.0	5.7	8.3
Nov.	4.0	3.9	7.3	7.8	5.6	10.0
Dec.	4.0	6.7	8.8	9.6	11.2	11.6
Year	–4.0	–2.8	–4.2	0.0	1.8	1.3
C. Extreme daily range						
Jan.	22.5	28.3	26.7	25.1	27.0	31.0
Feb.	23.4	26.1	24.7	24.4	26.4	26.3
Mar.	19.6	25.5	28.0	23.9	20.8	29.1
Apr.	22.3	30.6	30.5	24.5	29.0	31.6
May	22.3	31.6	31.0	26.7	28.8	31.0
Jun.	23.0	32.5	31.2	27.8	25.7	29.8
Jul.	23.3	31.1	33.1	29.4	27.9	33.2
Aug.	26.0	33.4	34.5	31.1	30.4	35.1
Sep.	29.5	34.2	37.5	30.6	35.4	30.6
Oct.	26.8	33.9	33.1	33.3	33.4	33.5
Nov.	25.1	32.2	29.9	30.0	32.6	30.0
Dec.	23.9	29.4	26.8	28.2	24.5	29.0
Year	33.1	38.9	41.7	38.3	38.6	41.5
D. Mean daily range						
Jan.	8.7	10.6	10.8	10.2	10.5	11.1
Feb.	9.1	9.9	10.6	9.2	10.7	10.8
Mar.	9.0	10.6	10.6	9.4	10.6	11.2
Apr.	9.1	12.2	13.0	9.7	11.5	13.0
May	9.4	15.0	15.9	11.0	12.5	14.9
Jun.	10.4	16.0	17.2	12.7	12.8	16.6
Jul.	10.2	15.6	17.3	12.7	13.0	17.1
Aug.	10.4	15.7	16.4	13.0	13.3	16.4
Sep.	11.3	14.6	15.5	12.6	13.4	15.1
Oct.	10.6	13.7	13.6	12.2	13.2	13.1
Nov.	9.4	12.1	11.9	10.8	12.1	11.9
Dec.	9.4	11.3	11.3	10.8	10.9	12.1
Year	9.8	13.1	13.7	11.2	12.0	13.6
E. Mean monthly temperature						
Jan.	16.6	20.1	21.1	21.5	22.8	24.6
Feb.	16.1	19.9	20.6	21.2	22.8	24.2
Mar.	15.3	19.1	19.6	20.4	21.9	23.6
Apr.	13.9	17.2	17.6	19.2	20.1	21.5
May	11.4	14.8	14.4	17.1	17.9	18.5
Jun.	8.9	12.8	12.2	14.9	16.0	16.1
Jul.	9.0	12.5	12.1	14.4	15.6	16.0
Aug.	10.4	14.2	13.8	16.1	17.2	17.8
Sep.	12.5	16.7	16.7	18.1	18.9	20.0
Oct.	13.9	18.6	18.9	19.7	20.9	21.5
Nov.	15.2	19.1	19.7	20.3	21.5	22.9
Dec.	16.2	19.7	20.7	21.1	22.4	24.2
Year	13.3	17.1	17.3	18.7	19.8	20.9

* Compiled and adapted from Weather Bureau, S.A. (1954a) and from climatological reports of the Soil and Irrigation Research Institute, Private Bag X79, Pretoria 0001.
HMB = Humid Mistbelt; SMB = Subhumid Mistbelt; TMB = Transitional Mistbelt; LC = Low Country.

Africa for the latitudinal range 20°S to 35°S by Schulze (1975). The following general trends for the study area (at 25°S) are derived from these data.

In midsummer, steep slopes receive less radiation than gentle slopes, regardless of aspect. Steep slopes with a south-facing aspect receive greater radiation than those with a north-facing aspect. Incoming radiation on gentle slopes, however, is apparently unaffected by aspect.

At the equinoxes and in midwinter, north-facing aspects receive greater radiation on steep slopes than they do on gentle slopes. The converse applies to south-facing aspects. Finally, regardless of steepness, slopes experience decreasing radiation as they tend more towards south-facing aspects.

TEMPERATURE

Although temperature alone may not be a significant factor in determining major regional vegetation formations, it does play a part in determining floristic variations on a meso- and micro-scale (Schulze & McGee 1978). Such variations result from differential effects of temperature on plant growth rates, seed germination, seedling survival and flowering phenology.

Temperature data for several stations in the study area are given in Tables 4 and 5 and in Figure 3. These data will be discussed comparatively with respect to the different climatic belts.

TABLE 5.—Occurrence of severe frost (less than 0°C in Stevenson screen) at two stations in the Sabie area of the Eastern Transvaal Escarpment*

	Tweefontein (1 152 m)	Bergvliet (982 m)
Earliest date	23 May	–
Latest date	8 September	–
Average first date	23 June	–
Average last date	24 July	–
Average duration	31 days	–
Period of observation	17 years	15 years
Percentage of frost years	59%	0

* Compiled from Weather Bureau, S.A. (1954a).

Subhumid Mistbelt

Long Tom station on the Summit Plateau is considered to be representative of the Subhumid Mistbelt. Mean monthly temperatures range from 8,9°C in June to 16,6°C in January (Table 4E). Average summer and winter temperatures are differentiated by 7,7°C. Extreme daily maxima are greatest in early summer (November: 29,1°C), and extreme daily minima are least in winter (June: −4,0°C) (Table 4A, B; Figure 3A). Both the mean and the extreme daily ranges are greatest in September (11,3°C and 29,5°C respectively) (Table 4C, D). Although data are lacking, frost is assumed to be a significant factor in the climate of the Subhumid Mistbelt.

Humid Mistbelt

Data for the stations Sabie and Tweefontein on the Escarpment Plateau are considered to be representative of the Humid Mistbelt. Mean monthly temperatures in the Humid Mistbelt range from 12,1°C in the coolest month (July) to 21,1°C in the warmest month (January) (Table 4E). Average summer and winter temperatures are differentiated by 9,0°C. Extreme daily maxima are greatest in late spring (October: 37,5°C), and extreme daily minima are least in winter (July: −4,2°C) (Table 4A, B; Figure 3B). Although the mean daily range is least in February (9,9°C) and greatest in July (17,3°C) (Table 4D), the extreme daily range can reach up to 37,5°C in early spring (August to September).

Severe frost (less than 0°C in Stevenson screen) is prevalent in the winter months (June to July), but has been known to occur as early as May and as late as September (Table 5). Its average duration, however, is only 31 days. The prevalence of extremely high day temperatures in the absence of rain in late spring could be inhibitory to many species, especially those on exposed, north-facing (xeric) sites. Likewise, frosty conditions would tend to exclude species which inhabit the lower frost-free climatic belts.

Transitional Mistbelt

Temperature conditions at Bergvliet (Escarpment Lower Slopes) are considered representative of the Transitional Mistbelt. Mean monthly temperatures range from 14,4°C in the coolest month (July) to 21,5°C in the warmest month (January) (Table 4E). Seasonal differentiation of mean monthly temperature is only 7,1°C.

As in the Humid Mistbelt, extreme daily maxima are greatest in late spring (October: 38,3°C), and extreme daily minima are least in winter (July: 0,0°C) (Table 4A, B). Extreme daily maxima, and especially extreme daily minima, are maintained at higher levels than in the Humid Mistbelt. The nett effect is a narrowing of the extreme daily range, its magnitude being greatest in October (33,0°C) and smallest in March (23,9°C) (Table 4C). The greatest mean daily range, however, occurs in August (13,0°C) and the smallest in February (9,2°C) (Table 4D).

Severe frost (less than 0°C in Stevenson screen) has never been recorded in 15 years of observation (Table 5). Isolated pockets of frost may occur, however, in areas of poor air drainage such as valley bottoms.

As in the Humid Mistbelt, the desiccating conditions of late spring are probably inhibiting to many plants. This is enhanced in the Transitional Mistbelt where the dampening effect of mist is less prevalent. Conversely, frost is no longer a factor limiting to plants in the Transitional Mistbelt.

Low Country

Temperature characteristics for this climatic belt are exemplified by the stations Emmett and Hazyview (Lower Foothills). Mean monthly temperatures range from 15,6°C in winter (July) to 24,6°C in summer (January) (Table 4E). As in the Humid Mistbelt, seasonal temperatures differ by 9,0°C. The greatest extreme daily maximum for Emmett (40,4°C) occurred in September, a month earlier than in the Humid and Transitional Mistbelts and two months earlier than in the Subhumid Mistbelt. Conversely, the lowest extreme daily minimum for Emmett (1,8°C) occurred in August, a month and two months later respectively (Figure 3; Table 4A, B). Thus, the Low Country apparently warms up sooner and cools down later than the Mistbelt as a whole. It therefore has a longer warm-hot season than the latter (Figure 3).

As in the Humid Mistbelt, the greatest extreme daily range occurs in September (36,6°C). The smallest extreme daily range, as in the Transitional Mistbelt, occurs in March (20,8°C) (Table 4C). These extreme ranges co-incide largely with the mean daily range for Emmett, which is greatest in September (13,4°C) and smallest in January (10,5°C) (Table 4D). This suggests that temperatures in the Low Country are seasonally more consistent than in the Humid and Transitional Mistbelts. Frost (less than 0°C in Stevenson screen) is not an important factor in the Low Country although it may occur in isolated pockets, as in the Transitional Mistbelt.

As for the other climatic belts, the Low Country experiences hot dry conditions in late spring prior to the rainy season, and with the absence of mist, conditions become quite arid. Compared to the Mistbelt, the long warm-hot season of the Low Country means an extended growing season for plants, without the inhibiting effect of frost. Furthermore, the greater predictability of temperature regimes in the Low Country probably moderates demands on the adaptive capability of plants.

The Mistbelt as a whole is consistently cooler than the Low Country (Figure 3). Mean monthly temperatures decrease with increasing altitude, Long Tom being approximately 7,5°C and Sabie 3,5°C cooler than Hazyview throughout the year (Table 4E). Likewise, but with the exception of anomalies caused by local geomorphology, the temperature range generally narrows with increasing altitude. For example, the annual average of the mean daily range is 13,6°C at Hazyview (530 m) and only 9,8°C at Long Tom (2 118 m) (Table 4D).

Wind

Although wind data for stations in the area are lacking, wind conditions at nearby stations are considered fairly representative and are therefore presented in Table 6.

TABLE 6.—Seasonal variation in wind direction for three stations in the vicinity of the study area*

Station	Period	Most significant sector from which wind blows during: January	July
Barberton	1939–1948	NE	NE
Pietersburg	1951–1957	E	SSW
Pilgrim's Rest	1939–1948	SE	SW

* Compiled from Weather Bureau, S.A. (1960).

South-easterly to easterly to north-easterly winds predominate during summer (January). These winds blow from the Indian Ocean and are often associated with anticyclonic systems, but can also be associated with cyclonic systems. Their persistence is often the harbinger of the steady rains, drizzle and mist so typical of Escarpment weather in summer.

Winds which blow from the southerly to south-westerly sectors during early summer, especially in the afternoon, are often associated with thunderstorms. During winter, these same winds are associated with cold fronts which are sometimes attended by mist and drizzle.

Violent bergwind conditions, such as the 115 kph westerly wind gust recorded in Pietersburg one September, may occasionally occur (Weather Bureau 1960). These winds become heated by compression as they drop over the Escarpment from the Highveld Plateau and are known to cause considerable physical damage to timber plantations. Indigenous vegetation does not apparently suffer much physical damage, but the low humidity of such winds in the presence of high spring temperatures is sure to have adverse physiological effects. Furthermore, such winds may seriously increase the risk of fire in the dry months of early spring.

Precipitation

Soil moisture is derived from precipitation mainly in the form of rainfall, mist (and fog), dew, hail and snow.

(a) *Rainfall*. The study area falls within the summer rainfall zone where the bulk (85 %) of annual rainfall occurs between November and March. During this period, rain is precipitated mainly in the form of afternoon thunderstorms and instability showers caused by convection in, and convergence of, tropical air masses (Weather Bureau 1965a). The convergence is often occasioned by a particularly pronounced trough of low pressure over Botswana-Namibia (Fabricius 1988). Light orographic rainfall (drizzle) without thunder, and associated with advection, is also prevalent in the summer months, especially on the windward sides of the Mountain and Escarpment Slopes. The small proportion of winter rainfall is derived solely from orographic precipitation, since conditions favouring thunderstorms and instability showers do not persist in the winter months (Weather Bureau 1965a).

On average, the Escarpment region experiences a maximum of over 140 days with measurable rainfall per annum, including 60 to 80 thunderstorms occurring early in the rainy season (Weather Bureau 1965a). Prolonged periods of rain, usually in the form of drizzle are fairly common. For instance, periods with seven consecutive rainy days are encountered on about two occasions per year, and periods with four consecutive rainy days may be encountered on as many as 10 occasions per year (Weather Bureau 1965a).

Rainfall along the eastern Escarpment is generally reliable. In 58 years of recording, 78 % of the annual falls lie within about 20 % of the normal rainfall. A further 10 % of annual falls may be regarded as 'wet' years (120–140 % of normal), and the remaining 12 % as 'dry' years (60–80 % of normal) (Weather Bureau 1965a).

The regional climate is of the monsoon type in which three seasons can be recognized:

1, the rainy season of summer and late summer (i.e. November to March); 2, the cool dry season of 'autumn' to early spring (i.e. April to August); 3, the warm dry season of spring and early summer (i.e. September to October).

The strongly seasonal nature of the rainfall at three stations in the study area is illustrated in Figure 4. (Caution should be exercised in comparing A and C because of the latter's relatively short period of recording). Maximum rainfall occurs during the warmer months, from November to March. In the Low Country and Humid Mistbelt, November to March are 'superhumid' months in which the monthly rainfall consistently exceeds 100 mm (Walter 1971). In the Subhumid Mistbelt, however, the superhumid period is limited largely to January and February. Also, there is a general increase in rainfall with altitude; the mean monthly January rainfall in the Humid Mistbelt being approximately 52 mm more than in the Low Country. This trend is interrupted on the Summit, however, where rainfall is considerably less than in the Low Country (Figure 4A), and where the humid period is considerably shorter.

The average number of rainy days in both the Mistbelt and Low Country shows much the same type of annual variation as the rainfall amount (Figure 4B, C). Rainfall is nevertheless consistently heavier in the Humid Mistbelt than in the Low Country. For example, for the same number of rainy days in December, Tweefontein in the Humid Mistbelt experiences 45 mm more rainfall than Emmett in the Low Country (Figure 4B, C). The heavier rainfall in the Humid Mistbelt may be attributed to the greater influence of orographic rainfall in this climatic belt.

Rainfall data for specific stations within and around the study area are given in Table 7. Stations are grouped according to the physiographic zones they occupy, and this facilitates the computation of a 'composite' mean or index for each zone (except the Escarpment Upper Slopes). This value broadly represents the mean annual rainfall of each zone. Zonal variability can be explained largely in terms of the prevailing physiography. Thus it is clear from Table 7 that rainfall increases steadily from the Lower Foothills (904 mm) up to a first maximum on the Plateau Crest (1 607 mm). This increase is due to the fact that elevations of land force air currents to rise and cool, and hence to precipitate moisture. Furthermore, even in the absence of general atmospheric movements, mountain regions are known to have local ascending currents that would enhance the precipitation process (Killick 1963). From the Plateau Crest, rainfall decreases into the Plateau Interior (1 200 mm). The effect of the Plateau Crest in creating a local rain-shadow may be responsible for this decrease. From the Plateau Interior, rainfall again increases steadily up to a second maximum on the Upper Mountain Slopes (1 853 mm). Above this zone, rain-shadow effects and falling temperatures probably cause significant reductions in the vapour content of the rising air masses, and rainfall consequently decreases to 774 mm on the Summit (Table 7).

TABLE 7.—Mean annual and absolute maximum and minimum rainfall for 22 stations in the Sabie area of the Eastern Transvaal Escarpment*

Physiographic zone	Station	Altitude (m)	Period (yrs)	Annual rainfall (mm)**			Composite mean (mm)
				mean	max.	min.	
Summit	Long Tom	2 118	47	568	–	–	
	Elandshoogte	1 980	13	981	–	–	774
Upper Mountain Slopes	Long Tom-Bos	1 525	17	1 853	–	–	1 853
Lower Mountain Slopes	Lisbon-Berlyn	1 370	15	1 382	–	–	1 461
	Mac-Mac	1 250	32	1 539	2 332	999	
Escarpment Plateau Interior	Spitskop	1 463	17	1 223	1 819	775	
	Tweefontein	1 152	20	1 241	1 939	806	1 200
	Sabie	1 108	49	1 134	1 967	708	
	Ceylon	1 075†	20	1 200	1 897	799	
Escarpment Plateau Crest	Ophir	1 524	23	1 469	2 317	944	
	Lekkerlach	1 520	21	1 525	–	–	1 607
	Graskop	1 478	44	1 749	–	–	
	Klipkraal	1 372	18	1 683	2 384	1 034	
Escarpment Lower Slopes	Hebron	1 341	16	1 383	1 880	927	
	Bergvliet	983	17	1 263	2 124	852	1 323
Upper Foothills	Swartfontein	1 067	17	1 073	2 157	661	
	Witwater	1 036	21	1 113	2 065	743	
	Wilgeboom	1 000	15	1 306	2 425	1 022	1 183
	Sabie gorge	975	23	1 207	1 901	801	
	Modderspruit	914	36	1 217	2 292	681	
Lower Foothills	Sandford	579	19	942	1 388	614	904
	Hazyview	530	13	866	–	–	

* Compiled from miscellaneous records of the Weather Bureau, Pretoria; from Weather Bureau, S.A. (1954b); and from climatological reports of the Soil and Irrigation Research Institute, Private Bag X79, Pretoria 0001.
**Rainfall figures adjusted to the nearest millimetre.
† Corrected altitude.

(b) *Mist*.* Precipitation from mist (and fog) supplements rainfall precipitation quite significantly. Preliminary results from 'fog-catchers' in the Eastern Transvaal have yielded precipitation figures that exceed those of standard rain gauges by between 105 and 280 % (Fabricius 1969). Where mist or fog is carried through the crown of trees, fine droplets of water collect on foliage and branches. These droplets coalesce and eventually become large enough to drip to the ground, thus contributing directly to soil moisture. This phenomenon, known as 'fog drip', is most significant when mist or fog is moving through tall vegetation. Even when mist or fog is stagnant or when it moves through short vegetation, it contributes indirectly to soil moisture by reducing evapotranspiration. Conversely, stagnant fogs may prevent the precipitation of dew by their inhibiting effect on radiation.

In the Mistbelt, mist is experienced extensively. It also occurs occasionally in the Low Country, on windward, mesic slopes during very wet periods in summer. Cold-air drainage on calm winter nights results in the formation of stagnant valley fogs. In the Low Country, these fogs do not persist beyond early morning, being soon dissipated by the heat of the sun.

(c) *Dew*. Radiation of heat at night causes surface temperatures to fall and, under relatively humid conditions, this results in precipitation of moisture in the form of dew. River valleys are especially subject to dew precipitation.

Dew contributes to soil moisture by reducing the rate and duration of evapotranspiration. Such reduction is accomplished when, with the evaporation of dew, rapid temperature-rises are checked and humidities raised. Dew precipitation may thus serve to ease, or even positively counteract, drought conditions.

(d) *Hail*. Precipitation by hail does not contribute very significantly to soil moisture and neither does it appear to cause much damage to indigenous vegetation. This is mainly because it occurs so infrequently, being prevalent during only four or five spring thunderstorms annually (Weather Bureau 1965a).

(e) *Snow*. Snowfall results from subpolar air masses advancing from the south of the study area (Fabricius 1988). Apart from increasing soil moisture during winter, snow acts as an insulating blanket protecting plants from excessively cold temperatures and preventing the ground beneath from freezing (Killick 1963). Owing to the dryness of the winter, snowfalls in the study area are not particularly frequent. Between 1969 and 1983, only four instances of snow were recorded, usually in early spring (August–September) (Mrs D. Livingstone pers. comm.). The snow is confined to the Summit and Mountain Slopes, where slopes as low as 1 600 m elevation may be affected. Snow in early spring may therefore be particularly beneficial to high-altitude plants whose soil moisture is largely depleted after the prolonged dry conditions of winter.

* In this text, the term 'mist' is used to indicate suspended moisture droplets condensed by the cooling of saturated air masses rising against sloping ground. In contradistinction, the term 'fog' is used to denote such suspended moisture droplets condensed from saturated air cooled at night by radiation and temperature inversion, being restricted mainly to low-lying and level terrain.

Humidity

Data for Hazyview in the Low Country and Long Tom in the Subhumid Mistbelt are presented in Table 8. As expected, humidity levels are correlated with precipitation, temperature, and wind; the highest mean values being recorded in April–May in the Low Country and in February–March in the Subhumid Mistbelt. These periods are associated with decreasing autumn temperatures (Figure 3A, C) near the close of the rainy season, when fairly high levels of soil and atmospheric moisture still prevail (Figure 4A, C). The lowest mean humidity values were recorded in June–July in both the Low Country and the Subhumid Mistbelt. This is a period of low rainfall and low temperatures (Figures 3 & 4). In addition, prevailing winds tend to be dry south-westerly (Table 6).

The period July–August in the Subhumid Mistbelt may be subject to large fluctuations in humidity. For example, the extreme minimum humidity may be as low as 2%, whereas the extreme maximum may be as high as 96% (Table 8). The low minima may arise on occasions when hot, dry south-westerly 'bergwinds' blow. Conditions in the Low Country are not as dry, the lowest extreme minimum humidity being 11% in September.

Table 8 shows the situation at the extremes of the study area only. Humidities for the intermediate Humid and Transitional Mistbelts are obviously expected to be higher than those for either the Subhumid Mistbelt or the Low Country.

CONCLUSION

The foregoing treatment has been necessary for establishing a basic environmental context for vegetation classification (cf. Deall *et al.* 1989). Environmental attributes are largely responsible for determining plant-species distributions. Discussion of the environment, therefore, draws attention to the potential determinants of vegetation composition, vegetation structure, and vegetation distribution. The Eastern Transvaal Escarpment is a region with a great diversity of natural habitats. It is this diversity which elicits the vegetation response reflected in the numerous syntaxa described elsewhere (cf. Deall *et al.* 1989).

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TABLE 8.—Annual march of mean and extreme maximum and minimum humidity for two stations in the Sabie area of the Eastern Transvaal Escarpment*

Humidity parameter (%)	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Long Tom Station (1980–1983) in the Subhumid Mistbelt, 2 118 m alt.												
Extreme max.	100,0	100,0	100,0	98,0	97,0	94,0	96,0	96,0	95,0	90,0	81,0	95,0
Extreme min.	16,0	12,0	14,0	13,0	9,0	8,0	2,0	3,0	11,0	9,0	10,0	13,0
Mean max.	85,7	89,8	88,7	81,9	73,7	65,2	66,7	66,5	69,1	69,0	69,5	73,5
Mean min.	47,3	50,1	44,6	38,3	33,9	27,7	26,9	30,1	30,5	31,5	36,9	36,2
Hazyview Station (1978–1983) in the Low Country, 530 m alt.												
Extreme max.	98,0	95,0	96,0	97,0	97,0	98,0	97,0	97,0	95,0	96,0	95,0	97,0
Extreme min.	16,0	20,0	17,0	19,0	17,0	15,0	13,0	12,0	11,0	14,0	16,0	18,0
Mean max.	85,6	85,7	86,5	88,5	88,0	85,1	83,9	82,0	83,7	84,7	85,1	86,1
Mean min.	41,9	39,4	38,4	35,5	33,8	28,7	29,3	30,9	32,9	37,0	40,7	37,7

*Compiled from climatological reports of the Soil and Irrigation Research Institute, Private Bag X79, Pretoria 0001.

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