

LANDSCAPES OF THE KRUGER NATIONAL PARK

W. P. D. GERTENBACH

Department of Research and Information

Private Bag X402

Skukuza

1350

Abstract — Knowledge on the abiotic and biotic components of the Kruger National Park (KNP) system has increased to such an extent, that it was possible to zonate the KNP into landscapes. A landscape was defined as an area with a specific geomorphology, climate, soil and vegetation pattern together with the associated fauna. On this basis 35 landscapes were identified and described in terms of the components mentioned in the definition.

The objective of classification is that future management should be based on these landscapes. Relevant management considerations may change, but the landscape as a basic functional unit should not be negotiable.

Introduction

The plant communities occurring in the Kruger National Park (KNP) were classified and described using the Braun-Blanquet technique (Van Rooyen 1978; Gertenbach 1978; Coetzee 1983). The geographical distribution and size of these plant communities have shown such a complex pattern as to render it impossible to indicate individual plant communities or associations on a map of reasonable scale. Despite intensive research regarding the ecology of these plant communities, no practical management program based on these communities has been forthcoming. The intensity of these surveys has thus apparently surpassed the practical application of the results.

Studies regarding the climate (Gertenbach 1980), geology (Schutte 1974, 1982) soils (Harmse & Van Wyk 1972; Harmse, Van Wyk & Gertenbach 1974; Webber 1979; Venter 1981), vegetation (Gertenbach 1978; Van Rooyen 1978; Coetzee 1983) and animal life (Pienaar 1963; Joubert *in prep.*) have contributed towards an improved interpretation of the functioning of the ecosystem as a whole. Equipped with this information an attempt was made to divide the KNP into significant units for the purpose of practical conservation management. Such a zonation of the KNP was suggested by Joubert (1975), but with the availability of additional data the necessity for adjustments became inevitable.

Prevailing requirements have necessitated the formulation and acceptance of the concept of a landscape in the nature conservation context. A landscape is defined by Coetzee (1983) as “ . . . an area with a recurrent pattern of plant communities with their associated fauna and abiotic habitat”. Considering that vegetation and

abiotic habitat are not consistently recurrent, the following definition of a landscape has been formulated for the purpose of this study: "A landscape is an area with a specific geomorphology, macroclimate, soil and vegetation pattern and associated fauna". Therefore a landscape is comparable to a "Landtype" (Macvicar, Scotney, Skinner, Niehaus & Loubser 1974).

Although the original study of plant communities and their abiotic habitat was ostensibly too intensive, it would appear from the definition, that it did form the basis of the landscape characterisation. On the contrary, the conclusion can be made that the identification of landscapes is not possible without a thorough knowledge of soil and vegetation patterns.

It cannot be expected that the classification of the KNP into landscapes should be a demarcation of homogeneous units. On the contrary, heterogeneity occurs within a landscape, but an attempt has been made to group the most dominant soil and vegetation patterns.

Methods

Each landscape is discussed with respect to the five components mentioned in the definition. The geomorphology is discussed using geological descriptions of Brandt (1948), Schutte (1974), Cleverly & Bristow (1979), Bristow (1980), Schutte (1982) and Schutte & Clubley-Armstrong (1982) and the 1:100 000 maps of the KNP.

Climatic data were received from 22 ranger stations where rainfall is measured, five Class II weather stations and one Class I weather station where limited temperature data are recorded. A rainfall chart was compiled by Gertenbach (1980).

Descriptions of the soil types were done using 2 000 soil profiles dug in the KNP, as well as charts by Harmse & Van Wyk (1972); Harmse *et al.* (1974); Webber (1979) and Venter (1981). Vegetation descriptions were done by Codd (1951), Van der Schijff (1957), Pienaar (1963), Van Wyk (1973), Gertenbach (1978), Van Rooyen (1978) and Coetzee (1983). Additional descriptions of vegetation were also obtained from 1 500 Braun-Blanquet-plots in the KNP. The discussion of the associated fauna was done with the help of observations made during the annual aerial surveys (Joubert *in prep.*) as well as the experiences of other field staff. The geographical distribution of each of these landscapes are represented on the accompanying map (Fig. 1).

The landscapes should therefore be seen as functional management units distinguished on the basis of the entities described in the definition. The ideal is that any form of management should henceforth be based on the zonation of the KNP into landscapes. Management considerations per landscape could change in the short term, and should thus be reviewed from time to time, but the landscapes as a functional unit should not be negotiable.

Discussion of Landscapes

1. Lowveld Sour Bushveld of Pretoriuskop

Location and Geomorphology

This landscape is located in the south-western corner of the KNP in the vicinity of Pretoriuskop and covers approximately 530 km² (2,8 percent of the KNP). Archain

granite and gneiss form the underlying material of this area and results in an undulating landscape with distinct uplands and bottomlands. Rocky granite koppies and deep incisions forming seasonal spruits are characteristic. Drainage takes place northwards *via* the Pabene and Mtshawu spruits to the Sabie River and south and eastwards via the Nsikazi and Mbyamide spruits to the Crocodile River. The altitude varies between 550 and 650 metres above sea level.

Climate

The annual rainfall varies between 600 and 1 000 mm with an average of 743,6 mm for Pretoriuskop (Gertenbach 1980). Precipitation usually occurs in summer with effective rains during the months October to April. The relatively high rainfall and absence of frost causes the grass to sprout even during winter, thereby providing green pasture out of season. Daytime temperatures of 35 °C during summer are common, but at the same time the temperature during winter is very moderate. Table 1 shows the average daily maximum and minimum and absolute maximum and minimum temperatures for each month for Pretoriuskop.

Table 1
Temperature data for Pretoriuskop
(Data collected since September 1981)

Temperature °C

Month	Average Daily Maximum	Absolute Maximum	Average Daily Minimum	Absolute Minimum
January	29,2	35,4	18,8	16,7
February	31,0	37,0	18,3	14,0
March	32,1	39,0	17,8	13,0
April	27,8	33,5	15,1	8,0
May	25,1	33,0	12,7	8,5
June	23,9	30,0	8,8	4,0
July	24,8	32,0	9,3	4,5
August	26,7	34,0	11,0	6,0
September	26,9	36,1	14,4	8,6
October	23,7	33,0	13,2	9,5
November	30,1	39,7	17,6	14,0
December	28,6	35,5	17,4	14,2

Soil pattern

The soil pattern of the landscape corresponds strongly with the position in the topography. The soil on the uplands is red to yellow-brown in colour, varies from a sand to a sandy loam (6 to 15 percent clay) and is deeply leached. Harmse & Van

Wyk (1972) classifies the soils into the Hutton and Clovelly Forms with Portsmouth/Moriah and Paleisheuvel/Denhere respectively as the dominant Series. Soils are classified by means of the South African soil classification system of Macvicar, Loxton, Lambrechts, Le Roux, Harmse, De Villiers, Verster, Merryweather & Van Rooyen (1977). A characteristic of the landscape is that the sandy soils occur from the uplands almost down to the drainage channels. This results in the bottomlands being narrow and relatively inconspicuous. An accumulation of clay and minerals has taken place in the bottomlands and therefore the soils in these areas are clayey with a strongly developed structure. Dominant soil Forms from the valleys are Estcourt, Wasbank, Valsrivier and Sterkspruit. On the banks of spruits soils occur that have been deposited in recent times and have undergone little or no soil forming processes. Such soils at times show clear layers of unconsolidated material and belong mainly to the Oakleaf and Dundee Forms.

Vegetation

Acocks (1975) describes the vegetation of this landscape under the name of Lowveld Sour Bushveld, while Van der Schijff (1957) and Pienaar (1963) provided long lists of plants which occur in this landscape. The vegetation structure of the uplands is an open tree savanna with relatively few low shrubs and the woody component is dominated by *Terminalia sericea* and *Dichrostachys cinerea* subsp. *nyassana* (Fig. 2). Important associated species are *Strychnos madagascariensis*, *S. spinosa*, *Peltophorum africanum*, *Combretum collinum* subsp. *suluense*, *C. zeyheri*, *C. apiculatum*, *C. molle*, *Ximenia caffra*, *Sclerocarya caffra*, *Parinari curatellifolia*, *Annona senegalensis*, *Antidesma venosum* and *Maytenus heterophylla*. This landscape is unique in the respect that many of the rarer species of trees in the KNP occur abundantly. Species that deserve mentioning are *Pterocarpus angolensis*,



Fig. 2. Landscape 1. Upland Lowveld Sour Bushveld of Pretoriuskop.

Albizia versicolor, *Lannea discolor*, *Piliostigma thonningii* and *Acacia sieberana* var. *woodii*. *Ficus sycomorus* which is common for riverine vegetation also occurs on the uplands of this landscape. The vegetation found on the koppies (Fig. 5) is comparable to that found in the Malelane Mountain Bushveld (Landscape 2).

The field layer is tall (1-2 metres), dense (70 percent crown cover) and is dominated by more sour species of grass like *Hyperthelia dissoluta*, *Elionurus argenteus*, *Hyparrhenia hirta*, *H. filipendula*, *Setaria perennis*, *Rhynchelytrum setifolium*, *Aristida congesta* susp. *congesta*, *Heteropogon contortus*, *Eragrostis lappula*, *E. atrovirens*, *Schizachyrium sanguineum*, *Diheteropogon amplexans*, *Pogonarthria squarrosa* and *Setaria flabellata*. *Vernonia natalensis* is the dominant forb in the field layer. The physiognomical dominance of *Hyperthelia dissoluta* is typical of the landscape.

The grass composition of the middleslopes of the landscapes change slightly and grasses such as *Loudetia simplex*, *Andropogon huillensis*, *Digitaria longiflora*, *Eragrostis capensis* and *E. gummiflua* occur more frequently.

The bottomlands in the landscape are narrow and when present is an open savanna with single trees and sparse shrubs and a denser grass cover (Fig. 3). Dominant woody species are *Acacia nilotica* subsp. *kraussiana*, *A. gerrardii*, *A. tortilis* subsp. *heteracantha*, *Combretum hereroense*, *Grewia bicolor*, *G. hexamita*, *G. monticola*, *Schotia brachypetala*, *Diospyros mespiliformis*, *Bolusanthus speciosus*, *Ziziphus mucronata*, *Cassine aethiopica*, *Euclea natalensis*, *E. divinorum*, *Rhus pyroides* and *A. nigrescens*. Grasses which occur in the bottomlands are *Digitaria eriantha* var. *pentzii*, *Eragrostis superba*, *Aristida congesta* subsp. *barbicollis*, *Sporobolus fimbriatus*, *Urochloa mosambicensis*, *Heteropogon contortus*, *Themeda triandra*,



Fig. 5. Landscape 1. Manung, a Granite Koppie.



Fig. 3. Landscape 1. Bottomland Lowveld Sour Bushveld of Pretoriuskop.



Fig. 4. Landscape 1. Vegetation on a stream bank.

Cymbopogon plurinodis and *Panicum maximum*. Because of the sweeter nature of the grasses in the bottomlands they are selected by game and it is usually these areas that show the first signs of overgrazing.

Spruit and river banks are dense and evergreen plants occur most frequently (Fig. 4). *Diospyros mespiliformis*, *Acacia robusta*, *Schotia brachypetala*, *Syzygium cordatum*, *S. guineense*, *Ficus sycomorus*, *Cassine aethiopica*, *Olea africana*, *Spirostachys africana*, *Bauhinia galpinii* and *Euclea natalensis* are the dominant woody species. The grass cover is sparse and is dominated by *Panicum maximum*. The palm *Phoenix reclinata* occurs in the sandy beds of the larger spruits.

Fauna

According to Pienaar (1963) this landscape is preferred habitat for reedbuck (*Redunca arundinum*) and kudu (*Tragelaphus strepsiceros*). White rhino (*Ceratotherium simum*) occur regularly and it is the area with the largest concentration of sable antelope (*Hippotragus niger*) in the southern part of the KNP. According to Joubert (*in prep.*) at least 150 of these animals occur in this landscape. Oribi (*Ourebia ourebi*) occurred in this area during earlier years, but later became extinct. Attempts to re-establish this species took place in 1973-74 when animals were transferred from the highveld and released in this landscape. There is no evidence to prove that these attempts were successful. The last remaining herd of roan antelope (*Hippotragus equinus*) in the southern part of the KNP is also found in this landscape. The relative absence of elephant (*Loxodonta africana*) and buffalo (*Syncerus caffer*) from this landscape is as significant as is the presence of other game species, since this area is not acceptable to them. This landscape in its present form is also not good habitat for short grass grazers such as wildebeest (*Connochaetus taurinus*) and zebra (*Equus burchelli*).

2. Malelane Mountain Bushveld

Location and Geomorphology

This landscape is located in the extreme south-western corner of the KNP and includes all the mountains of the Malelane and Stolznek areas. Geologically, archaean granite and rock formation of the Swaziland System form the underlying material of this area. Mountains such as Sithungwane and Newu consist of granite, while Khandizwe, Tlhalabye and Mathili are made up of Swaziland rock formation. Dolerite intrusions also occur in the Swaziland System and granite. It has been observed that the parent material of the eastern slopes of a koppie consist of dolerite while the western slopes are mainly granite. The altitude varies from 350 to 800 metres with Khandizwe being the highest point at 847 metres. This landscape represents 2,4 percent of the area of the KNP. The slopes are steep and the most important spruits are the Nsikazi, Matjulu and Matjulwana.

Climate

This area has a moderate sub-tropical climate with warm summers and cool winters. The climate on the mountain plateaus is probably more extreme with the possibility of frost not excluded. The annual rainfall varies from 600 to 700 mm and probably

increases to more than 1 000 mm on the mountains. The average annual rainfall for Malelane and Stolznek is 620 and 723 mm respectively. According to Gertenbach (1980) the abnormally high average rainfall at Stolznek can be attributed to the short period in which rainfall has been recorded.

Soil pattern

Harmse & Van Wyk (1972) regards the soils of this landscape as shallow rocky soils and classify them in the Lithosol category. The most common soil Forms that occur are Mispah and Glenrosa. Clay accumulation took place to a limited degree in the bottomlands and Valsriver and Oakleaf soils developed. The soils of the mountainous plateaus are well drained, more deeply leached and is generally classified as Hutton soils.

Vegetation

The vegetation of this landscape is very heterogeneous, but *Combretum apiculatum* is omnipresent on the shallow soils regardless of the parent material of the soil (Fig. 6). The structure of the woody component varies from dense to moderate, 3 metre high shrubs with single trees and can be described as a bushsavanna. Other woody plants which occur regularly are *Acacia nigrescens*, *Combretum zeyheri*, *C. collinum*, *Terminalia sericea*, *T. prunioides*, *Dichrostachys cinerea* subsp. *africana*, and *Acacia tortilis*. The vegetation is very similar to that found on the koppies in the Lowveld Sour Bushveld of Pretoriuskop and elements of this landscape are also sporadically found amongst the mountains. Considering that Landscape 5 is adjacent to this mountain bushveld, elements of the latter also occur regularly in this landscape.



Fig. 6. Landscape 2. Malelane Mountain Bushveld.

From the nature of this mountainous landscape different micro-habitats occur e.g. small ravines which result in the occurrence of a range of unique plant species. A few that deserve to be mentioned are the following: *Kirkia wilmsii*, *Sterculia murex*, *Commiphora harveyi*, *Strychnos henningsii*, *Homalium dentatum*, *Premna mooiensis*, *Celtis africana*, *Aloe bainesii*, *Ficus capensis*, *F. sonderi*, *F. soldanella*, *Urera tenax*, *Oxalys dissitiflora*, *Portulacaria afra*, *Albizia versicolor*, *Dalbergia armata*, *Pterocarpus angolensis*, *Erythrina latissima*, *E. lysistemon*, *Vepris reflexa*, *Pittosporum viridiflorum*, *Croton gratissimus*, *Euphorbia ingens*, *E. evansii*, *Maytenus undata*, *Cassine aethiopica*, *Hippobromus pauciflorus*, *Berchemia zeyheri*, *Grewia monticola*, *Dombeya kirkii*, *D. cymosa*, *Ochna natalitia*, *Mimusops zeyheri*, *Manilkara mochisia*, *Breonadia microcephala*, *Tarchonanthus camphoratus*, *Brachylaena huillensis*, *Rauvolfia caffra*, *Olea africana*, *Heteropyxis natalensis*, *Commiphora neglecta*, *Acacia karroo*, *Sideroxylon inerme*, *Manilkara concolor*, *Apodytes dimidiata*, *Calodendrum capense*, *Tecomaria capensis*, *Cussonia natalensis*, *Faurea saligna* and *F. speciosa*.

The dominant grasses in this area are *Heteropogon contortus*, *Pogonarthria squarrosa*, *Panicum maximum*, *Digitaria eriantha* subsp. *pentzii*, *Cymbopogon plurinodis*, *Aristida congesta* subsp. *barbicollis*, *Tricholaena monachne*, *Trichoneura grandiglumis*, *Enneapogon cenchroides* and *Themeda triandra*. A common garden flower *Gerbera jamesonii* occurs extensively in this mountain veld.

Recently a new plant community was discovered on the mountain plateaus. It is an open *Acacia davyi*-savanna with *Tristachya hispida* as the dominant grass. The occurrence of this community suggests that a higher rainfall prevails and the possibility of frost is not excluded. This community is related to the grassveld on the highveld.

The bushy ravines on the slopes of the mountains accommodate sub-tropical forest vegetation with *Aloe bainesii* being a unique component. Tree ferns (*Alsophila dregei*) are common.

Fauna

This area is the most important habitat for mountain reedbuck (*Redunca fulvorufula*), grey rhebuck (*Pelea capriolus*) and reedbuck (*Redunca arundinum*) in the KNP. The mountain reedbuck population was strengthened by the importation of ± 200 animals from the Mountain Zebra National Park, while for all practical purposes the grey rhebuck has become extinct. During 1981, 20 individuals were re-established on the *Acacia davyi*-plateaus. Kudu and impala (*Aepyceros melampus*) are common in this area, while sable antelope and white rhino are generally less abundant. Animals such as elephant and buffalo occur in relatively low numbers while the same applies to wildebeest and zebra to a lesser degree. As a result of the rocky nature of this area, klipspringers (*Oreotragus oreotragus*) are plentiful with duikers (*Sylvicapra grimmia*) constantly present.

Carnivores such as wild dog (*Lycaon pictus*) and spotted hyaena (*Crocuta crocuta*) frequently make their lairs in the caves and crevices of the mountainous parts of this landscape. The last observation of brown hyaena (*Hyaena brunnea*) in the KNP was recorded in this landscape. Baboons (*Papio ursinus*) are also inhabitants of these koppies.

3. *Combretum collinum*/*Combretum zeyheri* Woodland

Location and Geomorphology

This landscape is situated along the upper course of the Mbyamide River in the central southern district between the Sabie and Crocodile Rivers. It covers approximately 540 km² which represents 2.8 percent of the KNP. The underlying granite and gneiss is deeply weathered resulting in a undulating landscape with distinct uplands and bottomlands. The area is drained exclusively by the Mbyamide River and its tributaries. The altitude varies between 450 and 550 metres above sea level.

Climate

The climate is mild and the absence of frost is an important characteristic. Temperatures of about 40 °C in the summer is not unusual. The average rainfall varies between 600 and 700 mm per year and occurs mainly during the summer. The temperature data for Pretoriuskop (Table 1) is also applicable to this landscape.

Soil Pattern

Venter (1981) describes the soil of the uplands in this landscape as red, coarse, fersiallitic sands and loams. Harmse & Van Wyk (1972) classified the soil on the uplands mainly as Hutton and Clovelly Forms with Portsmouth and Paleisheuvel respectively as the dominant Series. The soil is deeply leached and has good internal drainage. The soil pattern differs from that of the Lowveld Sour Bushveld (Landscape 1) in that a definite ecotone is present.

There is a definite seepline where the topography changes from convex to concave and superfluous rainwater that has fallen on the uplands move downlands and laterally to appear on the surface. These soils are saturated with water in the rainy season and gleyed horizons are present (Fig. 7). It is in this seepline that temporary springs originate during the rainy season. Dominant types of soil under these conditions are Estcourt, Kroonstad, Cartref, Wasbank and Longlands. These types of soil are generally classified as duplex soils.

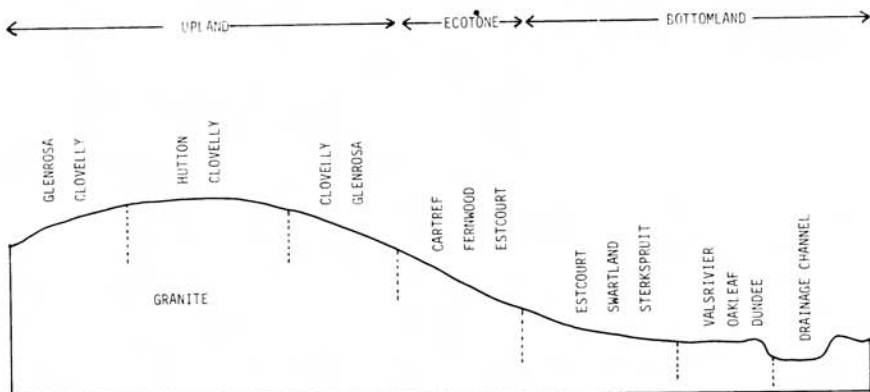


Fig. 7. Diagrammatic representation of a granite undulation.

Accumulations of clay and minerals have taken place in the bottomlands. The result is that the bottomland soils are clayey and have a high concentration of mineral salts. Soils commonly present in the bottomlands are Valsrivier, Swartland, Sterkspruit, Glenrosa, Wasbank, Cartref and Estcourt. On the banks of spruits, under-developed soils of the Oakleaf and Dundee Forms (Fig. 7) can be expected. This sequence of soil types from the upland to the bottomland is referred to as a catenary sequence and is usually constant for a specific landscape. That is why Coetzee (1983) as quoted in the introduction included the phrase "recurrent pattern" in the definition. Exceptions to this normal sequence of soil types do occur, but are not sufficiently important to justify the creation of a new "landscape".

Vegetation

As is indicated by the name of the landscape, the vegetation on the uplands is dominated by *Combretum collinum* subsp. *suluense* and *C. zeyheri* (Fig. 8). This is a relatively dense bush savanna between 1 and 5 metres in height with larger trees sparsely dispersed. Other woody species occurring constantly on the uplands are as follows: *Terminalia sericea*, *Combretum apiculatum*, *Dichrostachys cinerea* subsp. *nyassana*, *Strychnos madagascariensis*, *Peltophorum africanum*, *Combretum molle*, *Pterocarpus rotundifolius*, *Maytenus heterophylla*, *Sclerocarya caffra*, *Acacia exuvialis*, *Dalbergia melanoxylon* and *Xeromphis obovata*.

The field layer is moderate to dense, less than 1 metre in height and is dominated by *Pogonarthria squarrosa*, *Tricholaena monachne*, *Hyperthelia dissoluta*, *Setaria flabellata*, *Loudetia simplex*, *Eragrostis rigidior*, *Trichoneura grandiglumis*, *Perotis patens*, *Brachiaria nigropedata*, *Digitaria eriantha* subsp. *pentzii*, *Panicum maxi-*



Fig. 8. Landscape 3. Upland *Combretum collinum*/*Combretum zeyheri* Woodland.

mum, *Aristida congesta* subsp. *congesta*, *A. congesta* subsp. *barbicollis*, *Heteropogon contortus* and *Rhynchelytrum repens*. Forbs in the field layer include the following: *Waltheria indica*, *Agathisanthemum bojeri*, *Kohautia virgata*, *Tephrosia polystachya*, *Clerodendrum ternatum* and *Rhynchosia totta*. The vegetation which occurs on the ecotone is dominated by an almost homogeneous stand of *Terminalia sericea*. The field layer is dense, up to 1 metre high and includes the following species: *Eragrostis gummiflua*, *Pogonarthria squarrosa*, *Hyperthelia dissoluta* and *Epaltes gariiepina*.



Fig. 9. Landscape 3. Ecotone and Bottomland *Combretum collinum*/*Combretum zeyheri* Woodland.

The nutritive clayey bottomlands (Fig.9) are open savannas with a dense grass layer. Because of the sweeter nature of the grass in these bottomland areas, these parts are the first to be overgrazed and therefore are the first to show signs of retrogressive succession. The most important woody species are *Acacia nigrescens*, *A. nilotica* subsp. *kraussiana*, *Ormocarpum trichocarpum*, *Acacia gerrardii*, *Combretum hereroense*, *Grewia bicolor*, *Euclea natalensis*, *Ziziphus mucronata*, *Grewia hexamita*, *Albizia harveyi*, *Acacia exuvialis*, with *Spirostachys africana*, *Cassine aethiopica*, *Euclea divinorum*, *Schotia brachypetala*, *Pappea capensis* and *Diospyros mespiliformis* which are limited to the brackish footslopes. The field layer is dense with the following important species: *Themeda triandra*, *Digitaria eriantha* subsp. *pentzii*, *Heteropogon contortus*, *Cymbopogon plurinodis*, *Eragrostis superba*, *Enneapogon cenchroides*, *Aristida* subsp. *barbicollis*, *Schmidtia pappophoroides* and *Urochloa mosambicensis*. On the brackish footslopes

Dactyloctenium aegyptium and *Sporobolus nitens* are dominant. Dominant forbs are *Heliotropium steudneri*, *Abutilon austro-africanum*, *Ruellia patula*, *Justicia flava*, *Blepharis integrifolia* and *Cyphocarpa angustifolia*.

The riverine vegetation is very heterogeneous but the most common species are: *Diospyros mespiliformis*, *Spirostachys africana*, *Lonchocarpus capassa*, *Combretum imberbe*, *Schotia brachypetala*, *Acacia robusta*, *Cassine aethiopica* and *Euclea natalensis*. The grass layer is dominated by *Panicum maximum*.

Fauna

This landscape is preferred habitat for sable antelope, buffalo, kudu, white rhino, reedbuck and elephant, while smaller antelope like steenbok (*Raphicerus campestris*) and duikers occur constantly. Zebra are widely distributed forming groups of four to six individuals while wildebeest are normally absent from this landscape.

4. Thickets of the Sabie and Crocodile Rivers

Location and Geomorphology

As the name indicates this landscape consists of the low lying areas along the two rivers and is underlain by archian granite and gneiss intersected by dolerite intrusions. The landscape is horseshoe-shaped, starting at the Sabie River with the Mtshawuspruit as the western boundary, along the Sabie eastwards to Lubyelubye, then southwards across the watershed to the Crocodile River and then westwards following the river banks to the vicinity of the Malelane restcamp. The topography is concave to relatively flat but is intersected by numerous spruits that flow into the two rivers. Spruits worth mentioning are the Nwaswitshaka, Nwatimwambo, Nwatimhiri and Lubyelubye that flow into the Sabie River and the lower Mbyamide, Bume and Mlambane that flow into the Crocodile River. A few granite koppies occur in the landscape of which Shirimanthanga, Renoster Koppies, Thekwane, Mlalen, Siyalo and Sihlehleni are the most important.

The altitude varies between 200 and 350 metres and the landscape occupies 1 242 km² or 6,2 percent of the KNP, which makes it one of the largest landscapes in the southern district.

Climate

The climate of this low-lying landscape shows greater extremes than the adjacent landscapes. As far as temperature is concerned a great variation between day and night-time temperatures is experienced. The average daily maximum temperature is above 31 °C for the months of November to March (Table 2) while sporadic frost occurs in the winter in the bottomlands. The rainfall varies between 500 and 550 mm per year with an annual average of 546 mm for Skukuza (Gertenbach 1980).

Table 2
Temperature data for Skukuza
(Data collected since 1965)

Temperature °C

Month	Average Daily Maximum	Absolute Maximum	Average Daily Minimum	Absolute Minimum
January	32,3	42,3	19,6	7,2
February	32,2	40,3	19,4	7,2
March	31,2	40,3	17,9	8,3
April	29,8	38,3	14,8	3,3
May	27,4	37,0	10,2	2,2
June	25,6	35,3	6,1	-2,2
July	25,4	36,1	5,6	-2,5
August	27,2	37,9	7,6	-0,1
September	29,4	40,6	11,6	1,1
October	30,8	41,7	15,1	6,6
November	31,8	44,5	17,5	6,7
December	32,3	44,4	19,2	8,3

Soil pattern

The soils in this landscape are normally shallow and where it is deeper it is usually saturated with sodium. It developed mainly as a result of the accumulation of clay and mineral elements in the low lying areas. Harmse & Van Wyk (1972) identified two groups of soils in this landscape, namely Mispah and Glenrosa soils on the uplands and Sterkspruit, Estcourt and Valsrivier soils in the bottomlands. Dundee, Oakleaf and Inhoek Forms of soil are usually found on the banks of spruits and rivers. The soils present in the vicinity of dolerite intrusions are usually darker in colour and Forms that can be expected are Mayo, Milkwood and Swartland. As a rule it can be said that the soils of this landscape are usually shallow and show no signs of a recurrent pattern.

Vegetation

This landscape is characterised by a dense woody vegetation which can basically be referred to as an *Acacia nigrescens/Combretum apiculatum* association and it corresponds to a large extent with the bottomland vegetation in Landscapes 3 and 5. Van Wyk (1973) refers to this landscape as “. . . thorny thickets on brackish granite flats, . . .” while Coetzee (1983) calls it “. . . spiny arid bushveld”. Pienaar (1963) refers to it as “. . . dense thornbush thickets”.

The differentiating species of the landscape are *Acacia nigrescens*, *Combretum apiculatum*, *Grewia bicolor*, *G. flavescens*, *Dichrostachys cinerea* subsp. *africana*, *Euclea divinorum*, *Terminalia prunioides*, *Spirostachys africana* and *Acacia*

grandicornuta. Two variations of the vegetation can be identified viz. *Combretum apiculatum*-dominated uplands (Fig. 10) and *Acacia grandicornuta*-dominated bottomlands (Fig. 11). Both variations of vegetation are dense and according to Joubert (1976) the relative crown cover of woody species are as follows:

Stratum	Relative Crown Cover (%)
> 4 metres	7,4
3 - 4 metres	10,7
2 - 3 metres	11,0
1 - 2 metres	70,9

The soils of the uplands are shallow and stony and dense stands of the following woody plant species are present: *Combretum apiculatum*, *Acacia nigrescens*, *A. exuvialis*, *Terminalia prunioides*, *Dichrostachys cinerea* subsp. *africana*, *Grewia bicolor*, *G. flavescens*, *Combretum hereroense*, *Lannea stuhlmannii*, *Ziziphus mucronata*, *Sclerocarya caffra*, *Lonchocarpus capassa* and *Acacia tortilis*. The field layer is sparse and is dominated by *Aristida congesta* subsp. *barbicollis*, *Pogonarthria squarrosa*, *Rhynchelytrum repens*, *Panicum maximum*, *Urochloa mosambicensis*, *Schmidtia pappophoroides*, *Digitaria eriantha* var. *pentzii* and *Eragrostis rigidior*. Forbs normally present are *Waltheria indica*, *Tephrosia polystachya*, *Clerodendrum ternatum*, *Evolvulus alsinoides*, *Heliotropium steudneri*, *Aptosimum lineare*, *Kohautia virgata* and *Agathisanthemum bojeri*.



Fig. 10. Landscape 4. *Combretum apiculatum*-variation.



Fig. 11. Landscape 4. *Acacia grandicornuta*-variation.

On the brackish soils in the bottomlands *Combretum apiculatum* is less common and the lower shrub layer less dense. Sometimes large bare patches occur with only single *Acacia grandicornuta* trees. Dominant woody species are: *Acacia grandicornuta*, *Acacia nigrescens*, *A. exuvialis*, *Terminalia prunioides*, *Spirostachys africana*, *Dichrostachys cinerea* subsp. *africana*, *Grewia bicolor*, *G. flavescens*, *Xanthocercis zambesiaca*, *Euclea divinorum*, *Acacia tortilis*, *A. nilotica*, *Ormocarpum trichocarpum*, *Schotia brachypetala* and *Ehretia rigida*. Species which are relatively rare in other landscapes are constantly occurring in this landscape. Such species are: *Ptaeroxylon obliquum*, *Balanites maughamii*, *Croton gratissimus*, *Zanthoxylum humilis*, *Gardenia spatulifolia*, *Adenium obesum*, *Pavetta catophylla* and *Rhigozum zambesiaceum*.

The field layer of this variation is once again sparse and for the most part in an over-utilised condition. Even under very favourable conditions no good, stable grass cover develops. As a result of overgrazing, fires occur less frequently in this landscape and thus the reason why it is usually densely overgrown with woody species. Grasses found in the brackish bottomlands include the following: *Sporobolus nitens*, *Urochloa mosambicensis*, *Chloris virgata*, *Aristida congesta* subsp. *barbicollis*, *Bothriochloa radicans*, *Schmidtia pappophoroides*, *Digitaria eriantha* var. *pentzii* and *Eragrostis trichophora*. Under conditions of lower utilisation grasses such as *Themeda triandra*, *Panicum maximum*, *Heteropogon contortus*, *Sporobolus smutsii* and *Cymbopogon plurinodis* sometimes increase. Forbs found on brackish spots include the following: *Dyschoriste rogersii*, *Abutilon austro-africanum*, *Crossandra mucronata*, *Justicia flava*, *Cyphocarpa angustifolia*, *Blepharis integrifolia*, *Pupalea lappacea*, *Euphorbia neopolycnemoides*, *Sansevieria hyacinthoides* and *Achyranthus aspera*.

Some of the woody plant species that occur on the koppies in the landscape, strangely enough often concurs with vegetation expected on brackish soils. Such plants are: *Croton gratissimus*, *Schotia brachypetala*, *Sclerocarya caffra*, *Acacia nigrescens*, *Spirostachys africana* and *Lannea stuhlmannii*. Other woody species that occur on the koppies are: *Combretum hereroense*, *Ozoroa paniculosa*, *Ficus soldanella*, *Pterocarpus rotundifolius*, *Iboza riparia*, *Diospyros mespiliformis*, *Lannea discolor*, *Tricalysia allenii*, *Maytenus tenuispina*, and *Grewia hexamita*. Dominant grasses are *Panicum maximum* and *Digitaria eriantha* var. *pentzii*.

The soil is more clayey where dolerite intrusions occur and *Acacia nigrescens* is the dominant woody species. The grass cover is usually denser with grasses such as *Themeda triandra* and *Cymbopogon plurinodis* as the dominants.

The banks of the two large rivers in the landscape (Fig. 12) are densely overgrown with woody species and the following are the most common: *Ficus sycomorus*, *Breonadia microcephala*, *Nuxia oppositifolia*, *Combretum erythrophyllum*, *Diospyros mespiliformis*, *Acacia robusta*, *Trichilia emetica*, *Kigelia africana*, *Berchemia discolor* and *Ekebergia capensis*, while rare species such as *Anthocleista grandiflora* are also encountered here. The field layer is usually absent, but when present it is dominated by *Panicum maximum*.

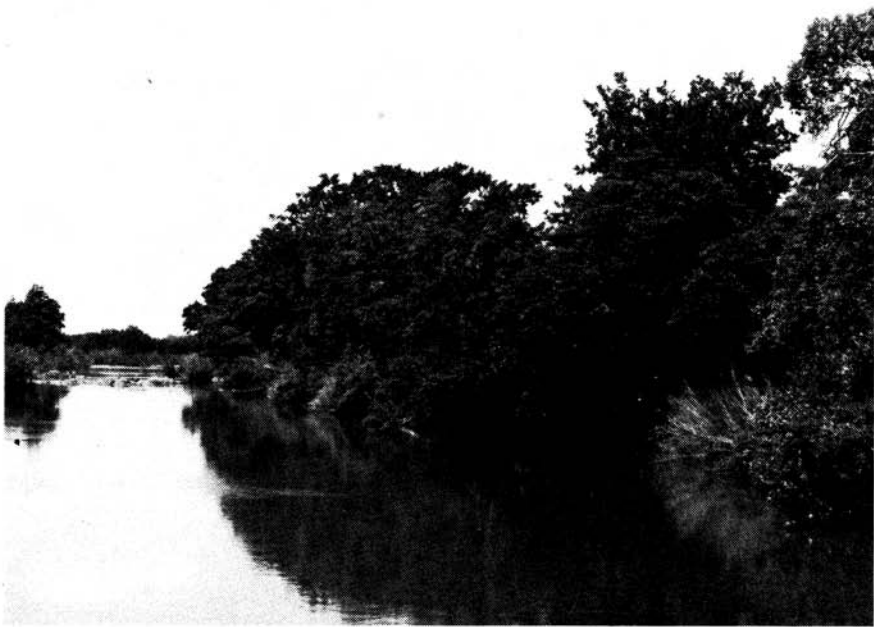


Fig. 12. Landscape 4. Sabie River, Riverine Vegetation.

Fauna

This landscape accommodates what is probably the largest impala population in the whole of the KNP. Other common game species present are kudu, duiker, steenbok, bushbuck and giraffe (*Giraffa camelopardalis*). During 1974 a number of red duiker (*Cephalophus natalensis*) were released in the dense riparian vegetation,

and in 1981 a number of nyalas (*Tragelaphus angasii*) from Natal were also released here. Elephants are frequently found in this landscape especially during the dry winter months and a herd of 80 are regularly found in the Nwatimhiri bush. Lion (*Panthera leo*), leopard (*Panthera pardus*), wild dog and spotted hyaena are the most important predators, especially the former two species are relatively abundant in this landscape. Buffalo bulls are sometimes present in the reeds of the river beds, but breeding herds only visit this landscape on route to water. Hippo (*Hippopotamus amphibius*) are plentiful in the rivers and contribute largely towards keeping the grass short.

5. Mixed *Combretum* spp./*Terminalia sericea* Woodland

Location and Geomorphology

This landscape is discontinuous due to the fact that it consists of two areas which are separated by Landscape 4 viz. the thickets of the Sabie and Crocodile Rivers. One portion of this landscape occurs in the southern district and the remainder forms the south western part of the Central District as far north as the Orpen/Timbavati area. The geological substrata are granite and gneiss with numerous dolerite intrusions which never exceed 10 metres in breadth (Schutte 1974). This landscape occurs mainly on or close to the watersheds and therefore includes only the upper courses of most spruits viz. the Mbyamite, Mlambane, Nwatimhiri and Nwatimwambu in the southern sub-region and the Nwatindlopfu, Nwaswitsontso, Sweni and Nwanedzi in the northern sub-region. The landscape is undulating with distinct uplands, ecotones and bottomlands. The altitude varies between 350 and 500 m and the landscape occupies 1 578 km² or 8,1 percent of the KNP.

Table 3
Temperature data for Satara
(Data collected since September 1981)
Temperature °C

Month	Average Daily Maximum	Absolute Maximum	Average Daily Minimum	Absolute Minimum
January	33,0	41,6	21,0	17,5
February	33,6	39,0	20,8	16,0
March	33,3	38,0	19,8	14,5
April	29,6	34,0	17,4	12,0
May	28,0	31,4	13,0	8,3
June	25,8	28,0	8,9	8,0
July	26,8	32,6	10,7	7,4
August	27,6	36,0	11,9	9,9
September	28,1	35,0	14,3	11,0
October	26,3	37,5	13,7	12,0
November	31,4	40,0	18,7	13,5
December	30,7	40,5	19,0	13,0

Climate

The landscape has a temperate climate with the occurrence of sporadic frost confined strictly to the bottomlands. The phenomenon of temperature inversions (Oosting 1956) is very distinct in this undulating landscape. During daytime higher temperatures are experienced in the bottomlands than on the uplands, but at night it becomes colder in the bottomlands. Table 3 gives the temperature data for Satara which is also applicable to this landscape. Rainfall varies between 550 and 600 mm per year with the average annual rainfall for Skukuza, Tshokwane and Kingfisherspruit 546,3, 561,3 and 582,3 mm respectively.

Soil pattern

This landscape has an interesting and most unique cantenary sequence of soils that correspond strongly with position in the topography. The upland soils are sandy with between 6 and 15 percent clay and the dominant soil Forms are Hutton and Clovelly with Portsmouth/Swartfontein and Denhere/Makuya respectively as the dominant Series. Where the slopes become steeper Glenrosa soils can be expected. Venter (1981) shows a diagrammatic representation of a cantena on granite which explains the situation in this landscape (Fig. 7). Where the convex topography changes into a concave topography conditions of temporary water saturation prevail and gleyed sandy soils are present (Cartref and Fernwood). Over a period of time an accumulation of clay has taken place in the bottomlands and therefore the soil in the bottomlands has become clayey, often sodium saturated with a massive prisma-cutanic structure in the underground horizons. Dominant soil Forms are Estcourt, Sterkspruit, Swartland and Valsrivier. Chemical and mechanical analysis of typical soils in the different positions in the topography are shown in Table 4.

Table 4
Chemical and mechanical analysis of soils in Landscape 5

Parent material	Granite		Granite		Granite	
Topography	Upland		Middleslope		Bottomland	
Soil Form	Clovelly		Cartref		Valsrivier	
Soil Series	Denhere		Kusasa		Valsrivier	
	A-Horizon	B-Horizon	A-Horizon	B-Horizon	A-Horizon	B-Horizon
% Sand	84	81	82	83	70	63
% Silt	6	5	7	8	11	6
% Clay	9	10	7	7	12	22
pH (H ₂ O)	6,2	5,6	5,9	6,1	6,0	6,6
P (ppm)	2	2	4	2	2	2
K (ppm)	40	20	80	20	60	20
Ca (ppm)	320	140	260	140	520	520
Mg (ppm)	208	50	196	116	266	306
Na (ppm)	140	40	80	80	640	140
Resistance (Ohm)	7 800	16 000	1 300	4 100	2 600	2 000

The banks of the spruits are formed by recent alluvial soils of which Oakleaf, Dundee and Inhoek are the most important Forms.

The frequent occurrence of dolerite intrusions in the granite of this landscape sometimes has the potential to obscure the catenary sequence, as described above. The soil on the dolerite intrusions is darker in colour (Mayo, Milkwood, Bonheim) and usually much more clayey (15 to 35 percent for the A-horizons). In the vicinity of a dolerite intrusion the weathered material from the dolerite and granite blends and it sometimes happens that the A-horizon originates from dolerite but the B-horizon from granite. These soils accommodate a heterogeneous vegetation that does not always fit in with the recurrent pattern (Mayo, Glenrosa).

Vegetation

The vegetation of this landscape is described under the following names: *Combretum*-veld (Van der Schijff 1957), Mixed *Combretum* Savanna Woodland (Pienaar 1963) *Combretum*-veld on Granite Undulations (Van Wyk 1973), Tropical Semi-Arid Granitic Lowveld (Coetzee 1983) and Arid Lowveld (Acocks 1975). It is an area with dense bush savanna vegetation on the uplands, open tree savanna in the bottomlands and with dense riverine vegetation on the banks of spruits and rivers.

The vegetation on the deep sandy soils of the uplands consist of a *Terminalia sericea*/*Combretum zeyheri*/*Combretum apiculatum*-community with a dense low and high shrub layer and few or no trees (Fig. 13). Dominant woody species are *Combretum apiculatum*, *C. zeyheri*, *Terminalia sericea*, *Strychnos madagascariensis*, *Commiphora africana*, *Cissus cornifolia*, *Dichrostachys cinerea* subsp. *africana*, *Sclerocarya caffra*, *Acacia exuvialis*, *Dalbergia melanoxylon*, *Lannea stuhlmannii*, *Pterocarpus rotundifolius*, *Acacia burkei*, *Peltophorum africanum*, *Ormocarpum trichocarpum* and *Ziziphus mucronata*.

Where the slopes become steeper and the soils more shallow, *Strychnos madagascariensis* disappears and larger trees such as *Sclerocarya caffra*, *Albizia harveyi* and *Brachylaena nigrescens* are found. The difference between the two variations of vegetation on the uplands is mainly due to the composition of the field layer. The field layer on the uplands of the landscape is dominated by *Pogonarthria squarrosa*, *Tricholaena monachne*, *Eragrostis rigidior*, *Rhynchelytrum repens*, *Trichoneura grandiglumis*, *Perotis patens*, *Brachiaria nigropedata*, *B. serrata*, *Aristida argentea*, *Digitaria eriantha* var. *pentzii*, *Panicum maximum*, *Aristida congesta* subsp. *barbicollis*, *A. meridionalis*, *Schmidtia pappophoroides*, *Urochloa mosambicensis*, *Enneapogon cenchroides* and *Heteropogon contortus*. The dominant forbs are *Tephrosia polystachya*, *Commelina bengalensis*, *Rhynchosia totta*, *Clerodendrum ternatum*, *Leucas glabrata*, *Evolvulus alsinoides*, *Cassia mimosoides*, *Waltheria indica*, *Indigofera filipes*, *Agathisanthemum bojeri*, *Kohautia virgata*, *Cassia absus*, *Merremia tridentata* and *Stylosanthus fruticosa*. The two variations of the community on the uplands are distinguished by the absence of *Strychnos madagascariensis* in the *Sclerocarya caffra*-variation and the following herbaceous plants are limited to the last named variation: *Ceratotheca triloba*, *Cyperus rupestris*, *Andropogon gyanus*, *Crotalaria virgulata*, *Hibiscus micranthus*, *Phyllanthus asperulatus*,



Fig. 13. Landscape 5. Upland Mixed *Combretum* spp./*Terminalia sericea* Woodland.



Fig. 14. Landscape 5. Bottomland Mixed *Combretum* spp./*Terminalia sericea* Woodland.

Brachiaria xantholeuca, *Cucumis africanus*, *Tragia dioica* and *Hermannia boraginiflora*.

On the ecotone or seepline where the convex topography changes to a concave topography, a dense fringe of *Terminalia sericea* trees occur. Other woody species present in this association are *Combretum zeyheri*, *C. apiculatum*, *Sclerocarya caffra*, *Maytenus heterophylla*, *Peltophorum africanum*, *Albizia harveyi* and *Acacia gerrardii*. The field layer is very similar to that of the uplands except that the following species are also present: *Eragrostis gummiflua*, *Hyperthelia dissoluta*, *Sporobolus fimbriatus*, *Cyperus* sp., *Fimbristylis complanata* and *Epaltes gariepina*.

The bottomlands of this landscape are open tree savanna with a dense grass cover if not overgrazed (Fig. 14). Gertenbach (*in prep.*) classifies it as an *Acacia nigrescens/Combretum apiculatum* association which is comparable to the vegetation of Landscape 4. Depending on the clay content of the soil and the degree of overgrazing the following two sub-associations in the bottomlands of this landscape can be differentiated viz. *Aristida barbicollis/Acacia nigrescens/Combretum apiculatum*-sub-association and the *Acacia gerrardii/Acacia nigrescens/Combretum apiculatum*-sub-association.

Dominant woody species for both these sub-associations are *Combretum apiculatum*, *Acacia nigrescens*, *Combretum hereroense*, *Dichrostachys cinerea* subsp. *africana*, *Grewia bicolor*, *Acacia gerrardii*, *Dalbergia melanoxylon*, *Lannea stuhlmannii*, *Ziziphus mucronata*, *Acacia tortilis*, *Pterocarpus rotundifolius*, *Cissus cornifolia*, *Combretum imberbe*, *Commiphora africana*, *Ormocarpum trichocarpum*, *Ehretia rigida*, *Albizia harveyi* and *Bolusanthus speciosus*. The difference between the two sub-associations is mainly determined by the composition of the field layer. Grasses normally present in both these sub-associations are *Digitaria eriantha* var. *pentzii*, *Panicum maximum*, *Aristida congesta* subsp. *barbicollis*, *Schmidtia pappophoroides*, *Urochloa mosambicensis*, *Heteropogon contortus* and *Enneapogon cenchroides*, but more specifically *Cymbopogon plurinodis*, *Eragrostis superba*, *Bothriochloa radicans* and *Eragrostis rigidior*. In the *Aristida barbicollis*-sub-association *Aristida congesta* subsp. *barbicollis*, *Pogonarthria squarrosa* and *Andropogon gayanus* are more dominant, while *Themeda triandra*, *Urochloa brachyura* and *Panicum coloratum* are more dominant in the *Acacia gerrardii*-sub-association.

Characteristic forbs of both the sub-associations of the bottomlands of this landscape are *Waltheria indica*, *Asparagus plumosus*, *Blepharis integrifolia*, *Pavonia patens*, *Hibiscus micranthus*, *Phyllanthus asperulatus*, *Tragia dioica*, while more common species such as *Tephrosia polystachya*, *Commelina bengalensis*, *Rhynchosia totta*, *Clerodendrum ternatum*, *Cyphocarpa angustifolia* and *Leucas glabrata* also occur. The banks of the spruits have a dense, mostly evergreen, forest community with the following dominant species: *Diospyros mespiliformis*, *Combretum imberbe*, *Acacia robusta*, *Euclea divinorum*, *Lonchocarpus capassa*, *Schotia brachypetala*, *Cassine aetiopica* and *Spirostachys africana*. Dominant grasses are *Panicum maximum*, *Digitaria eriantha* var. *pentzii*, *Sporobolus fimbriatus* with *Abutilon guineense* as the most common forb.

On the numerous dolerite intrusions that occur in the granite, the woody vegetation immediately becomes more sparse with a denser grass cover. *Acacia nigrescens* usu-

ally occurs in denser stands and *Bolusanthus speciosus* is a good indicator of doleritic soils. Dominant grasses are *Themeda triandra*, *Bothriochloa radicans* and *Cymbopogon plurinodis*. The plant communities on dolerite can be compared to that of Landscape 19 viz. Thornveld on Gabbro and it is also similar to that occurring in the bottomlands of the landscape.

Fauna

Time has shown this landscape to be ideal habitat for sable antelope, while kudu and giraffe are well represented. Zebra occur in smaller groups but wildebeest are restricted to dolerite intrusions or brackish soils with sparse grass cover. Elephant and buffalo are commonly found and impala are limited to the spruits where water is available. Small game such as steenbok and duiker are dispersed throughout the landscape. Warthogs (*Phacochoerus aethiopicus*) are plentiful in the brackish bottomlands where surface water is available. Carnivores such as lion and leopard are present.

6. *Combretum* spp./*Colophospermum mopane* Woodland of the Timbavati-area

Location and Geomorphology

This landscape is located in the triangle formed by the Olifants River, Timbavati River and the western boundary of the KNP. The substratum is mainly granite and gneiss intersected by numerous intrusions of dolerite. This landscape is also intersected by a large gabbro-body which is classified as a separate landscape (Landscape 19). Amphibolite from the Swaziland System occur extensively throughout this landscape (Schutte 1982) and have an important influence on the soil and vegetation. The terrain is undulating and is drained by the tributaries of the Timbavati River of which the Shisakashanghondo, Chalons, Brak, Mbhanswe and Mshatu spruits are the most important.

The altitude of this landscape varies between 300 and 500 metres and it occupies 469,3 km² or 2,4 percent of the KNP.

Climate

This landscape is subject to a temperate climate with hot summers and cool winters with frost as an exception in the low lying areas. Compare Table 3 for temperature data. Rainfall varies between 450 and 550 mm per year (Kingfisherspruit 582,3 mm, Letaba 462,2 mm) (Gertenbach 1980).

Soil pattern

The soil pattern of the *Combretum* spp./*Colophospermum mopane* Woodland of the Timbavati-area is, to a limited extent, similar to that of the Mixed *Combretum* spp./*Terminalia sericea* Woodland (Landscape 5). As a result of the lower rainfall and the influence of the Swaziland System the uplands are less sandy with Hutton-/Zwartfontein, Clovelly/Denhere and Glenrosa/Dunvegan as the dominant soils. The seep line is usually absent and the soil becomes increasingly more clayey with the movement towards the bottomlands. The common soils for the middleslopes are Glenrosa, but the more clayey series occur in the bottomlands viz. Dothole and



Fig. 16. Landscape 6. Bottomland *Combretum* spp./*Colophospermum mopane* Woodland of the Timbavati-area.

Woody species typical of the middle-and footslopes are again *Colophospermum mopane* (Fig. 16) with less *Combretum apiculatum* and species such as *Ormocarpum trichocarpum*, *Acacia gerrardii*, *A. nigrescens*, *Euclea divinorum*, *Bolusanthus speciosus*, *Combretum hereroense*, *C. imberbe*, *Terminalia prunioides*, *Grewia bicolor*, *Maerua parvifolia* and *Ximenia caffra*.

Herbaceous plants in the field layer which are common for the uplands and bottomlands of this landscape are *Pogonarthria squarrosa*, *Eragrostis rigidior*, *Aristida congesta* subsp. *barbicollis*, *Digitaria eriantha* var. *pentzii*, *Panicum maximum*, *Enneapogon cenchroides*, *Heteropogon contortus*, *Schmidtia pappophoroides*, *Urochloa mosambicensis*, *Indigofera floribunda*, *Rhinacanthus rotundifolius*, *Cyphocarpa angustifolia*, *Rhynchosia totta*, *Indigofera bainesii*, *Tephrosia polystachya*, *Ruellia patula*, *Asparagus plumosus*, *Corchorus asplenifolius* and *Hibiscus micranthus*. Species associated with the above-mentioned plants and occurring only on the uplands are *Tricholaena monachne*, *Rhynchelytrum repens*, *Brachiaria serrata*, *Trichoneura grandiglumis*, *Waltheria indica*, *Evolvulus alsinoides*, *Euphorbia neopolycnemoides*, *Kohautia virgata*, *Agathisanthemum bojeri* and *Fimbristylis complanata*. Characteristic herbaceous species for the bottomlands are *Themeda triandra*, *Cymbopogon plurinodis*, *Eragrostis gummiflua*, *E. superba*, *Panicum coloratum*, *Bothriochloa radicans*, *Dyschoriste rogersii*, *Pavonia patens*, *Vernonia fastigiata* and *Abutilon austro-africanum*.

Riverine vegetation is comparable from landscape to landscape and the following plant species are typical of spruits for landscapes 6, 8, 9, 10 and 11 (Fig. 17): *Colophospermum mopane*, *Combretum imberbe*, *C. hereroense*, *Lonchocarpus capassa*, *Acacia robusta*, *Albizia harveyi*, *Diospyros mespiliformis*, *Schotia brachypetala*, *Euclea natalensis*, *Ziziphus mucronata*, *Dalbergia melanoxylon*, *Lannea stuhlmannii* and *Euclea diviurum*. Dominant plants in the field layer are *Panicum maximum*, *Urochloa mosambicensis*, *Cenchrus ciliaris*, *Abutilon ramosum*, *A. guineense*, *Justicia flava*, *Pupalea lappacea* and *Achyranthes aspera*.



Fig. 17. Landscape 6. Stream bank *Combretum* spp./*Colophospermum mopane* Woodland of the Timbavati-area.

The dolerite intrusions that occur in the granite are not very broad, but as a result of the mixing of the weathered material of dolerite and granite the influence of the dolerite is sometimes bigger than can be expected. The vegetation structure on these soils derived from dolerite and amphibolite are much the same. It is usually an open savanna with large *Colophospermum mopane* trees, a moderate shrub layer of 1 to 1,5 metres high and a dense grass cover of *Bothriochloa radicans*, *Themeda triandra*, *Cymbopogon plurinodis*, *Heteropogon contortus* and *Eragrostis superba*. The vegetation on the dolerite intrusions are also comparable to that of the granitic bottomlands.

Fauna

The landscape is suitable habitat for sable antelope, elephant, buffalo, kudu and impala close to the spruits. Zebra occur regularly but in smaller groups of about six individuals. Giraffe are not very common in the mopane-veld, but do occur where the veld is more mixed. Due to the density of the woody vegetation there is a relatively low density of plains preferring game.

7. Olifants River Rugged Veld

Location and Geomorphology

This landscape includes the direct drainage area adjoining the Olifants River, from the western boundary of the KNP to approximately the sandstone koppies at Shiswayini. To the north it extends to about the Letaba/Phalaborwa powerline and southwards to the northern boundary of the neighbouring area of Peru. It is a strongly undulating terrain with steep slopes and a great number of small spruits which drain into the Olifants River. Among the most important are the Tshutsi, Mulalane, Misumane, Manyukelani from the north and the Klaseri, Tseri, Nhlaralume and Mvubuspruits from the south. According to Schutte (1982) the parent material of the area comprises metamorphic rock such as amphibolite, serpentine, quartzite, quartz-schist and other rocks of Swazium age.

The altitude varies a lot but the greater portion of the landscape is situated between 250 and 300 metres. In the north-western part of this area the uplands can reach 400 metres above sea level. The landscape occupies 360 km² or 1,8 percent of the KNP.

Climate

This landscape is relatively dry with a rainfall of between 450 and 500 mm per year. The dryness of the area is accentuated by the steep slopes and shallow soils. High temperatures are experienced during the summer months and a temperature of 40° C at Letaba is not uncommon. Frost sometimes occurs during the winter but is limited to the low lying areas. Table 5 provides the temperature data for Letaba which is largely applicable to this landscape.

Table 5
Temperature data for Letaba
(Data collected since September 1981)

Temperature °C				
Month	Average Daily Maximum	Absolute Maximum	Average Daily Minimum	Absolute Minimum
January	34,0	42,2	22,0	17,3
February	34,9	42,3	21,5	17,7
March	34,3	39,5	20,5	15,4
April	33,4	39,5	19,4	14,0
May	28,6	33,0	12,6	7,7
June	26,7	33,0	8,0	4,0
July	26,7	34,0	10,4	3,0
August	28,9	38,4	11,3	5,5
September	27,8	35,5	12,9	8,3
October	27,3	39,8	14,0	12,5
November	33,3	42,6	19,0	13,8
December	32,4	43,0	19,1	18,0

Soil Pattern

The soils of this landscape are shallow and stony and can only be described by the term lithosols. Shallow Mispah and Glenrosa soils also occur. The shallow soil is a result of steep slopes and a relatively stable parent material. Loose rocks of all sizes are present on the surface.

Vegetation

As a result of the steep slopes and shallow stony soil, the landscape is relatively dry and the vegetation shows xerophytic characteristics (Fig. 18). The field layer, especially, is very sparse and never develops a stable grass cover even under circumstances of no grazing. The woody component is usually not higher than 5 metres and can sometimes be quite dense. The reason for the relative high density of the woody component lies in the absence of regular fires. Woody plants that dominate the landscape are as follows: *Combretum apiculatum*, *Colophospermum mopane*, *Commiphora mollis*, *C. africana*, *Terminalia prunioides*, *Grewia villosa*, *Boscia albitrunca*, *Acacia nigrescens*, *Combretum hereroense*, *Albizia harveyi*, *Cissus cornifolia*, *Dichrostachys cinerea* subsp. *africana*, *Grewia bicolor*, *Sclerocarya caffra*, *Dalbergia melanoxylon*, *Lannea stuhlmannii*, *Maerua parvifolia*, *Rhigozum zambesiaccum*, *Zanthoxylum humilis*, *Ziziphus mucronata*, *Combretum imberbe*, *Acacia nilotica*, *Securinega virosa*, *Acacia exuvialis*, *Maytenus heterophylla*, *Ozoroa engleri*, *Tricalysia allenii*, *Grewia flavescens* and *Pappea capensis*. As a result of the variation in habitat a variety of trees occur here which are relatively scarce in the KNP. Species that can be mentioned are *Holmskioldia tettensis*, *Kirkia wilmsii*, *Ficus smutsii*, *Olex dissitiflora*, *Hexalobus monopetalus*, *Albizia anthelmintica*,

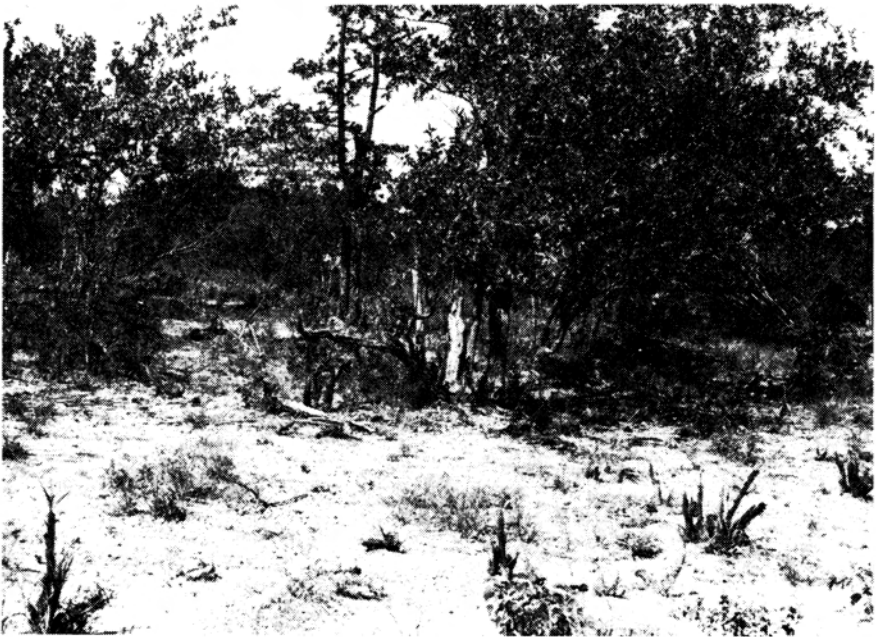


Fig. 18. Landscape 7. Olifants River Rugged Veld.

A. brevifolia, *Garcinia livingstonei* and *Bridelia micrantha*. Species differentiating the field layer are *Melhania forbesii*, *Justicia kraussii*, *Sporobulus panicoides*, *Bidens pilosa*, *Calostephane divaricata*, *Hemizygia elliotii*, *Hibiscus sidiformis* and *Ocimum americanum*. A rare species of grass, *Schizachyrium exile* also occurs in this landscape. *Sansevieria hyacinthoides* is common in this as in all other rugged veld in the KNP.

The field layer seldom develops further than the pioneer stage and the grasses which normally dominate are *Rhynchelytrum repens*, *Sporobulus panicoides*, *Bothriochloa radicans*, *Digitaria eriantha* var. *pentzii*, *Panicum maximum*, *Aristida congesta* subsp. *barbicollis*, *Brachiaria xantholeuca*, *Enneapogon cenchroides*, *Tragus berteronianus*, *Fingerhutia africana*, *Aristida congesta* subsp. *congesta*, *Enteropogon monostachus*, *Aristida curvata*, *Oropetium capense* and *Cymbopogon plurinodis*. Forbs, on the other hand, are relatively common and the following species dominate: *Hibiscus sidiformis*, *Melhania forbesii*, *Hemizygia elliotii*, *Xerophyta retinervis*, *Achyranthus aspera*, *Justicia kraussii*, *Asparagus plumosus*, *Bidens pilosa*, *Crabbea velutina*, *Melhania rehmannii*, *Hibiscus micranthus*, *Phyllanthus asperulatus*, *Heliotropium steudneri*, *Mariscus rehmannianus*, *Tephrosia polystachya*, *Commelina bengalensis*, *Cyphocarpa angustifolia*, *Corchorus asplenifolius*, *Solanum panduraeforme*, *Calostephane divaricata*, *Waltheria indica* and *Abutilon austro-africanum*.

Fauna

A large variety of game occurs in this landscape despite the sparse veld. Elephant are regularly found along the Tshutshi and Manyukelani, while zebra are common but in small groups. Impala are plentiful along the rivers, but buffalo herds only move sporadically into the area. Giraffe, kudu and waterbuck (*Kobus ellipsiprymnus*) are relatively abundant. A herd of sable antelope are also found in this landscape every year during the aerial census. Lion, leopard and spotted hyaena are the most important carnivores.

8. Phalaborwa Sandveld

Location and Geomorphology

- * This landscape occupies the largest portion of the watershed between the Olifants and Letaba Rivers. It is high lying (between 350 and 450 metres) and the underlying material consists mainly of granite and gneiss. Isolated plugs of syenite from the Phalaborwa Igneous Complex have penetrated into the granite to form koppies of which Masorini, Shishwani, Shikumbu, Shivulani and Vodogwa are the most outstanding. The area is situated on the upper courses of a few spruits that drain into the Letaba and Olifants Rivers. Most important of these are the Tshutsi, Mulalane and Misumane which drain into the Olifants River and the Malopene, Ngwenyeni and Nwanedzi into the Letaba River. This undulating landscape occupies 396 km² or 2 percent of the KNP.

Climate

As a result of the higher altitude of this landscape the rainfall increases slightly. Letaba, to the east of this area has an annual rainfall of 462 mm, while Phalaborwa

receives 481 mm per year. High temperatures are registered during the summer and frost is generally non-existent in the winter because of the relatively higher altitude.

Soil Pattern

The soil pattern of the landscape is much the same as that of Landscapes 5, 6 and 11. The soils on the uplands are sandy, light-yellow to grey in colour and belong mainly to the Clovelly Form. The clay contents of the A-horizon is less than 10 percent.

As a result of the lower rainfall the seepline is poorly developed, if at all present. Normally the soils becomes gradually more clayey towards the bottomlands with dominant Forms Glenrosa, Valsrivier and Sterkspruit.

Two important characteristics of this landscape are firstly, the occurrence of large numbers of termite mounds on the uplands. These mounds are comprised of light grey soil and are clearly visable on aerial photographs. Secondly, the syenite plugs form prominent koppies which give a unique appearance to the landscape. The soil on the koppies is shallow and can be described as lithosols.

Vegetation

The vegetation on the uplands of this landscape is dominated by *Terminalia sericea* (Fig. 19). Depending on the clay content of the soil the following species occur in association with *Terminalia sericea*, *Combretum apiculatum*, *Colophospermum mopane*, *Peltophorum africanum*, *Tephrosia sericea*, *Dalbergia melanoxylon*, *Strychnos madagascariensis*, *Albizia harveyi*, *Commiphora africana*, *Grewia bicolor*, *Lannea stuhlmannii*, *Cissus cornifolia*, *Dichrostachys cinerea* subsp. *africana*, *Sclerocarya caffra*, *Ozoroa engleri* and *Ziziphus mucronata*. *Combretum zeyheri* and *Pseudolachnostylis maprouneifolia* are also present on the heavily leached sandy uplands.



Fig. 19. Landscape 8. Upland Phalaborwa Sandveld with termite mound.

As the soil becomes more clayey towards the bottomlands (Fig. 20), *Terminalia sericea* disappear together with a few of the above-mentioned species which occur on sandy soils. Woody species more common in the bottomlands are: *Colophospermum mopane*, *Acacia nigrescens*, *Combretum hereroense*, *Acacia tortilis*, *Bridelia mollis*, *Cassia abbreviata*, *Lonchocarpus capassa*, *Grewia flavescens*, *Acacia exuvialis*, *Maerua parvifolia*, *Euclea divinorum*, *Securinea virosa*, *Acacia gerrardii* and *Ximenia caffra*.

Dominant species in the field layer of the landscape are *Digitaria eriantha* var. *pentzii*, *Pogonarthria squarrosa*, *Andropogon gayanus*, *Brachiaria nigropedata*, *Panicum maximum*, *Eragrostis rigidior*, *Schmidtia pappophoroides*, *Aristida congesta* subsp. *barbicollis*, *Heteropogon contortus*, *Cassia absus*, *Hemizygia elliotii*, *Clerodendrum ternatum*, *Cyphocarpa angustifolia*, *Evovulus alsinoides*, *Kohautia virgata*, *Tephrosia polystachya* and *Limeum fenestratum*.

The following species are more typical of the field layer on the uplands: *Aristida argentea*, *A. meridionalis*, *Perotis patens*, *Trichoneura grandiglumis*, *Rhynchelytrum repens*, *Tricholaena monachne*, *Ipomoea magnusiana*, *Crotalaria schinzii*, *Merremia tridentata*, *Polygala sphaenoptera*, *Oxygonum alatum*, *Hemizygia bracteosa*, *Tephrosia longipes*, *Agathisanthemum bojeri*, *Arthrosolon serricocephalus*, *Striga bilabiata*, *Jatropha zeyheri* and *Aptosimum lineare*. Differentiating species of the field layer in the bottomlands are: *Enneapogon cenchroides*, *Urochloa mosambicensis*, *Cymbopogon plurinodis*, *Tragus berteronianus*, *Aristida congesta* subsp. *barbicollis*, *Panicum coloratum*, *Brachiaria xantholeuca*, *Eragrostis superba*, *Bothriochloa radicans*, *Urochloa brachyura*, *Themeda triandra*, *Corchorus asplenifolius*, *Ceratotheca triloba*, *Heliotropium steudneri*, *Cucumis africanus*, *Solanum panduraeforme*, *Melhaniea forbesii*, *Orthosiphon australis*, *Crotalaria virgulata*, *Blepharis integrifolia*, *Hermannia odorata* and *Asparagus plumosus*.



Fig. 20. Landscape 8. Bottomland Phalaborwa Sandveld.

The koppies in the landscape give a unique character to the surroundings (Fig. 21). The plants occurring on the koppies are usually also unique and the following woody species are noted: *Kirkia acuminata*, *Steganotaenia araliacea*, *Homalium dentatum*, *Sclerocarya caffra*, *Combretum apiculatum*, *Maerua angolensis*, *Berchemia discolor*, *Ficus soldanella*, *Commiphora mollis*, *Manilkara mochisia*, *Sterculia rogersii* and *Croton gratissimus*. The riverine vegetation is the same as that described in Landscape 6.

Fauna

The *Terminalia sericea* sandveld is preferred habitat for sable antelope. They occur fairly generally in this landscape and represent one of the highest concentrations of this species in the KNP. Buffalo occur in large herds, but elephants are usually represented by lone bulls. Kudu, impala and giraffe are well represented, but warthog especially are plentiful in the brackish spots around Phalaborwa. The presence of zebra is determined by whether the veld was burnt the previous year or not. The danger exists of an increased zebra population becoming a threat to the sable. Small game such as steenbok and duiker occur predictably and each koppie has its own one or two pairs of klipspringer. It is interesting to note that the koppies in this landscape form an important habitat for dassies (*Procavia capensis*). Further south in the KNP this species occurs only on the Lebombo mountains and in an isolated spot at Ntlokweni in Landscape 2.

Termitaria in this area, as in many other landscapes on granite, have an interesting vegetation. There are three species of termites which occur in the KNP viz. *Macrothermes bellicosus*, *M. natalensis* and *M. swaziae*. The former two species build sharply pointed termite mounds that normally have no vegetation cover. The latter species builds a rounded mound with a very interesting vegetation composition. It would appear that the plant species occurring on the termite mounds normally have an affinity for sodic soils. Such species are *Euclea divinorum*, *Ehretia rigida*, *Rhus spinescens* and *Spirostachys africana*. It could possibly be that these species bear an edible fruit that have been transported to the mounds by birds. The most common species of grass found on termite mounds are *Cenchrus ciliaris*,



Fig. 21. Landscape 8. Shishwani, a syenite plug.

Chloris roxburghiana and *Enneapogon cenchroides*. The fact remains that these termite mounds make an important contribution to the physiognomy of the landscape.

9. *Colophospermum mopane* Savanna on Basic Soils

Location and Geomorphology

The parent material underlying this landscape is mainly amphibolite from the Swaziland System and to a lesser degree granite and gneiss mixed with weathered material from gabbro and dolerite (Schutte 1974). It is a relatively flat landscape in comparison with the adjacent undulating terrain on granite. This area is situated north of the old Letaba/Phalaborwa tourist road and south of the Letaba River, excluding the direct southerly drainage to the Letaba River. It is drained by the Ngwenyeni, Malopene and Nwanedzi spruits, and is situated between 300 and 380 metres above sea level. This landscape occupies 546 km² or 2.8 percent of the KNP.

Climate

There is no reason to believe that the climate of this landscape differs much from Landscapes 8 and 10. Surrounding weather stations and their annual average rainfall are Mahlangene 490 mm, Phalaborwa 481 mm, Letaba Ranch 487 mm and Letaba 471 mm (Gertenbach 1980). As a result of the flat terrain the possibility of frost in winter is poor (See Table 5 for temperature data).

Soil Pattern

Considering that this landscape is reasonably flat, there is no great variation in soil types. There is a gradation in the clay content of the soil from the uplands to the bottomland areas with the more clayey soils occurring in the latter. The soil is normally red in colour and the following soil Forms and series can be expected: Glenrosa/Dunvegan — Lomondo — Dothole — Achterdam — Ponda and Hutton/Malonga — Vergenoeg — Shigalo — Hardap. A characteristic of this landscape is the presence of small pans which once again indicates that the landscape is reasonably flat. It sometimes happens that weathered granite mix with material originating from the great gabbro sills that intersect the landscape. In such cases soils of the Mayo Form can be expected.

Vegetation

The vegetation of this landscape is an open savanna with a sparse shrub layer and a relatively dense grass cover (Fig. 22). The structural analysis of the woody component of the landscape is approximately as follows:

Stratum	Percentage Crown Cover
5 - 10 metres	1
2 - 5 metres	12
1 - 2 metres	5
0,5 - 1 metre	3
Field layer	80
	41



Fig. 22. Landscape 9. *Colophospermum mopane* Savanna.

The woody vegetation is dominated by *Colophospermum mopane*. *Combretum apiculatum* occurs commonly where the soil is more sandy, but disappears completely on clayey soils. Other associated woody species are: *Acacia nigrescens*, *Cissus cornifolia*, *Combretum imberbe*, *Ozoroa engleri*, *Maerua parvifolia*, *Albizia harveyi*, *Lannea stuhlmannii*, *Grewia bicolor*, *Neorautanenia amboensis* and *Commiphora africana*. The vegetation of this landscape shows similarity to the vegetation on granite bottomlands and also with vegetation of dolerite intrusions. The field layer is dense with the following dominant grasses: *Bothriochloa radicans*, *Themeda triandra*, *Digitaria eriantha* var. *pentzii* and *Heteropogon contortus*. Other associated grass species are *Pogonarthria squarrosa*, *Schmidtia pappophoroides*, *Panicum coloratum*, *P. maximum*, *Urochloa mosambicensis*, *Eragrostis superba* and *Aristida congesta* subsp. *barbicollis*. The following forbs occur regularly: *Seddera capense*, *Cassia mimosoides*, *Crotalaria virgulata*, *Rhynchosia totta*, *Phyllanthus asperulatus*, *Corchorus asplenifolius*, *Hibiscus micranthus* and *Cucumis hirsutus*. The riverine vegetation is comparable to that of Landscape 6.

Fauna

This landscape provides ideal habitat for game preferring plains. The only herd of roan antelope in the central KNP occurs in this landscape and on the adjacent gabbro intrusions. Eland (*Taurotragus oryx*), another relatively rare game species in the KNP is also encountered here. Quite a few groups of wildebeest are present and zebra are common and usually found in larger groups. Browsers such as kudu and giraffe are not well represented and impala may be sporadically found in this landscape close to water. This landscape is ideal for buffalo but elephant are generally less common. As a result of a large number of veld pans, water is reasonably

available until late into the dry season and therefore warthog are very common in this landscape. Interesting to note is that sable antelope which are plentiful in the adjoining landscapes are not present here.

10. Letaba River Rugged Veld

Location and Geomorphology

This landscape includes the whole western drainage to the Letaba and Klein Letaba Rivers. It occupies 700 km² or 3,6 percent of the KNP and is comparable to Landscape 7 viz. Olifants River Rugged Veld. The slopes are relatively steep and there are quite a few prominent koppies viz. Ngodzi, Kaleka, Milavamhisi, Munamungwe and Byashishi koppies. The drainage takes place via the Shipikane, Byashishi and Tsende to the Letaba and Klein Letaba Rivers. The underlying material is granite, gneiss and Swaziland rock formations like amphibolite, serpentine and schist (Schutte 1974). Although the landscape is comparable to the Olifants River Rugged Veld as far as the vegetation is concerned, it is different as far as the geology and terrain formation is concerned. The Letaba River Rugged Veld is less dissected and the slopes less steep. The area is nevertheless naturally dry and the altitude varies between 250 and 400 metres with the Ngotsekop as the highest point viz. 473 metres.

Climate

This landscape experiences a dry climate, the result of a low rainfall (450 to 500 mm per year), steep slopes and shallow soils. The summers are very hot and the winters mild with frost as the exception in the bottomlands. Average monthly maximum and minimum temperatures for Letaba are given in Table 5.

Soil Pattern

The soils of this landscape are shallow and stony and can be classified as lithosols. Other soil Forms that can be expected are Mispah, Glenrosa and Hutton. Where the influence of the Swaziland rock formation is strong the soil is normally red in colour, the slopes are not as steep and the soils are deeper than on the adjacent granites.

Vegetation

The vegetation of this landscape is very similar to that of the Olifants River Rugged Veld (Landscape 7) and also includes certain elements of the vegetation of the Thickets of the Sabie and Crocodile Rivers (Landscape 4). The woody vegetation is usually dense in the shrub layer with single trees (Fig. 23). Dominant woody species are *Colophospermum mopane*, *Combretum apiculatum*, *Terminalia prunioides*, *Grewia* spp., *Rhigozum zambesiaceum* and *Dichrostachys cinerea* subsp. *africana*. Other species that occur here are the same as those of the Olifants River Rugged Veld.

The field layer is sparse and is dominated by annual grasses and forbs such as: *Aristida congesta* subsp. *barbicollis*, *Enneapogon cenchroides*, *Melhanian forbesii*,



Fig. 23. Landscape 10. Letaba River Rugged Veld.



Fig. 24. Landscape 10. Riverine vegetation, Letaba River.

Phyllanthus asperulatus, *Heliotropium steudneri* and *Solanum panduraeforme*. The grey perennial forb *Hemizygia elliotii* and *Xerophyta retinervis* are typical plants for this dry landscape. Refer to Landscape 7 for a complete list of plants which are also found in the field layer of this landscape. The stream banks of the Letaba River (Fig. 24) are more open than the Olifants River (Landscape 7), but the species occurring are the same.

Fauna

A large variety of game is found in this landscape of which elephant, buffalo, zebra, impala and giraffe are the most important. Waterbuck are plentiful along the Letaba River and the area possibly accommodates the largest population of the species in the KNP. Baboon, warthog and steenbok also occur regularly. White rhino are also present in this landscape, since a group of \pm four animals are encountered every year in the vicinity of Tsale windmill. Sable antelope are found in the far eastern and northern areas of this landscape and eland are often seen along the Mooiplaas/Phalaborwa service road. A small group of \pm 15 wildebeest occur on the brackish spots in the vicinity of Tsale windmill. Elephant are present in large herds along the Letaba and the Shipikane spruit is a popular environment for breeding herds. South of Ngotsikop elephants are encountered and the confluence of the Klein Letaba and Byashishi accommodates what is possibly the largest and most stable breeding herd of elephant in the KNP. Spring hare (*Pedetes capensis*) are present along the Letaba River.

11. Tsende Sandveld

Location and Geomorphology

This landscape forms the high lying area between the Letaba and Shingwedzi Rivers on the western side of the KNP. North of the Shingwedzi the landscape is discontinuous with sub-sections right up to the Mphongolo River. This landscape is undulating granite terrain with distinct uplands and bottomlands. Amphibolite from the Swaziland System occurs fairly regularly and the remainder of the landscape is intersected by numerous dolerite intrusions. An interesting phenomenon about the dolerite intrusions is that they have a south-west/north-east orientation. This is explained by the theory that, as a result of the eastward movement of a portion of the African continent, a downward pressure is being exerted on the eastern edge of the continent which has resulted in a south-west/north-east tension. A result of this tension was that cracks formed into which the melted magma has entered to cause the south-west/north-east orientated dolerite intrusions (Brandt 1948; Schutte 1974).

The topography of the landscape is similar to that of the Phalaborwa Sandveld (Landscape 8). It is drained by the Shingwedzi with all its tributaries, the Tsende, the Byashishi and to a lesser degree the Phugwane and Mphongolo. The altitude varies between 300 and 450 metres and an important characteristic of the landscape is the absence of prominent koppies. On the other hand, veldpans are a very common phenomenon and can be seen as a unique characteristic. The following large pans occur in this landscape: Mahubyeni, Mtomene, Mhlatuba, Tol-se-Pan, Basa-Basa, Olifantbadpan and Uitspan. This landscape occupies 1 156 km² or 5.9 percent of the KNP.

Climate

According to Gertenbach (1980) this area receives between 450 and 550 mm rain per year. Shangoni in the north-western corner of this landscape has an annual average rainfall of 572 mm and it can be concluded that this landscape, as a result of orographical conditions, receives more rain than the adjacent Letaba River Rugged Veld (Landscape 10). Due to the high altitude of this area frost is the exception. Average monthly maximum and minimum temperatures for Shingwedzi are given in Table 6.

Table 6

Temperature data for Shingwedzi
(Data collected since September 1981)

Temperature °C

Month	Average Daily Maximum	Absolute Maximum	Average Daily Minimum	Absolute Minimum
January	34,3	42,5	21,7	17,0
February	33,9	43,2	21,2	16,5
March	33,2	39,7	20,0	13,7
April	30,4	35,0	17,4	11,5
May	26,8	31,8	11,5	6,5
June	25,8	28,5	6,7	4,1
July	25,9	33,5	9,2	3,0
August	28,3	37,2	10,6	5,0
September	27,8	34,6	12,9	7,2
October	27,3	38,9	14,0	8,2
November	33,3	42,0	19,0	13,4
December	32,4	42,0	19,1	15,4

Soil Pattern

The soil pattern of the landscape is comparable to that of landscapes 5, 6 and 8. The soils of the uplands are sandy with less than 15 percent clay in the A-horizon. The dominant soil Forms are Hutton, Clovelly and Glenrosa. The seepline is poorly developed to absent and the soils of the bottomlands are more clayey, with the dominant Forms being Valsrivier, Sterkspruit, Glenrosa with Estcourt as an exception.

The soils originating from amphibolite of the Swaziland System are deeper and red in colour. Dominant soil Forms are Hutton and Glenrosa with the more clayey series most common. Soils that develop on dolerite can be red or even black in colour. Expected soil Forms are Swartland, Glenrosa, Hutton, Mayo and Milkwood.



Fig. 25. Landscape 11. Upland Tsende Sandveld.



Fig. 26. Landscape 11. Bottomland Tsende Sandveld.

Vegetation

The vegetation on the uplands of this landscape is moderately high shrub savanna with single large trees (Fig. 25). The structural analysis of the vegetation of an upland, middleslope and a bottomland is more or less as follows:

Stratum	Percentage Crown Cover		
	Upland	Middleslope	Bottomland (brack)
5 - 10 metres	2	6	4
2 - 5 metres	12	8	10
1 - 2 metres	8	4	6
0,5 - 1 metre	1	3	1
Field layer	75	80	50

The dominant woody plants of this landscape are: *Colophospermum mopane* and *Combretum apiculatum*. On the sandy uplands the latter is more dominant. However, moving towards the bottomlands the soil becomes more clayey and *Combretum apiculatum* gives way to *Colophospermum mopane* (Fig. 26). Plants more common to the uplands are *Combretum apiculatum*, *Colophospermum mopane*, *Cissua cornifolia*, *Albizia harveyi*, *Tephrosia sericea*, *Terminalia sericea*, *Grewia bicolor*, *Dichrostachys cinerea* subsp. *africana*, *Sclerocarya caffra*, *Dalbergia melanoxylon*, *Peltophorum africanum*, *Strychnos madagascariensis* and *Commiphora africana*.

The field layer is dense, approximately 750 mm high and is dominated by *Digitaria eriantha* var. *pentzii*, *Panicum maximum*, *Heteropogon contortus*, *Pogonarthria squarrosa*, *Schmidtia pappophoroides*, *Tephrosia polystachya*, *Cassia absus* and *Cyperus rupestris*. Other species in the field layer are: *Brachiaria nigropedata*, *Aristida meridionalis*, *Perotis patens*, *Eragrostis rigidior*, *Tricholaena monachne*, *Rhynchelytrum repens*, *Bothriochloa radicans*, *Aristida congesta* subsp. *barbicollis*, *Andropogon gayanus*, *Vigna stenolobum*, *Dolichos trilobus*, *Agathisanthemum bojeri*, *Cassia mimosoides*, *Clerodendrum ternatum*, *Phyllanthus asperulatus*, *Rhynchosia totta*, *Talinum caffrum*, *Ipomoea magnusiana*, *Indigofera filipes*, *Merremia tridentata*, *Hemizygia bracteosa*, *Tephrosia longipes*, *Jatropha zeyheri*, *Evolvulus alsinoides* and *Fimbristylis complanata*.

Woody plants in the bottomlands are *Colophospermum mopane*, *Combretum apiculatum*, *Lonchocarpus capassa*, *Grewia monticola*, *Acacia nigrescens*, *Combretum hereroense*, *Acacia tortilis*, *Bridelia mollis*, *Grewia bicolor*, *Cassia abbreviata*, *Grewia flavescens* and *Albizia harveyi*. The field layer of the bottomlands are more dense and species such as *Eragrostis superba*, *Bothriochloa radicans*, *Themeda triandra*, *Urochloa mosambicensis*, *Panicum coloratum*, *Cymbopogon plurinodis* and *Enneapogon cenchroides* are more common. Associated forbs are *Corchorus asplenifolius*, *Ceratotheca triloba*, *Heliotropium steudneri*, *Melhanian forbesii*, *Orthosiphon australis*, *Crotalaria virgulata*, *Cleome monophylla*, *Blepharis integrifolia*, *Hermibstaedtia odorata* and *Asparagus plumosus*.

Along certain spruits on brackish spots a type of vegetation occurs that differs from the normal bottomlands (Fig. 27). Woody species under such conditions are *Euclea divinorum*, *Colophospermum mopane*, *Spirostachys africana*, *Ehretia rigida* and

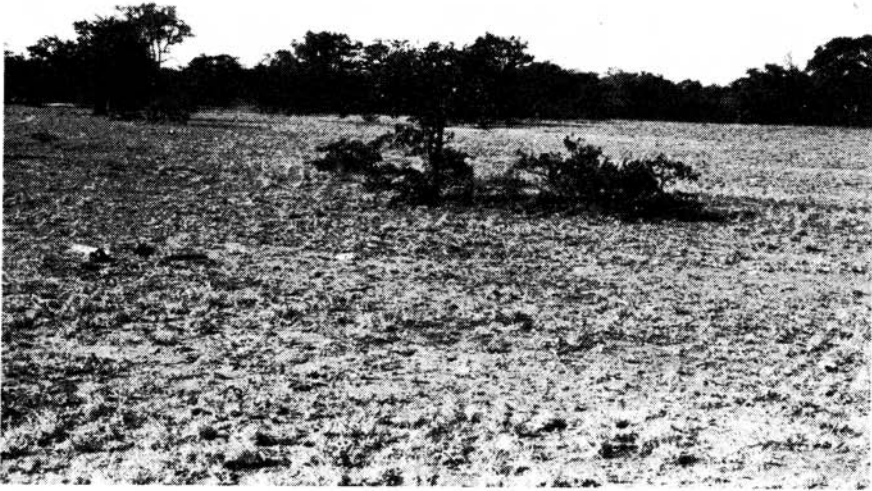


Fig. 27. Landscape 11. Sodic bottomland Tsende Sandveld.



Fig. 28. Landscape 11. Dolerite intrusion Tsende Sandveld.

Albizia harveyi with *Sporobolus fimbriatus*, *Dactyloctenium aegyptium*, *Eragrostis lehmanniana*, *Sporobolus nitens*, *Chloris virgata*, *Portulaca kermesina*, *Pharnaceum elongatum*, *Justicia flava*, *Mariscus rehmannianus*, *Asparagus buehneri* and *Sansevieria grandis* as the dominants in the field layer.

On the clayey soil originating from dolerite and amphibolite, the mopanies are usually more dense and larger trees occur (Fig. 28). The shrub layer is not strongly developed and the field layer is dominated by dense stands of *Themeda triandra* and *Bothriochloa radicans*. The denser grass cover possibly results in hotter fires which control the shrub layer.

The riverine vegetation of this landscape is the same as that of the *Combretum* spp./*Colophospermum mopane* Bushveld of the Timbavati area (Landscape 6).

Fauna

The Tsende Sandveld is also preferred habitat for sable antelope. Elephant, buffalo, kudu and zebra are present while waterbuck and impala are restricted to areas close to water. Eland are fairly common in this area and in 1981 a herd of ± 50 animals were counted along the upper course of the Tsende spruit. White rhino had become extinct in this part of the KNP, but in 1964, 13 bulls and three cows were released along the Shongololo spruit. At first they wandered all over the area, eventually settling down and at present a population of 30 animals including calves are regularly seen. Although giraffe are relatively scarce in the mopane-veld, a group of 20 to 30 are regularly encountered along the Shongololo spruit. A few groups of roan antelope also occur in this landscape but these animals are more associated with Landscape 24 which is basically a gabbro intrusion which cuts through the Tsende Sandveld. Lion, leopard and hyaena are scarce and plains loving animals such as wildebeest and tsessebe (*Damaliscus lunatus*) are altogether absent.

12 *Colophospermum mopane*/Acacia nigrescens Savanna

Location and Geomorphology

The major portion of the area between the Bububu and Mphongolo Rivers consists of this landscape. A sub-section of this landscape also occurs further south towards the western boundary of the KNP in the vicinity of Timatoro. It extends northwards up to the Waterberg Sandstone. The underlying geological formations are undifferentiated metamorphic rock and amphibolite from the Swaziland System, as well as granite and gneiss. The terrain is much less dissected than the adjacent granite and small pans are common. The following pans are the most well known: Nyamnyulu, Mahlbandlopfu and Solle-se-Pan.

The landscape is drained by the Shingwedzi, Bububu, Phungwane and Mphongolo Rivers and three warm springs viz. Malahlapanga, Mafayeni, and Matiovila occur. The absence of prominent koppies are characteristic of the area and the altitude varies between 400 and 460 metres above sea level. The landscape occupies 1 042 km² or 5,5 percent of the KNP.

Climate

Rainfall in the vicinity varies between 500 and 600 mm per year, with Shangoni with an annual average of 572 mm as the centre point of this landscape. Temperatures are mild and frost seldom occurs. It can be concluded that the temperature will correspond with or be even milder than that of Shingwedzi as provided in Table 6.

Soil Pattern

Due to the relatively flat topography there is very little variation in soil types. The soil, usually red to reddish brown in colour, is deeper than the soils found on granite. Dominant soil Forms are Hutton, Swartland, Glenrosa and Shortlands and the clay content of the soils is 15 percent and more. Close to the Bububu, Phungwane and Mpongolo Rivers, brackish floodplains occur which can be classified as Valsrivier and Sterkspruit soils. On the dykes of the rivers Oakleaf soils can be expected.

Vegetation

The vegetation of this landscape is an open tree savanna with odd low shrubs (Fig. 29). The structural analysis is as follows:

Stratum	Percentage Crown Cover
5 metres	10
2-5 metres	4
1-2 metres	2
0-1 metre	5

The grass cover is dense (90%) with an average height of 1 metre.



Fig. 29. Landscape 12. *Colophospermum mopane*/*Acacia nigrescens* Savanna.

Dominant trees in the landscape are: *Colophospermum mopane*, *Acacia nigrescens*, *Combretum hereroense* and *Acacia gerrardii*. The shrub layer consists of the following species: *Euclea divinorum*, *Albizia harveyi*, *Dalbergia melanoxylon*, *Cissus cornifolia*, *Neorautanenia amboensis*, *Maytenus heterophylla*, *Rhus spinescens*, *Combretum apiculatum* and *Tephrosia sericea*. *Combretum collinum* subsp. *suluense* is also present in this landscape but always at low densities.

The field layer is dense and is dominated by *Themeda triandra*, *Bothriochloa radicans*, *Digitaria eriantha* var. *pentzii* and *Panicum maximum*. Other species which may occur are *Pogonarthria squarrosa*, *Urochloa mosambicensis*, *Eragrostis rigidior*, *Cymbopogon plurinodis*, *Aristida congesta* subsp. *barbicollis*, *Heteropogon contortus*, *Eragrostis superba*, *Urochloa brachyura*, *Brachiaria nigropedata* and *Setaria holstii*. Herbaceous plants are *Clerodendrum ternatum*, *Cassia mimosoides*, *Indigofera schimperi*, *Evolvulus alsinoides*, *Ruellia patula*, *Mariscus rehmannianus* and *Corchorus asplenifolius*.

On the brack soils along the spruits the grass cover is usually much sparser and species such as *Chloris virgata*, *Sporobolus nitens* and *Urochloa mosambicensis* occur. Woody species such as *Colophospermum mopane*, *Spirostachys africana*, *Diospyros mespiliformis* and *Euclea divinorum* are present.

Fauna

This landscape is preferred habitat for a variety of game. Depending on whether the veld has been burnt, large numbers of zebra, buffalo, eland, elephant, ostriches (*Struthio camelus*), tsessebe and warthog are present. Sable and roan antelope, kudu and even white rhino occur in this veld when the grass increases in height. Impala are restricted to the areas close to the rivers.

13. *Acacia welwitschii* Thickets on Karoo Sediments

Location and Geomorphology

Geologically the KNP can roughly be divided into granite and gneiss in the western half and basalt in the eastern half (Schutte 1974, 1982). Karoo sediments occur where the granite and basalt make contact and this forms a strip that extends from north to south throughout the KNP. The Karoo sediments consist of Cave Sandstone, Red Beds and Eccas-shales. This landscape is limited to the Eccas-shales. The terrain is concave, low lying and reasonably flat with slight slopes. It extends as a narrow strip from Crocodile Bridge northwards to the vicinity of the Timbavati picnic area. The thickets are seldom broader than four kilometres.

The general orientation of the spruits and rivers in the KNP are from west to east. Considering that the shales are prone to weathering and erosion it often happens that the spruits running from west to east through granite, turns north or south when reaching the shales. Examples of such spruits in this landscape are the Vurhami, Salitji, Nwaswitsontso and Nsemani. The soils have a strong structure and poor internal drainage with the result that small pans commonly occur. Examples are Leeupan, Nkayapan and Ngumula pan. The landscape is low lying (between 260 and 320 metres above sea level) and occupies 520 km² or 2,7 percent of the KNP.

Good examples of this landscape can be seen along the tourist roads at Gomandwane and Leeupan.

Climate

According to Gertenbach (1980) this landscape receives a wide range of rainfall (500 to 600 mm). In the vicinity of Crocodile Bridge the annual rainfall is 599 mm and it declines to as low as 548 mm at Satara. The temperature is high during the summer and there is little possibility of frost during winter. Table 3 indicates the daily maximum and minimum temperatures for Satara which could possibly be the same for this landscape.

Soil Pattern

The Ecc-a-shales were deposited under warm humid conditions and the soils that develop from these shales are rich in sodium. The presence of large quantities of sodium results in the development of soils with a very strong prismatic structure in the B-horizons. A gleyed horizon sometimes develops on the prismatic B-horizon, but usually this horizon as well as the A-horizon have been washed away. The common soil Forms in this landscape are thus Sterkspruit, Swartland and Estcourt. Where the material from weathered shales and Cave Sandstone mix, Valsrivier and Oakleaf soils sometimes occur. The soils in this landscape are generally very susceptible to erosion and therefore any disturbance should be kept to a minimum.

Vegetation

The vegetation of this landscape is described by Van Wyk (1973) as Delagoa Thorn Thickets, while Pienaar (1963) describes it as dense thorny bush thickets. The landscape is unique considering that the vegetation is dominated by *Acacia welwitschii* subsp. *delagoensis*, a taxon only found in the Republic of South Africa, apart from certain stands in Swaziland and in the south of Zimbabwe.

According to Gertenbach (*in prep.*) this landscape is differentiated by the following woody species: *Euclea divinorum*, *Acacia welwitschii* subsp. *delagoensis*, *Teclea pilosa*, *Capparis tomentosa*, *Boscia mossambicensis*, *Grewia bicolor*, *Maerua parvifolia*, *Dichrostachys cinerea* subsp. *africana*, *Spirostachys africana* and *Rhus spinescens* (Fig. 30). Other woody species that do occur are *Ehretia rigida*, *Zanthoxylum humilis*, *Securinega virosa*, *Acacia tortilis*, *Bolusanthus speciosus* and *Acacia gerrardii*.

The *Acacia welwitschii*-thickets can be divided into two variations on the basis of the field layer. The *Senecio longiflorus*-variation is characterised by the occurrence of *Senecio longiflorus*, *Enteropogon macrostachyus*, *Oropetium capense*, *Sporobolus smutsii* and *Hibiscus palmatus* while the *Urochloa mosambicensis*-variation does not include these species. Dominant grass species in the field layer of both the variations are *Sporobolus nitens*, *Dactyloctenium aegyptium*, *Chloris virgata*, *Panicum coloratum*, *Chloris roxburghiana*, *Aristida congesta* subsp. *barbicollis*, *Tragus berteronianus*, *Panicum maximum*, *Urochloa mosambicensis*, and *Bothriochloa radicans*. Forbs present are *Abutilon austro-africanum*, *Ruellia patula*, *Cyphocarpa angustifolia*, *Justicia flava*, *Blepharis integrifolia*, *Pupalia lappacea*, *Tragia dioica*,



Fig. 30. Landscape 13. *Acacia welwitschii* Thickets.



Fig. 31. Landscape 13. *Albizia petersiana*-variation.

Solanum coccineum, *Achyranthes aspera*, *Amaranthus thunbergii*, *Ocimum americanum*, *Gisekia africana*, *Cyathula crista*, *Commelina bengalensis*, *Phyllanthus asperulatus*, *Seddera suffruticosa*, *Heliotropium steudneri*, *Solanum panduriforme*, *Neuracanthus africanus* and a large variety of other species. The combination of grasses and the variety of forbs show that this landscape is heavily grazed. The grass cover is therefore usually less dense (between 30 and 60% crown cover) and sometimes disappears altogether with the advent of the dry season.

The structure of the woody component is a moderate tree savanna with tall shrubs and sparse low shrubs. The following structural analysis describes the landscape fairly accurately.

Stratum	Percentage Crown Cover
>4 metres	20
2-4 metres	20
0,5-2 metres	4

Where the soils originating from shales and Cave Sandstone mix a complex of plant communities occur that consist of a combination of one of the varieties of the *Acacia welwitschii* community and a *Albizia petersiana* subsp. *evansii* community. The latter community usually contains dense tall shrubs with a better grass cover than the *Acacia welwitschii* community (Fig. 31). Other woody species that occur with *Albizia petersiana* are *Dichrostachys cinerea* subsp. *africana*, *Acacia nigrescens*, *Euclea divinorum*, *Acacia tortilis* and *Lonchocarpus capassa*.

Fauna

This landscape carries what is possibly the largest biomass of game in the KNP. As a result of the palatable short grazing and open low shrub layer, a large number of impala, wildebeest and zebra are present. *Acacia welwitschii* is a good fodder tree and therefore giraffe, kudu, steenbok and duiker are all present. Elephant breeding herds prefer the dense tree veld and buffalo are continuously on the move through the thickets. White rhino have a strong association with this landscape and waterbuck are often encountered at the pans between the trees. As a result of the high density of prey species, lion and hyaena are plentiful while cheetah are regularly seen.

14. Kumana Sandveld

Location and Geomorphology

This landscape lies between the Nwaswitsontso and Swenispruits, east of the main tourist road to the north. It is a relatively small landscape that occupies approximately 164 km² or 0,8 percent of the KNP. Coetzee (1983) describes this landscape under the name "Tropical Semi-arid Lowveld on Karoo Sediment Anticline". Venter (1981) refers to an Ecce — Red Bed — Cave Sandstone — Ecce — Cave Sandstone — Anticline in the vicinity of the Sweni spruit and it is also possibly the case in this landscape. Coetzee (1983) claims that the surrounding basalt in this landscape degraded to expose the Karoo sediment anticline. This is a lightly undu-

lating landscape that is drained by the tributaries of the Sweni, namely the Marheya, Mrunzuluku and the Guweni spruits. Drainage to the Nwaswitsontso is very limited.

This landscape is high lying in comparison to the surrounding basalt and the altitude varies between 260-360 metres above sea level.

Climate

According to Gertenbach (1980) the rainfall in this landscape is approximately 550 to 600 mm per annum. Temperatures are probably the same as that of Satara as shown in Table 3. The landscape is slightly undulating and very little difference can be expected in the micro-climate due to the topography.

Soil Pattern

Coetzee (1983) distinguishes nine different habitats in this landscape. The soils vary accordingly from lithosols on sandstone outcrops, shallow sandy soils, deep sandy soils, clayey soils and sodium rich brackish soils. The soil Forms concerned are Mispah and Glenrosa, with between 13 and 15 percent clay in their A-horizons (Coetzee 1983). Deeper Glenrosa and Clovelly soils occur on sandstone, while Swartland soils occur on associated dolerite intrusions. On the shales and finer sandstone, duplex soils occur of which Estcourt and Sterkspruit are the most important.

Vegetation

The sandstone koppies are relatively rich in woody plants and according to Coetzee (1983) the following species are common: *Ficus soldanella*, *Ximenia americana*, *Thilachium africanum*, *Albizia forbesii*, *A. harveyi*, *Acacia welwitschii*, *Dichrostachys cinerea* subsp. *africana* var. *pubescens*, *Schotia brachypetala*, *Cassia abbreviata*, *Peltophorum africanum*, *Erythroxylum emarginatum*, *Phyllanthus reticulatus*, *Bridelia cathartica*, *Spirostachys africana*, *Lannea stuhlmannii*, *Maytenus heterophylla*, *Hippocratea longipetiolata*, *Pappea capensis*, *Grewia bicolor*, *G. flavescens*, *Combretum apiculatum*, *Manilkara mocharia*, *Euclea natalensis*, *E. undulata* and *Diospyros mespiliformis*. •

The field layer consists of the following species: *Heteropogon contortus*, *Digitaria eriantha* var. *pentzii*, *Panicum maximum*, *Rhynchelytrum repens*, *Enteropogon macrostachyus*, *Pogonarthria squarrosa*, *Sansevieria hyacinthoides*, *Asparagus falcatus*, *A. minutiflorus* and *Sarcostemma viminalis*.

The deep sandy soils carry a vegetation with a moderate to dense low shrub layer, a sparse tall shrub layer and a tree layer that is sparse to completely absent (Fig. 32). Dominant woody species are *Balanites maughamii*, *Grewia bicolor*, *Cassia abbreviata*, *Acacia tortilis*, *Peltophorum africanum*, *Combretum apiculatum*, *Dichrostachys cinerea* subsp. *africana*, *Grewia monticola*, *G. flavescens*, *Acacia nigrescens*, *Sclerocarya caffra*, *Lannea stuhlmannii*, *Combretum hereroense*, *Albizia harveyi* and *Ziziphus mucronata*. The field layer is dominated by *Schmidtia pappophoroides*, *Digitaria eriantha*, *Pogonarthria squarrosa*, *Sporobolus fimbriatus*, *Panicum maximum*, *Urochloa mosambicensis* and *Eragrostis rigidior*.



Fig. 32. Landscape 14. Kumana Sandveld.

Where dolerite intrusions are present in the landscape, the soil is clayey and the vegetation changes to a moderate shrubveld with a dense grass cover. Woody species such as *Acacia tortilis*, *Grewia bicolor*, *Acacia nigrescens*, *Maytenus senegalensis* and *Combretum hereroense* are present. The field layer is dominated by *Bothriochloa radicans*, *Themeda triandra*, *Heteropogon contortus* and *Eragrostis superba*.

Sodium-saturated soils occur where the shales appear on the surface because of the anticline. On these soils *Acacia welwitschii* thickets, similar to that described for Landscape 13, are present.

Fauna

Elephant breeding herds prefer the Kumana Sandveld because it is relatively dense and provides shelter for the animals. Browsers such as kudu, giraffe and impala are commonly found, while white rhino are regularly encountered. Wildebeest and zebra are less common but warthog are plentiful. Carnivores such as lion and leopard are present and waterbuck can be seen near permanent water.

15. *Colophospermum mopane* Forest

Location and Geomorphology

This landscape occurs in the vicinity of Punda Maria on the Eccas-shales of the Karoo System. It is situated between the basalts and the Waterberg Sandstone and extends from Vlakteplaas in the south to the Levubu River. Elsewhere in the KNP a comparable mopane forest occurs, but then it is usually on alluvial soil close to larger

spruits and rivers. Examples of this mopane forest is south of the Letaba River, along the Nwanedzi, Tsende, Mpongolo and Shisha. In the latter cases the parent material of the soil is mostly granite. It is a flat to concave landscape and is drained by the tributaries of the Shisha. The altitude varies between 360 and 420 metres above sea level.

Climate

The landscape receives an annual rainfall of between 500 and 550 mm which is restricted to the summer months. The summers are hot with cool winters and frost being the exception. The prevailing temperature of the landscape must be extrapolated from the two weather stations at Shingwedzi and Punda Maria (Tables 6 and 7).

Table 7

Temperature data for Punda Maria
(Data collected since September 1981)

Temperature °C

Month	Average Daily Maximum	Absolute Maximum	Average Daily Minimum	Absolute Minimum
January	34,4	41,4	21,2	17,5
February	31,7	39,0	19,8	16,0
March	31,7	38,0	19,8	14,5
April	29,3	34,0	16,6	12,0
May	26,2	31,4	12,7	8,3
June	24,6	28,0	9,8	8,0
July	25,0	32,6	12,8	7,4
August	26,4	36,0	14,1	9,9
September	27,1	35,0	14,5	11,0
October	29,0	37,1	17,0	12,0
November	32,7	40,0	19,7	13,5
December	31,1	40,5	19,0	13,0

Soil Pattern

The soils in this landscape are usually deep with a strong structure in the subsoil and rich in salts especially sodium salts. These salts possibly originated from the shales from which the soils developed. The following soil Forms and series are the most common: Swartland-Uitsicht/Brokespruit/Malakata/Nyoka, Valsrivier/Craven/Lindley/Valsrivier and Zuiderzee. Hutton soils are usually those with a massive apedal structure such as Hardap, Shigalo, Shorrocks and Makatini. Sterkspruit soils also occur. According to Van Rooyen (1978), the pH of the soil varies between 6,1 and 8,7. The soils of this landscape are similar to those of the *Acacia welwitschii*-thickets.

Colophospermum mopane as the climate became wetter. Both landscapes are unique to South Africa and deserve special priority in conservation.

Fauna

The thick mopane forest is ideal habitat for elephant breeding herds. Buffalo and impala are commonly found. Rare species of game such as nyala and Sharpe's grysbok (*Raphicerus sharpei colonicus*) are fairly common in this landscape. Kudu bushbuck and duiker prefer the dense bush. Steenbok occur less frequently in this area.

16. Punda Maria Sandveld on Cave Sandstone

Location and Geomorphology

Cave Sandstone of the Clarence Formation form outcrops extending from north-east of Punda Maria to just north of the Levubu River. A small strip of this sedimentary rock also occurs on the contact between the granite and basalt and is particularly conspicuous near the Timbavati picnic area, between the Olifants and Letaba Rivers and along the Tsende River. This Cave Sandstone forms prominent koppies and is a unique and impressive landscape. Important koppies in the KNP can be associated with this landscape. Good examples are Matikiti, Mangadyane, Nsemane, Mtshatu, Hatlani, Xantangelane, Makahanya, Hutwini and Mashikiri. The most important spruit that drains this landscape in the north is the Nkovakulu. The main component of the landscape is koppies or outcrops with sand plateaus and bottomlands. The altitude varies between 300 and 370 metres and the landscape occupies 117 km² or 0,6 percent of the KNP.

Climate

The annual rainfall of this landscape varies considerably seeing that it is a long narrow area running throughout the KNP. The applicable rainfall is most likely that of Punda Maria which receives 588 mm annually. The part of the landscape in the south-east of Letaba most probably receives far less rain. The temperature data for Punda Maria presented in Table 7, is applicable to this landscape.

Soil Pattern

The soils of this landscape are mainly lithosols or solid rock with a thin layer of soil (Mispah) in the hollow places. On the plateaus and bottomlands, a deep grey to yellow sandy soil, of the Clovelly or Fernwood Forms is present.

Vegetation

The koppies in the landscape accommodate a unique vegetation which includes many rare species (Fig. 35). Van Rooyen (1978) regards the following woody species as characteristic: *Stadmannia oppositifolia* subsp. *rhodesica*, *Steganotaenia araliacea*, *Boscia angustifolia*, *Diospyros lysioides*, *Ficus ingens*, *F. soldanella*, *F. tettensis*, *F. sonderi*, *Commiphora marlothii*, *Terminalia sericea*, *Rothmannia fischeri*, *Maerua angolensis*, *Kirkia acuminata*, *Gyrocarpus americanus*, *Ptaeroxylon*

obliquum, *Strychnos decussata*, *Commiphora mollis*, *Manilkara mocharia*, *Euphorbia tirucalli*, *Pachypodium saundersii*, *Antidesma venosum*, *Hippocratea crenata*, *Urera tenax*, *Vepris reflexa*, *Hexalobus monopetalus*, *Ochna inermis*, *Croton menyhartii*, *Drypetes gerrardii*, *Adenium obesum* var. *multiflorum*, *Flacourtia indica*, *Cassia petersiana* and *Tinnea juttae*.

The herbaceous layer of the community on the koppies is sparse and includes among others the following: *Urginea epigea*, *Vahlia capensis*, *Coleochloa rehmanniana*, *Thunbergia hirta*, *Tinospora fragosa*, *Felicia bechuanica*, *Jatropha messinica*, *Ocimum canum*, *Gloriosa superba*, *Portulaca kermesina*, *Sida hoefnieri*, *Tephrosia virgata* and *Limeum fenestratum*.

A tall shrub savanna occurs on the deep sandy soils which is dominated by *Terminalia sericea* and *Dichrostachys cinerea* (Fig. 34). This community was named by Van Rooyen (1978) as *Terminalia sericea*/*Pogonarthria squarrosa*-tree savanna. Other woody species are *Cissus cornifolia*, *Cassia petersiana*, *Grewia hexamita*, *Lannea stuhlmannii*, *Combretum zeyheri*, *Strychnos madagascariensis*, *Maytenus heterophylla* and *Peltophorum africanum*. Dominant grasses and forbs are *Digitaria eriantha* var. *pentzii*, *Brachiaria serrata*, *Pogonarthria squarrosa*, *Perotis patens*, *Aristida graciliflora*, *Schmidtia pappophoroides*, *Aristida congesta* subsp. *barbicollis*, *Clerodendrum ternatum*, *Commelina africana*, *C. bengalensis*, *Vigna triloba*, *Talinum cafferum*, *Monsonia glauca*, *Limeum sulcatum*, *Merremia tridentata* and *Stylosanthus fruticosa*. Along certain dry slopes, dense stands of *Androstachys johnsonii* occur which will be discussed in more detail under Landscape 31.



Fig. 34. Landscape 16. Punda Maria Sandveld on Cave Sandstone.



Fig. 35. Landscape 16. Cave Sandstone outcrop.

Fauna

This landscape is relatively poor as far as numbers of large game is concerned. Elephant and buffalo are the most important animals with kudu and impala omnipresent. Steenbok, grysbok and nyala are also regularly found. Due to the hilly nature of the landscape, pairs of klipspringer regularly occur. Baboons are plentiful especially along the rivers.

17. *Sclerocarya caffra*/*Acacia nigrescens* Savanna

Location and Geomorphology

This landscape extends from the Crocodile River in the south to just north of Satara with the Lebombo Mountains as the eastern and the Karoo sediments as the western boundary. It is one of the largest landscapes and occupies 1 411 km² or 7,2 percent of the KNP. A characteristic of this landscape is that it consists of reasonably flat plains with individual well defined drainage channels. All the larger rivers such as the Crocodile, Sabie, Nwaswitsonto, Nwanedzi and Sweni cut through the landscape while smaller spruits such as the Nhlowa, Mlondozi, Guweni, Mrunzuluku, Gudzane, and Mtomene drain this area. According to Bristow (1980) the underlying parent material of this landscape is Sabi River Basalts with a possibility of dolerite intrusions in the basalt.

The altitude varies from 170 metres in the vicinity of Crocodile Bridge to as much as 250 metres above sea level, just north of Satara.

Climate

Gertenbach (1980) states that the rainfall of this landscape diminishes from south to north. The long-term average annual rainfall at Crocodile Bridge is 599,6 mm while the average for Satara is 548,2 mm. The temperature experienced in this landscape probably varies as well, but Table 3 gives the temperature for Satara which is probably applicable to this landscape as a whole. Frost is limited to the bottomlands along the rivers and even then on an irregular basis.

Soil Pattern

The Sabi River Basalts weather to form a black, brown or red clayey soil. The soil depth does not normally exceed one metre and the dominant Forms are Bonheim, Shortlands, Swartland, Milkwood, Mayo, Glenrosa and Valsrivier. In the low lying areas vertisols of the Arcadia and Rensburg Forms can also be expected. The soil pattern is relatively homogeneous and no great changes in soil types occur over short distances. The clay contents in the soil varies between 25 and 50 percent and it is rich in plant nutrients. Table 8 indicates the quantity of exchangeable plant nutrients of a typical soil sample.

Table 8
Exchangeable plant nutrients of a typical soil sample in Landscape 17

Soil Form:	Bonheim	
Soil Series:	Bushman	
Parent Material:	Basalt	
	A-Horizon	B-Horizon
% Sand	42,4	43,0
% Silt	24,9	14,6
% Clay	25,2	30,4
pH (H ₂ O)	7,4	7,4
P (ppm)	372	470
K (ppm)	160	60
Ca (ppm)	2 760	2 840
Mg (ppm)	1 260	1 510
Na (ppm)	80	160
Resistance (Ohm)	800	800

Vegetation

Van Wyk (1973) divides the landscape in two, viz. Knobthorn/Maroela-veld and the Leadwood/Maroela/*Albizia*-veld. Pienaar (1963) calls it the *Sclerocarya caffra*/*Acacia nigrescens* savanna, while Van der Schijff (1957) referred to it as the Knoppiesdoring/Maroela bushveld with five associations of which only two have a direct bearing on this landscape. The other three associations belong to other landscapes. Coetzee (1983) describes this landscape as a non-vertic, tropical, semi-arid,



Fig. 36. Landscape 17. *Sclerocarya caffra*/*Acacia nigrescens* Savanna south of Tshokwane.



Fig. 37. Landscape 17. *Sclerocarya caffra*/*Acacia nigrescens* Savanna north of Tshokwane.

basaltic lowveld. He distinguish 14 different plant communities that represent different variations of *Sclerocarya caffra*/*Acacia nigrescens*-veld.

The most important two components of this landscape are the *Sclerocarya caffra*/*Dichrostachys cinerea*/*Pterocarpus rotundifolius*/*Themeda triandra*-tree-veld south of Tshokwane (Fig. 36) and the *Sclerocarya caffra*/*Acacia nigrescens*/*Themeda triandra*/*Bothriochloa radicans*-tree-veld north of Tshokwane (Fig. 37). This larger division is mainly attributed to the higher rainfall in the southern and the lower rainfall in the northern section of this landscape, with the 550 mm isohyet as the reputed boundary. The other associations described by Coetzee (1983) for this landscape are either very local or are secondary communities as a result of overgrazing.

The *Sclerocarya caffra*/*Dichrostachys cinerea*/*Pterocarpus rotundifolius*/*Themeda triandra*-tree-veld south of Tshokwane is an open tree savanna with a moderate shrub layer, but with a dense field layer. Dominant trees in this association are *Sclerocarya caffra*, *Acacia nigrescens*, *Lannea stuhlmannii* and *Lonchocarpus capassa*. Species in the shrub layer are *Dichrostachys cinerea* subsp. *africana*, *Pterocarpus rotundifolius*, *Acacia nilotica*, *A. gerrardii*, *Albizia harveyi*, *Maytenus senegalensis*, *Ozoroa engleri*, *Ximenia caffra*, *Dalbergia melanoxylon*, *Maytenus heterophylla* and *Cissus cornifolia*. The two variations of the veld are best distinguished by the presence or absence of *Maytenus senegalensis*. The field layer is dense and the sequence of dominance is *Themeda triandra*, *Panicum coloratum*, *Digitaria eriantha* var. *pentzii*, *Bothriochloa radicans*, *Panicum maximum*, *Heteropogon contortus* and *Urochloa mosambicensis*.

The *Sclerocarya caffra*/*Acacia nigrescens*/*Themeda triandra*/*Bothriochloa radicans*-tree-veld north of Tshokwane is also an open tree savanna with a moderate to sparse shrub layer and a dense field layer. The dominant trees are *Sclerocarya caffra*, *Acacia nigrescens*, *Lannea stuhlmannii* and *Combretum imberbe*. The shrub layer is sparse to moderate and *Acacia nigrescens*, *Dichrostachys cinerea* subsp. *africana*, *Albizia harveyi*, *Acacia gerrardii*, *A. tortilis*, *Grewia bicolor*, *Dalbergia melanoxylon*, *Securinega virosa*, *Combretum hereroense*, *Ziziphus mucronata*, *Ormocarpum trichocarpum*, *Maerua parvifolia* and *Ehretia rigida* are usually present. The big difference between the two associations, nevertheless, lies in the composition of the field layer. The field layer of the latter association is also dense but the sequence of dominance is *Themeda triandra*, *Bothriochloa radicans*, *Digitaria eriantha* var. *pentzii*, *Panicum coloratum*, *Urochloa mosambicensis*, *Aristida congesta* subsp. *barbicollis* and *Eragrostis superba*. Other species that occur regularly are *Enneapogon cenchroides*, *Schmidtia pappophoroides*, *Panicum maximum*, *Heteropogon contortus* and *Sporobolus fimbriatus*. Everything indicates that the latter is a drier variation of the *Sclerocarya caffra*/*Acacia nigrescens* Savanna.

Forbs which commonly occur in both the variations of the *Sclerocarya caffra*/*Acacia nigrescens* Savanna are *Vernonia oligocephala*, *Rhynchosia minima*, *Chascanum hederaceum*, *Heliotropium steudneri*, *Crotalaria virgulata*, *Tephrosia polystachya*, *Rhynchosia densiflora* and *Cassia mimosoides*. A characteristic of this landscape is that forbs are fairly scarce in the stable undisturbed veld. Under conditions of moderate to heavy grazing the above-mentioned forbs show a marked increase and species such as *Solanum panduraeforme*, *Sericorema remotiflora*, *Pavonia patens*,

Ipomoea obscura, *Justicia flava*, *Hemmbstaedtia odorata*, *Corchorus asplenifolius*, *Barleria prionitis* and *Phyllanthus asperulatus* increase considerably.

On the floodplains along the Sweni spruit in this landscape a unique community which consists of a *Hyphaene natalensis*-savanna occurs (Fig. 38). Dominant woody species are *Hyphaene natalensis*, *Acacia tortilis*, *Euclea divinorum*, *Lonchocarpus capassa* and *Croton megalobotrys*. Dominant grasses are *Sporobolus nitens*, *S. smutsii*, *Dactyloctenium aegyptium*, *Chloris virgata* and *Schmidtia pappophoroides*. This stand of *Hyphaene natalensis* is the most southerly and impressive occurrence of this species in the KNP and is therefore given special attention and protection against fires.



Fig. 38. Landscape 17. *Hyphaene natalensis* Savanna.

The vegetation on the Oakleaf-soils on the banks of spruits and rivers is a tall tree savanna and includes the following woody species: *Lonchocarpus capassa*, *Ficus sycomorus*, *Diospyros mespiliformis*, *Kigelia africana*, *Trichelia emetica*, *Croton megalobotrys*, *Acacia robusta*, *A. tortilis*, *Combretum hereroense*, *C. imberbe*, *Maytenus senegalensis*, *Acacia xanthophloea* and *Hyphaene natalensis*. *Phoenix reclinata* and *Cyperus sexangularis* occur in the stream beds, together with *Phragmites australis*. The stream banks of this landscape has a typical floodplain, dyke wall and stream bed (Fig. 39).

Local vegetation variations of this landscape were described by Coetzee (1983). Where soils become shallow the following species occur more commonly: *Combretum apiculatum*, *Acacia exuvialis*, *Terminalia prunioides*, *Grewia bicolor*, *Digitaria eriantha* var. *pentzii*, *Aristida congesta* subsp. *barbicollis* and *Heteropogon contortus*.



Fig. 39. Landscape 17. Sweni stream bank.



Fig. 40. Landscape 17. *Acacia gerrardii* Savanna.

In the vicinity of Rietpan/Mlondozi, *Acacia gerrardii* and *Pterocarpus rotundifolius* are dominant and *Sclerocarya caffra* is almost absent (Fig. 40). In certain low lying parts, species such as *Acacia tortilis*, *Combretum imberbe*, *Lannea stuhlmannii*, *Dalbergia melanoxylon* and *Lonchocarpus capassa* are more common. Where soils are very clayey and show vertic characteristics stunted *Acacia nigrescens* with

Setaria woodii-stands occur and where the soils show signs of sodium saturation, species such as *Acacia borleae* associated with *Chloris mossambicensis* and *Setaria woodii* occur (Fig. 41). The grass *Schoenefeldia transiens* is limited to this community and it is the only record of this grass being found in the Republic of South Africa. The latter vegetation variation will be discussed in more detail under Landscape 18.



Fig. 41. Landscape 17. *Acacia borleae* thickets.

Fauna

The *Sclerocarya caffra*/*Acacia nigrescens* savanna is the centre of the wildebeest and zebra habitat in the KNP. These animals migrate annually between the northern and southern parts of this landscape (Smuts 1974). In summer when water and grazing are plentiful the game congregates in the vicinity of Tsokwane/Lindanda/Guweni/Sweni to migrate southwards to the Mlondozi/Sabie River area in the dry season. It appears that the annual migrations take place between the two most important variations of the *Sclerocarya caffra*/*Acacia nigrescens* savanna as described above.

Buffalo, kudu, giraffe, waterbuck, steenbok and ostrich occur in large numbers but elephant are only represented by lone bulls. These elephant bulls have caused considerable damage to large trees near the tourist and firebreak roads. The role played by herds of buffalo in keeping the veld short and open for animals such as wildebeest and zebra is a feature which should be exploited in the management of buffalo. Tsessebe are present at Mlondozi. Individual reedbuck are regularly seen in the long grassveld north of Satara. Lions are abundant, and like the wildebeest and zebra, this landscape is probably the centre of their distribution in the KNP. Hyenas are plentiful, while cheetah are well represented.

The occurrence of impala in this relatively high grassveld is observed from time to

time. This phenomenon should be seen in a serious light considering that the occurrence of this game species, especially in the inner veld, indicates a deterioration of the field layer and suggests that bush encroachment is taking place. The use of such indicator species is of great value in monitoring natural phenomena in the KNP.

18. Dwarf *Acacia nigrescens* Savanna

Location and Geomorphology

The basalts in the vicinity of the watershed between the Olifants and Nwanedzi Rivers north of Satara contain a lot of amygdaloids and olivine and decompose to form dark coloured soils. The area is reasonably flat to concave, high lying plains and is drained by the Mtomeni, Mapetane and Gudzane spruits. Shitsalaleni is a well known pan in this area. The altitude varies between 250 and 300 metres and the landscape is relatively small (356 km² or 1,8 percent of the KNP).

Climate

According to Gertenbach (1980) this area receives between 500 and 550 mm of rain annually and the temperature is comparable to that of Satara which is given in Table 3.

Soil Pattern

The catenary sequence of soils in this landscape include the occurrence of darkly coloured clayey soils on the uplands with dominant Forms Swartland, Bonheim, Milkwood and Mayo. The percentage of clay in the A-horizons varies between 15 and 35 percent and the pH between 5,6 and 6,8 (Coetzee 1983). The B-horizons contain between 35 and 55 percent clay and the pH varies between 6,1 and 7,7. In situations where there is a concave topography clayey soil of the Arcadia Form can be expected. These are soils with dark coloured vertic characteristics that sometimes granulate spontaneously on the surface.

Vegetation

The vegetation of this landscape varies from a pure grass veld on the vertisols and calcrete soils, to a stunted *Acacia nigrescens* savanna on the middleslopes (Fig. 42). Where pure grass veld occurs on the uplands it is dominated by *Themeda triandra*, *Bothriochloa radicans*, *Digitaria eriantha* var. *pentzii*, *Panicum coloratum*, *P. maximum*, *Enneapogon cenchroides*, *Ischaemum brachyatherum*, *Sorghum versicolor*, *Schmidtia pappophoroides*, *Urochloa mosambicensis* and *Cenchrus ciliaris*. Shrubs that sporadically occur are *Acacia nigrescens*, *Ehretia rigida*, *Cordia sinensis*, *Ormocarpum trichocarpum*, *Securinega virosa*, *Acacia tortilis*, *Dichrostachys cinerea* subsp. *africana* and *Ziziphus mucronata*.

On the slopes where the soil is less clayey the above-mentioned woody plants occur more commonly and a dense low tree savanna dominated by *Acacia nigrescens* is characteristic. These small trees have a single stem and are usually between two and four metres high. The stunted growth form of the trees can be attributed to slow growth as a result of high moisture retention in the soil, combined with the high grass cover and regular occurrence of hot fires. The same limiting factors probably



Fig. 42. Landscape 18. Dwarf *Acacia nigrescens* Savanna.

play a role in *Colophospermum mopane* becoming a shrub in Landscape 23. A characteristic of this landscape is the occurrence of many upright dead tree trunks. The reason for this phenomenon is not clear, but drought probably played an important role.

Vertisols of the Arcadia Form develop in the bottomlands and they contain a large amount of soluble salts. Grasses such as *Setaria woodii*, *Ischaemum brachyatherum*, *Panicum maximum*, *Digitaria eriantha* var. *pentzii*, *Brachiaria eruciformis* and *Urochloa mosambicensis* usually occur here. Close to the spruit *Sporobolus consimilis* occur generally and can reach a height of two metres.

A unique component of this landscape are stands of *Acacia borleae* which occur on the brackish vertisols. The dense stands are approximately one to two metres high and almost impenetrable. *Acacia borleae* is the sole dominant and the following woody species occur sporadically: *Azima tetracantha*, *Cadaba natalensis*, *Maerua parvifolia*, *Capparis tomentosa*, *Boscia mossambicensis* and *Cordia ovalis*. The following plants occur in the field layer: *Cenchrus ciliaris*, *Sporobolus smutsii*, *Sansevieria hyacinthoides*, *Cyathula crista*, *Neuracanthus africanus*, *Asparagus minutiflorus*, *Abutilon guineense* and *Cienfuegosia hildebrandtii*.

Fauna

The largest concentration of kudu in the KNP is present in this landscape and the role they play in stunting the small knobthorn trees should not be disregarded. A few groups of sable antelope occur in this part of the KNP. Zebra, impala, wildebeest, giraffe, waterbuck and warthog occur regularly but in lower densities. Elephants are relatively scarce but herds of buffalo are constantly moving through this area. Lion, hyaena and cheetah occur regularly but not in large numbers.

19. Thornveld on Gabbro

Location and Geomorphology

The park's "Gabbro intrusion" (Brandt 1948; Gertenbach 1978; Schutte 1982) extends from Malelane in the south of the KNP to Phondaheuwels west of Shingwedzi. The southernmost section of this intrusion in the vicinity of Orpen, is characterised by a thorn savanna with a dense grass cover. This landscape is a series of islands of gabbro origin, sometimes linked by narrow dykes. It extends from Malelane including koppies such as Ship Mountain and Sithlave, extending beyond the borders of the KNP at Mkhuhlu Station. A number of sub-units of this landscape occur between the Sabie and Nwawitsontso Rivers and at Orpen it forms extensive outcrops. Coetzee (1983) describes the geology of this landscape as dolerite, but evidence indicates that it is gabbro (Brandt 1948; Schutte 1974; Gertenbach 1978).

The landscape generally has a higher altitude than the surrounding granite (between 550 and 600 metres a.s.l.) and it is flat to slightly undulating with prominent koppies such as Ship Mountain and Sithlave. North of Orpen the thornveld on the gabbro is replaced by a shrub *Colophospermum mopane* community (Landscape 24). This landscape covers 685 km² or 3,5 percent of the KNP.

Climate

The rainfall of this landscape varies considerably from south to north. At Malelane in the south an average rainfall of 620 mm prevails while that of Kingfisherspruit is 582 mm. Temperature data from Pretoriuskop (Table 1), Skukuza (Table 2) and Satara (Table 3) are applicable to this landscape.

Soil Pattern

The soils that develop from gabbro are usually dark in colour and clayey. Where the terrain is flat to slightly concave, the soil becomes deeper and the following soil Forms can be expected: Bonheim, Mayo, Shortlands, Arcadia and Swartland. On the middleslopes, Mayo, Milkwood, Glenrosa and even Hutton soil Forms can be expected. In the southern parts of this landscape the soils are darker in colour and the grass cover more dense. Loose rock is often present on the surface and there is little soil development on the koppies and it can be classified as lithosols.

Where the gabbro and surrounding granite are in contact a mixed soil sometimes develops. It frequently happens that the A-horizon originates from gabbro that has spilled over the B-horizon (which originated from granite).

Vegetation

In certain areas of the landscape the vegetation is dominated by stands of *Acacia nigrescens* trees which vary in height from three to seven metres. Where the knobthorn trees become dense, the trees are usually lower. Otherwise the landscape is characterised by an open savanna with a dense grass cover.

Gertenbach (1978) divided the vegetation on gabbro, in the vicinity of Orpen, into two communities viz. *Chloris virgata*/*Acacia nigrescens*-shrubveld (Fig. 43) and a *Sclerocarya caffra*/*Acacia nigrescens*-savanna (Fig. 44). The first mentioned commu-



Fig. 43. Landscape 19. Dwarf *Acacia nigrescens* Thornveld on Gabbro.



Fig. 44. Landscape 19. *Sclerocarya caffra*/*Acacia nigrescens* Savanna on Gabbro.

nity occurs on shallow soil and normally has a sparser grass cover and is grazed more intensively. It is a low tree veld to a shrub veld with *Acacia nigrescens*, *Ziziphus mucronata*, *Acacia tortilis*, *Ormocarpum trichocarpum*, *Bolusanthus speciosus*, *Securinega virosa* and *Grewia bicolor*, as the most important woody species with *Chloris virgata*, *Cenchrus ciliaris*, *Sporobolus nitens*, *Enneapogon cenchroides*, *Schmidtia pappophoroides*, *Digitaria eriantha* var. *pentzii*, *Bothriochloa radicans*, *Eragrostis superba*, *Panicum maximum* and *Urochloa mosambicensis* as the dominant grasses. Forbs present are *Cyphocarpa angustifolia*, *Sida rhombifolia*, *Solanum panduraeforme*, *Corchorus asplenifolius*, *Seddera suffruticosa*, *Heliotropium steudneri* and *Abutilon austro-africanum* (Gertenbach 1978).

The *Sclerocarya caffra*/*Acacia nigrescens*-savanna occurs on deeper soils and has a dense grass cover which is not intensively grazed. It is an open tree savanna with *Acacia nigrescens*, *Sclerocarya caffra*, *Acacia tortilis*, *Combretum apiculatum*, *Albizia harveyi*, *Dalbergia melanoxylon*, *Bolusanthus speciosus*, *Lannea stuhlmannii* and *Grewia bicolor* as the dominant woody species. *Themeda triandra*, *Digitaria eriantha* var. *pentzii*, *Bothriochloa radicans*, *Cymbopogon plurinodis*, *Panicum maximum* and *Urochloa mosambicensis*, are the dominant grasses with a few forbs of which *Heliotropium steudneri*, *Pavonia patens*, *Ipomoea crassipes*, *Lantana rugosa* and *Tephrosia polystachya* are the most important.

Coetzee (1983) distinguishes another vegetation variation on gabbro between Skukuza and Tshokwane and he referred to it as a *Lannea stuhlmannii*/*Pterocarpus rotundifolius*/*Themeda triandra* dominant shrubby tree veld (Fig. 45). The same



Fig. 45. Landscape 19. *Pterocarpus rotundifolius*/*Themeda triandra* Savanna on Gabbro.



Fig 46. Landscape 19. Ship Mountain, a gabbro outcrop.



Fig. 47. Landscape 19. Open thornveld on gabbro near Pretoriuskop.

woody species that occur in the *Sclerocarya caffra*/*Acacia nigrescens*-savanna described by Gertenbach (1978) also occur here, but woody species such as *Lannea stuhlmannii*, *Pterocarpus rotundifolius* and *Combretum hereroense* are prominent dominants. *Themeda triandra*, *Digitaria eriantha* var. *pentzii*, *Panicum maximum*, *P. coloratum* and *Urochloa mosambicensis* are the dominant grasses. Where the topography is very flat or concave *Setaria woodii* can be expected.

Where soils originating from gabbro and granite mix, a situation is encountered where the woody species correspond to the adjacent granite landscape, while the field layer corresponds very much to the gabbro landscape (Gertenbach 1978; Coetzee 1983).

On gabbro koppies such as Ship Mountain and Sithlave unique vegetation occurs (Fig. 46). Woody species worth mentioning are: *Aloe marlothii*, *Ficus soldanella*, *Balanites maughamii*, *Spirotachys africana*, *Ozoroa paniculosa*, *Maytenus heterophylla*, *Cassine transvaalensis*, *Hippocratea longipetiolata*, *Grewia subspathulata*, *Sterculia rogersii*, *S. murex*, *Vangueria infausta*, *Erythrina lysistemon*, *E. latissima*, *Urea tenax* and *Cussonia natalensis*.

Coetzee (1983) distinguished nine different vegetation variations on gabbro in the Central District of the KNP. This includes the two variations of Gertenbach (1978). In the vicinity south of the Sabie River where there is a slight increase in the rainfall a further variation of the landscape occurs. This is an open shrub savanna with a dense field layer (Fig. 47). Between Skukuza and Pretoriuskop the tarred road crosses this variation and the common woody species are *Dichrostachys cinerea* subsp. *nyassana*, *Dalbergia melanoxylon*, *Albizia harveyi*, *Lannea discolor*, *Acacia nigrescens*, *Pterocarpus rotundifolius*, *Combretum collinum* subsp. *suluense*, *Acacia gerrardii* and *Bolusanthus speciosus*. Dominant grasses are *Themeda triandra*, *Cymbopogon plurinodis*, *Urochloa mosambicensis* and *Heteropogon contortus*.

Fauna

An interesting association exists between this landscape and the most southern distribution of the roan antelope. Gertenbach (1978) has already referred to this association and it would appear as if this applies to the whole landscape. The last group of roan antelope at Pretoriuskop occurs on the gabbro intrusion and until quite recently there were still some of these animals present at Orpen, associated with the gabbro. Other species of game occurring in this landscape are kudu, impala, giraffe, waterbuck, warthog, buffalo and elephant bulls. Zebra and wildebeest usually occur in the largest parts of this landscape shortly after a fire, but the *Chloris virgata*/*Acacia nigrescens*-shrubveld near Orpen is an area highly preferred by wildebeest.

20. Bangu Rugged Veld

Location and Geomorphology

This landscape occurs as a strip that extends from the Timbavati picnic area up to the Lebombo Mountains at the Olifants River. It covers 204 km² or one percent of the KNP. This area is lightly undulating to undulating basalt terrain and is drained

via the Bangu and Ngotsa spruits into the Olifants River. This landscape occupies the middleslopes to the Olifants and Timbavati Rivers and varies in altitude between 250 and 300 metres.

Climate

The area is relatively dry, not only because of the low rainfall but also as a result of shallow stony soils and steep slopes. The landscape receives between 500 and 550 mm rain annually and the temperature is high in summer and mild in winter (Tables 3 and 5 for Satara and Letaba).

Soil Pattern

The soils of this landscape are shallow, dark brown to grey in colour, melanic to orthic and contains a reasonable amount of weathered basalt in the profile. Lime concretions are common and the dominant soil Forms are Milkwood, Mispah, Mayo and Glenrosa. The shallow soils and steep slopes cause the area to be relatively dry and prone to erosion.

Vegetation

The vegetation of this area is described by Coetzee (1983) as an *Acacia nigrescens*/*Grewia bicolor*-dominated shrub veld (Fig. 48). The area was severely overgrazed in the past and shows distinct signs of retrogressive succession. With the exception of *Acacia nigrescens* and *Grewia bicolor* the following woody species also occur: *Terminalia prunioides*, *Acacia exuvialis*, *A. tortilis*, *Maerua parvifolia*, *Dichrostachys cinerea* subsp. *africana*, *Commiphora africana*, *Grewia villosa* and *Securinega virosa*. The field layer is sparse to moderate and the grasses are mostly



Fig. 48. Landscape 20. Bangu Rugged Veld.

annual species with a great variety of forbs present. *Panicum coloratum*, *Aristida congesta* subsp. *barbicollis*, *Enneapogon cenchroides*, *Brachiaria xantholeuca*, *Bothriochloa radicans*, *Schmidtia pappophoroides*, *Heliotropium steudneri*, *Solanum panduraeforme*, *Indigofera floribunda* and *Barleria prionitis* are the dominant species.

Gertenbach (*in prep.*) classifies this landscape as a *Panicum coloratum/Bothriochloa radicans/Acacia nigrescens* sub-association and it shows great similarity to the vegetation of Landscape 21.

Fauna

This shrub veld is ideal habitat for wildebeest and zebra. These species were mainly responsible for overgrazing in this area in the past. Impala are less common but kudu and giraffe are plentiful. The area is preferred to a lesser extent by buffalo and elephant, but carnivores such as lion and hyaena are abundant.

21. *Combretum* spp./*Acacia* spp. Rugged Veld

Location and Geomorphology

The eastern slopes to the lower Timbavati River and the slopes to the Olifants River where it cuts through the basalt is an undulating landscape with shallow stony soils. It is an arid veld and is known as the *Combretum* spp./*Acacia* spp. Rugged Veld. It occupies only 270 km² or 1,4 percent of the area of the KNP. The area is drained by a great number of small spruits that empty into the Timbavati and Olifants Rivers and the altitude varies between 180 and 300 metres. The above-mentioned two rivers comprise a large component of the landscape. One of the most permanent springs in the south of the KNP also occurs in this landscape *viz.* Nyamari spring.

Climate

According to Gertenbach (1980) the 500 mm isohyet passes just south of the landscape. The area thus receives between 450 and 500 mm of rain annually. The average rainfall for Letaba is 462 mm per year and is comparable to that of this landscape. Table 5 presents the temperature data for Letaba and is applicable to this landscape.

Soil Pattern

The soils of this landscape is shallow and low outcrops and rocky ridges are commonly found. The soils can hardly be classified into soil Forms, but when possible Mispah and Milkwood are the dominant Forms. Alluvial soils which occur on the banks of the Olifants and Timbavati Rivers mainly belong to Oakleaf and Inhoek Forms.

Vegetation

Coetzee (1983) describes the vegetation of this landscape under the name "Tropical, Basaltic Lowveld of the Olifants River Valley". This landscape basically con-

sists of three components viz. the koppies, the undulating middleslopes and the riverine vegetation.

Dominant woody species on the koppies are *Combretum apiculatum*, *C. mossambicense*, *Sterculia rogersii*, *Ptaeroxylon obliquum*, *Hippocratea longipetiolata*, *Manilkara mocharia*, *Boscia albitrunca*, *Pappea capensis*, *Commiphora glandulosa*, *Spirostachys africana*, *Kirkia acuminata* and *Terminalia prunioides*. Lianes such as *Cissus quadrangularis*, *C. rotundifolia* and *Sarcostemma viminale* are plentiful while *Sansevieria hyacinthoides* is common in the field layer. *Sesamothamnus lugardii* which is typical of arid areas also occur in this landscape.

The undulating middleslopes of this landscape is *Terminalia prunioides*/*Combretum apiculatum*/*Acacia nigrescens*-shrub bushveld with only small trees (Fig. 49). Other woody species in this community are *Acacia exuvialis*, *Grewia bicolor*, *Commiphora glandulosa*, *Maerua parvifolia*, *Combretum mossambicense*, *Securinega virosa*, *Dichrostachys cinerea* subsp. *africana* and *Acacia senegal* var. *leiorhachis*. Except for the mountains at Malelane and Punda Maria the distribution of the latter species in the KNP is limited to this landscape.

The field layer of the undulating middleslopes is sparse to absent and is dominated by *Aristida congesta* subsp. *barbicollis*, *Enneapogon cenchroides*, *Urochloa mosambicensis*, *Schmidtia pappophoroides*, *Sporobolus nitens*, *Bothriochloa radicans*, *Fingerhutia africana* with *Panicum coloratum*, *Themeda triandra*, *Panicum maximum*, *Heteropogon contortus* and *Digitaria eriantha* var. *pentzii* less common. Forbs are relatively plentiful with the following species as the most common: *Hibiscus micranthus*, *Seddera capense*, *Melhania rehmannii*, *Neuracanthus africanus*, *Pavonia patens*, *Lantana rugosa*, *Heliotropium steudneri*, *Tephrosia polystachya* and *Rhynchosia totta*.



Fig. 49. Landscape 21. *Combretum* spp./*Acacia* spp. Rugged Veld.

The river banks are characterised by the relatively open tree veld with the following as the species most commonly present: *Ficus sycomorus*, *Breonadia microcephala*, *Trichilia emetica*, *Combretum imberbe*, *Lonchocarpus capassa*, *Diospyros mespiliformis*, *Acacia nigrescens*, *A. robusta*, *A. senegal* var. *leiorhachis*, *A. xanthophloea*, *Schotia brachypetala*, *Xanthocercis zambesiaca*, *Croton megalobotrys*, *Berchemia discolor* and *Galpinia transvaalica*.

Shrubs such as *Maytenus senegalensis*, *Acacia tortilis*, *Combretum paniculatum* subsp. *microphyllum*, *Cordia ovalis*, *Acokanthera oppositifolia*, *Maerua machonica*, *Gardenia spatulifolia*, *Combretum mossambicense*, *Securinega virosa*, *Combretum hereroense* and *Capparis tomentosa* occur regularly. The grass layer is dominated by *Panicum maximum* with grasses such as *Cynodon dactylon*, *Schmidtia pappophoroides* and *Sporobolus smutsii* present. *Phragmites australis* is present on the sand in the riverbeds. The seed of the alien species *Xanthium strumarium* washes down with the water of the Olifants River continuously. This species also occurs in dense stands on the banks of the river. River sand is spread over the tarred roads mechanically after resealing and consequently dense stands of *Xanthium strumarium* are established on the shoulders of the roads.

Fauna

The sparse veld along the Olifants River is mainly utilized by impala, kudu, waterbuck and giraffe. The numbers of wildebeest and zebra are relatively low probably as a result of the denser woody component. Elephant bulls are regularly present along the river, but breeding herds are scarce. At least one herd of buffalo can regularly be seen at the Nyamari spring. Buffalo bulls are often found in the reeds along the river beds. Warthog are scarce, but troops of baboons occur regularly in the river. Carnivores are restricted to lion, leopard and hyaena. A large portion of this landscape is utilized for the Olifants Wilderness Trail.

22. *Combretum* spp./*Colophospermum mopane* Rugged Veld

Location and Geomorphology

This landscape extends from the confluence of the Timbavati and Shisakashangondo spruits, northwards as a narrow strip up to the rhyolites of the Lebombo Mountains. To the north it follows the lower lying areas of the Lebombo Mountains and widens again at the Shingwedzi River as far west as the Nkokodzi spruit. The slopes of the Tsende River are also reckoned as part of this landscape. The underlying parent material of this area is basalt with a large amount of outcrops of tuff and breccia in the vicinity of Shamiriri and rhyolite along the Timbavati and Olifants Rivers. Outcrops of limburgyte (Schutte 1974) also occur north of the Letaba River. The narrow strip along the pediment of the Lebombo Mountains originates from colluvium of rhyolite.

The landscape is characterised as flat plains, interchanging with a series of outcrops as described above. Koppies such as Shamiriri and Shithaburi, are very conspicuous in the Olifants/Letaba area and the slopes are much steeper. The outcrops around Mooiplaas viz. Bowkerkop and Shipandani are limburgyte.

The area is low lying (between 200 and 300 metres a.s.l.) and therefore it usually forms the lower slopes of the Olifants, Timbavati, Letaba and Shingwedzi Rivers and larger spruits including the Tsende, Mkhadzi, Hlamfu and Nkokodzi.

The landscape covers 894 km² or 4.6 percent of the area of the KNP.

Climate

The average rainfall for this landscape is low and varies between 450 and 500 mm per annum. The averages for Letaba and Shingwedzi are 462 and 471 mm respectively. The temperature is high in summer with no frost in winter. Tables 5 and 6 provide the temperature data for Letaba and Shingwedzi which is applicable to this landscape.

Soil Pattern

The soils of this landscape are relatively shallow. On the numerous koppies and outcrops shallow, stony soil of the Mispah Form occurs. In the low lying areas the soil is deeper and the following soil Forms can be expected: Milkwood, Mayo, Bonheim, Glenrosa and Swartland. The skeletal soils of the rhyolite of the Lebombo Mountains contains much sodium and soils with a strong structure in the B-horizon normally develop. This is the case with this part of the landscape situated at the pediment of the Lebombo range. Dominant soil Forms in this case are Valsrivier, Swartland, Sterkspruit and Estcourt.

Vegetation

The vegetation of this landscape can basically be divided into three components. The first occurring on stony outcrops, the second in bottomlands and finally along the Lebombo pediment. The woody plant species that occur on the shallow soil on the koppies is comparable to those of Landscape 21. The following species are very common: *Combretum apiculatum*, *Colophospermum mopane*, *Kirkia acuminata*, *Sterculia rogersii*, *Boscia albitrunca*, *Combretum mossambicense*, *Commiphora mollis*, *Manilkara mocharia*, *Terminalia prunioides*, *Pappea capensis*, *Ptaeroxylon obliquum* and *Spirostachys africana*. *Panicum maximum* is the dominant grass.

The vegetation of the plains between the outcrops is an open shrub savanna that is dominated by *Colophospermum mopane* (Fig. 50). Other woody plants that occur are *Combretum apiculatum*, *Terminalia prunioides*, *Maerua parvifolia*, *Combretum mossambicense*, *Acacia nigrescens*, *A. tortilis*, *A. exuvialis*, *Grewia bicolor* and *Dichrostachys cinerea* subsp. *africana*. The field layer is dense and the dominant grasses are the following: *Panicum maximum*, *Aristida congesta* subsp. *barbicollis*, *Bothriochloa radicans*, *Urochloa mosambicensis*, *Tragus berteronianus*, *Heteropogon contortus*, *Rhynchelytrum repens*, *Enneapogon cenchroides*, *Schmidtia pappophoroides*, *Cenchrus ciliaris*, *Digitaria eriantha* var. *pentzii*, *Eragrostis superba* and *Fingerhutia africana*. Forbs are very abundant and the following deserve mentioning: *Heliotropium steudneri*, *Tephrosia polystachya*, *Phyllanthus asperulatus*, *Asparagus plumosus*, *Ceratotheca triloba*, *Euphorbia neopolycnemoides*, *Dicoma tomentosa*, *Crabbea velutina*, *Cyphocarpa angustifolia*, *Hibiscus micranthus*, *Seddera capense*, *Sansevieria hyacinthoides*, *Rhynchosia totta*, *Melhanie rehmannii*, *Clerodendrum ternatum*, *Leucas glabrata* and *Indigofera bainesii*.



Fig. 50. Landscape 22. *Combretum* spp./*Colophospermum mopane* Rugged Veld.



Fig. 51. Landscape 22. *Colophospermum mopane* trees along the foot of the Lebombo Mountains.

The vegetation on the skeletal soils of the Lebombo Mountain is comparable to the vegetation of the *Colophospermum mopane* Forest (Landscape 15). Two variations can be distinguished. On the soils with a strong structure (Sterkspruit Form) the mopane are severely stunted and the field layer is almost absent (Fig. 52). The structure of the woody vegetation is simple, to such an extent that the 0,5 to 2 metres layer dominates with a 35-50 percent crown cover. No taller plants occur. The mopane is therefore stunted due to the strong structure of the soils. Woody species associated with *Colophospermum mopane* are *Salvadora angustifolia*, *Maerua parvifolia*, *Euclea divinorum*, *Cissus cornifolia*, *Rhigozum zambesiaceum*, *Albizia harveyi*, *Ormocarpum trichocarpum*, *Acacia exuvialis* and *Ehretia rigida*. In the vicinity of the Shawu-plots dense stands of *Acacia borleae* also occur in this landscape.

Dense mopane forest similar to Landscape 15 develops on the soils with pedocutanic structure (Valsrivier and Swartland). Once again *Colophospermum mopane* dominates, but both as trees and shrubs (Fig. 51). Other woody species occurring are *Euclea divinorum*, *Zanthoxylum humilis*, *Salvadora angustifolia*, *Grewia bicolor*, *Acacia exuvialis*, *Securinega virosa*, *Maerua parvifolia*, *Ehretia rigida*, *Dalbergia melanoxylon*, *Acacia nigrescens*, *Combretum imberbe* and *Sclerocarya caffra*. *Adansonia digitata* occurs on the koppies near Mooiplaas, but they currently suffer from bad damage by elephant.

The field layer of both these variations is sparse and the following grass species occur constantly: *Urochloa mosambicensis*, *Panicum maximum*, *Bothriochloa radicans*, *Aristida congesta* subsp. *barbicollis*, *Chloris roxburghiana*, *Digitaria eriantha* var. *pentzii*, *Eragrostis superba*, *E. rigidior*, *Urochloa brachyura*, *Schmidtia pappophoroides*, *Sporobolus fimbriatus*, *Panicum coloratum*, *Heteropogon*



Fig. 52. Landscape 22. *Colophospermum mopane* shrubs along the foot of the Lebombo Mountains.

contortus and *Themeda triandra*. Dominant forbs are *Tephrosia polystachya*, *Corchorus asplenifolius*, *Cyperus rupestris*, *Dyschoriste rogersii*, *Sericorema remotiflora*, *Thunbergia dregeana*, *Ruellia patula* and a series of other species. The vegetation of the spruits and river banks correspond with that of Landscape 21.

Fauna

Buffalo and zebra are probably the most important game species in this landscape, but impala, waterbuck, kudu, giraffe and elephant bulls are well represented. Wildebeest are not very common. The role played by hippos in the utilization of this landscape must not be underestimated. Large numbers of these animals occur along the rivers and they graze intensively. Rare game such as eland, tsessebe and roan antelope also occur in the northern areas of this landscape.

23. *Colophospermum mopane* Shrubveld on Basalt

Location and Geomorphology

This landscape extending northwards from the Timbavati River, is intersected by the Olifants and Letaba Rivers, broadens to include the plains of Tsende and Dzombo, is again intersected by the Shingwedzi River and extends further north to Kloppefontein. Structurally it consists of flat to concave plains with a number of drainage channels which can ultimately be classified as marshes or vleis. Good examples of such marshes are Shawu, Dzombo, Nkulumbeni, Boyela, Nwatwitsumbe and Hlamalala. The geological rock formations upon which this landscape developed is basalt, and Bristow (1980) classifies the basalts of this specific part of the KNP as Letaba Basalts. Darker coloured soils with vertic characteristics usually develop here as opposed to the Sabi River Basalts which occur further south and give rise to more red soil. Dolerite intrusions occur extensively in the basalts.

The mopane shrubveld is situated between 300 and 400 metres a.s.l. and is the largest and most homogeneous landscape. It covers 1 993 km² or 10,3 percent of the KNP.

Climate

The rainfall of this landscape varies between 450 and 500 mm per annum (Gertenbach 1980). Letaba (462 mm) and Shingwedzi (472 mm) are comparable rainfall stations. Temperature data is also available for the two stations in Tables 5 and 6. The summers are very hot and as a result of the flat topography there is relatively little difference in micro-climate.

Soil Pattern

The soils that occur in this landscape are darker in colour (melanic) and usually have a high clay content (20 to 50% clay). In some cases the A-horizon is thin (300 mm) and overlay a thick layer of lime concretions. Such soils belong to the Milkwood, Mayo and Mispah Forms. These types of soil occur mainly on the middle-and footslopes. On the higher middleslopes the colour of the soils are usually red and the dominant soil Forms are Bonheim, Swartland and Mayo. Where the topography is flat or even concave, darker coloured soils with vertic characteristics occur.

The soils expand and contract with wetting and drying because of the presence of montmorillonite-type clay. Soils developing under such circumstances are Bonheim, Arcadia and Rensburg. These vertisols are inclined to granulate spontaneously on the surface. The soils on the dolerite intrusions are more shallow and are better drained with Mayo, Milkwood and Glenrosa as the dominant Forms. The spruits that drain the landscape are shallow marshes and the soils are dark in colour, sometimes having a gleyed clayey B-horizon. Dominant soil Forms are Willowbrook, Bonheim and Inhoek.

Vegetation

The woody vegetation of this landscape is dominated by multi-stemmed mopane shrubs, one to two metres in height. As many as 600 of these shrubs can occur per hectare. The absolute dominance of *Colophospermum mopane* results in other woody species being relatively scarce. Individual species that occur are the following: *Combretum imberbe*, *Euphorbia guerichiana*, *Grewia bicolor*, *Commiphora glandulosa*, *Acacia exuvialis*, *Combretum apiculatum*, *Lannea stuhlmannii*, *Acacia nigrescens*, *Dalbergia melanoxylon*, *Lonchocarpus capassa*, *Sclerocarya caffra*, *Ozoroa engleri*, *Securinega virosa*, *Grewia villosa*, *Albizia harveyi*, *Acacia tortilis*, *Ehretia rigida*, *Combretum mossambicense*, *Maerua parvifolia*, *Combretum hereroense* and *Dichrostachys cinerea* subsp. *africana*.

The mopane-shrubveld can be divided into three variations on the basis of the composition of the field layer. The occurrence of the three variations corresponds to a large extent with the position in the topography. Gertenbach (1983 in prep.) refers to the three variations as the *Bothriochloa radicans*-variation, the *Themeda triandra*-variation and the *Setaria woodii*-variation.

The *Bothriochloa radicans*-variation (Fig. 53) occurs mainly on the lower-, middle- and footslopes on the Milkwood soils. The woody component of this variation is a typical open shrubveld, but the field layer is dominated by *Bothriochloa radicans*. Other important species that differentiate the variation are *Indigofera heterotricha*, *Neuracanthus africanus*, *Brachiaria eruciformes*, *Dicoma tomentosa* and *Euphorbia guerichiana*. Species in common with the *Themeda triandra*-variation are *Clerodendrum ternatum*, *Rhynchosia totta*, *Enneapogon cenchroides*, *Aristida congesta* subsp. *congesta*, *Fingerhutia africana*, *Seddera capense*, *Indigofera schimperi*, *Tephrosia polystachya*, *Schmidtia pappophoroides*, *Heteropogon contortus*, *Cenchrus ciliaris*, *Urochloa mosambicensis*, *Panicum coloratum*, *P. maximum* and *Digitaria eriantha* var. *pentzii*.

The *Themeda triandra*-variation (Fig. 54) occurs on the middleslopes and convex uplands. The soils are usually deeper (Bonheim, Swartland, Mayo) and the woody structure differs slightly from the *Bothriochloa radicans*-variation. Small *Colophospermum mopane* and *Combretum imberbe* trees are dispersed in between the mopane shrubs. The field layer is dominated by *Themeda triandra* and *Panicum coloratum*, but *Bothriochloa radicans* occurs especially under overgrazed conditions. Other grasses occurring in the *Themeda triandra*-variation are *Setaria woodii*, *Eragrostis superba*, *Aristida congesta* subsp. *barbicollis*, *Schmidtia pappophoroides*, *Heteropogon contortus*, *Cenchrus ciliaris*, *Urochloa mosambicensis*, *Panicum maximum*, *Sorghum versicolor* and *Digitaria eriantha* var. *pentzii*. Forbs are scarce in the



Fig. 53. Landscape 23. *Bothriochloa radicans*-variation. Mopane Shrubveld.



Fig. 54. Landscape 23. *Themeda triandra*-variation. Mopane Shrubveld.

veld because of the dense grass cover but the following species are common: *Heliotropium steudneri*, *Clerodendrum ternatum*, *Rhynchosia totta*, *Seddera capense*, *Indigofera schimperi*, *Tephrosia polystachya*, *Vernonia fastigiata*, *Cassia mimosoides*, *Sericorema remotiflora*, *Tephrosia multijuga* and *Rhynchosia minima*.

The *Setaria woodii*-variation (Fig. 55) occurs on concave terrain where soils are very clayey and expands and contracts with wetting and drying (Arcadia, Rensburg and Bonheim). The woody structure differs from the former two variations in that *Colophospermum mopane*-shrubs are more sparse and other species such as *Acacia nigrescens*, *Albizia harveyi* and *Lonchocarpus capassa* become more dominant. In certain areas such as Tihongonyeni an almost homogeneous stand of *Acacia nigrescens* trees occurs. The field layer comprises all the species occurring in the former two variations, but they differ in dominance. *Setaria woodii* is the dominant grass with *Cenchrus ciliaris*, *Urochloa mosambicensis*, *Panicum coloratum*, *Themeda triandra*, *Eragrostis superba*, *Panicum maximum* and *Sorghum versicolor* as constant species. Forbs which occur are *Solanum panduraeforme*, *Ipomoea obscura*, *Merremia kentrocaulos*, *Rhynchosia minima*, *Tephrosia multijuga* and *Vigna triloba*.

Where dolerite intrusions occur in the basalt, the soils are shallow and the internal drainage better. The grass cover is also sparser and according to Gertenbach & Potgieter (1979) small mopane trees are present. They explain this on the basis of a sparser grass cover and a lower intensity fire. Considering that the dolerite intrusions occur as reasonably straight dykes, the small trees tend to occur in straight lines. These dolerite intrusions give a good indication as to where to drill for water for game.

The drainage channels in the landscape are shallow marshes or vleis (Fig. 56) with a dense grass cover from 1 to 1,5 metres high and practically no trees. Woody species that occur here are *Acacia xanthophloea*, *Lonchocarpus capassa*, *Hyphaene natalensis*, *Albizia harveyi*, *Dalbergia melanoxylon* and *Croton megalobotrys*. *Sporobolus consimilis* is the dominant grass with the following constant species: *Cyperus sexangularis*, *Corchorus asplenifolius*, *Sutera bolusii*, *Ischaemum brachyatherum*, *Chloris gayana*, *Phragmites australis*, *Eustachys paspaloides*, *Corchorus trilocularis*, *Sesbania sesban*, *Sporobolus fimbriatus*, *Cynodon dactylon*, *Leptochloa uniflora* and *Typha latifolia*.

Fauna

This landscape is of major importance to the rare game species that occur in the KNP. Almost 85 percent of the roan antelope population of the KNP occurs in this landscape. Tsessebe, sable and eland occur in fair numbers. Zebra and buffalo are, however, the animals that are present in the largest numbers. Elephant bulls are common, while breeding herds occasionally move through to other landscapes. Waterbuck generally occur at permanent waters and at Shawu dam a population of approximately 150 animals can regularly be seen.

In the shrub mopane-veld impala are very rare but steenbok and Sharp's grysbok are quite common. Reedbuck occur widespread but concentrations are usually restricted to the marshy flats. Kudu and giraffe are very poorly represented and



Fig. 55. Landscape 23. *Setaria woodii*-variation. Mopane Shrubveld.



Fig. 56. Landscape 23. Nwashitsumbe vlei. Mopane Shrubveld.

warthog occur near permanent water. Ostriches prefer this open shrubveld and are seen regularly. Carnivores such as lion, hyaena and cheetah are scarce but leopard can be encountered frequently.

24. *Colophospermum mopane* Shrubveld on Gabbro

Location and Geomorphology

The landscape forms a narrow intermittent strip from the Timbavati River to Phonda hillocks west of Shingwedzi. It is a continuation of the gabbro intrusion that also forms the underlying material of Landscape 19. The terrain of this landscape is flat to slightly undulating and is higher situated than the surrounding granite (± 350 metres). Numerous outcrops or koppies like Shilawuri, Chugamila, Tsange and Phonda consist of undecomposed gabbro.

This landscape covers 284 km² or 1,5 percent of the area of the KNP.

Climate

The mopane shrubveld on gabbro is high lying and frost seldom occurs. Temperature data for Letaba and Shingwedzi (Tables 5 and 6) are applicable to this landscape. Rainfall varies between 450 and 500 mm per annum.

Soil Pattern

The soils that develop from the gabbro are dark in colour and contain relatively large amounts of clay. These soils contain more exchangeable nutrients compared to soils that develop from granite, therefore the grazing on the gabbro is usually more palatable. Dominant soil Forms are Milkwood, Mayo, Bonheim and Swartland with vertisols in the areas with a concave topography. The soils on the koppies are shallow and can be classified as lithosols.

Vegetation

Gertenbach (1978) gives a complete description of this landscape under the name of *Themeda triandra/Colophospermum mopane*-shrubveld (Fig. 57). Two variations of the shrubveld viz. a *Sclerocarya caffra*- and an *Acacia nigrescens*-variation occur. The two variations differ not only as far as their botanic composition is concerned but have considerable differences in structure. The *Sclerocarya caffra*-variation is dominated by *Colophospermum mopane* shrubs and the following woody species are common: *Commiphora africana*, *Sclerocarya caffra*, *Acacia exuvialis*, *Albizia harveyi*, *Dalbergia melanoxylon*, *Grewia bicolor* and *Cissus cornifolia*. There are practically no large trees in this shrubveld. A structural comparison of the two variations is described below.

Percentage Crown Cover

	<i>Sclerocarya caffra</i> - variation	<i>Acacia nigrescens</i> - variation
Tree layer	0	13
High shrub layer	8	4
Low shrub layer	18	27
Field layer	71	77
	88	



Fig. 57. Landscape 24. *Colophospermum mopane* Shrubveld on Gabbro.

The *Acacia nigrescens*-variation is also a shrubveld, but a few larger shrubs and trees occur. *Colophospermum mopane* trees and shrubs occur and the following woody species are present: *Acacia nigrescens*, *Commiphora africana*, *Dichrostachys cinerea* subsp. *africana*, *Acacia tortilis*, *Ziziphus mucronata*, *Acacia exuvialis*, *Albizia harveyi*, *Securinega virosa*, *Lannea stuhlmannii*, *Grewia bicolor*, *Cissus cornifolia* and *Dalbergia melanoxylon*. As far as the botanic composition is concerned the *Acacia nigrescens*-variation has a greater variety of species than the *Sclerocarya caffra*-variation.

The field layer of both these variations are dense and have the following dominant species in common: *Fingerhutia africana*, *Panicum coloratum*, *Schmidtia pappophoroides*, *Heteropogon contortus*, *Digitaria eriantha* var. *pentzii*, *Bothriochloa radicans*, *Themeda triandra*, *Cymbopogon plurinodis*, *Eragrostis superba*, *Panicum maximum*, *Urochloa mosambicensis*, *Heliotropium steudneri*, *Phyllanthus pentandrus*, *P. asperulatus*, *Corbichonia decumbens*, *Euphorbia neopolycnemoides*, *Tephrosia polystachya*, *Indigofera bainesii*, *Corchorus asplenifolius*, *Rhynchosia totta* and *Ipomoea crassipes*. The following herbaceous species are restricted to the *Acacia nigrescens*-variation: *Sporobolus nitens*, *Pavonia patens*, *Veronia fastigiata*, *Hibiscus pusillus*, *Tragia dioica*, *Ipomoea obscura* and *Commelina bengalensis*.

The vegetation that occurs on the gabbro outcrops (Fig. 58) include the following species: *Combretum apiculatum*, *Pappea capensis* (mountain type), *Kirkia acuminata*, *Acacia nigrescens*, *Berchemia discolor*, *Bridelia mollis*, *Cassia abbreviata*, *Commiphora mollis*, *Diospyros mespiliformis*, *Dombeya rotundifolia*, *Ficus soldanella*, *Steganotaenia araliacea*, *Sterculia rogersii*, *Terminalia prunioides*, *Combretum mossambicense*, *Gardenia resiniflua*, *Grewia hexamita* and *G. flavescens*.



Fig. 58. Landscape 24. Shilawari, a gabbro outcrop.

Fauna

Seeing that the structure of the mopane-shrubveld corresponds with that of Landscape 23 (*Colophospermum mopane* Shrubveld on Basalt) there is also a similarity in the animals that occur here. Roan antelope for example occur on the gabbro between Letaba and Phalaborwa. The same applies for small herds around Stapelkop dam and Nkokodzi. Other game species that occur in this landscape are buffalo, zebra, eland, ostrich, white rhino (at Chugamila) and single elephant bulls. Tsessebe occur around Swartkops, Stamp-en-Stoot and Stapelkop dams. Kudu, waterbuck, impala and giraffe are notably scarce in this type of veld.

25. *Adansonia digitata/Colophospermum mopane* Rugged Veld

Location and Geomorphology

The basalt slopes towards the Levubu River are physiologically dry as a result of the steep slopes and shallow calcareous soils. The terrain is strongly undulating and is comparable to the slopes of the Olifants, Letaba and Shingwedzi Rivers (Landscapes 7, 10, 21 and 22). Spruits draining this area are the Madzaringwe, Nkovakulu and Thambyi. Koppies occur regularly in this landscape.

Climate

The *Adansonia digitata/Colophospermum mopane* Rugged Veld is rugged in the true sense of the word. Rainfall varies between 450 and 500 mm annually and there is a relatively high run-off of rainwater as a result of the steep slopes. Pafuri with an

average rainfall of 438 mm per year is in the centre of this landscape. The summer temperatures are very high with 40°C often experienced during the period November to March. Temperature data for Shingwedzi (Table 6) is probably the most applicable for this landscape where frost seldom, if ever, occurs.

Soil Pattern

The soils of this landscape are shallow, calcareous and contain a reasonable amount of clay. The soils are mostly dark in colour, but the structure of the topsoil is sometimes poorly developed. Dominant Forms are Milkwood, Mayo, Mispah and Glenrosa. Shallow lithosols occur on the koppies.

Vegetation

The vegetation of this landscape is discussed in detail by Van Rooyen (1978) under the heading *Colophospermum mopane/Commiphora glandulosa/Seddera capensis* — Open Bush Savanna. This vegetation corresponds to that of the *Colophospermum mopane* shrubveld on basalt (Landscape 23) and also to other forms of rugged veld viz. Landscapes 4, 7, 10, 21 and 22.

It is an open tree savanna and the physiognomic dominance of *Adansonia digitata* and *Colophospermum mopane* trees and shrubs give the landscape its name (Fig. 59). The following woody species also occur regularly: *Kirkia acuminata*, *Sclerocarya caffra*, *Combretum apiculatum*, *Commiphora glandulosa*, *Terminalia prunioides*, *Grewia bicolor*, *Cissus cornifolia*, *Acacia nigrescens*, *Maerua parvifolia*, *Zanthoxylum humilis*, *Commiphora mollis*, *C. edulis*, *Sterculia rogersii*, *Dichrostachys cinerea* subsp. *africana*, *Combretum mossambicense*, *Markhamia acuminata*, *Grewia villosa*, *Gardenia resiniflua* and *Ormocarpum trichocarpum*.



Fig. 59. Landscape 25. *Adansonia digitata/Colophospermum mopane* Rugged Veld.

The sparse field layer is dominated by *Enneapogon cenchroides*, *Aristida congesta* subsp. *congesta*, *Panicum maximum*, *Digitaria eriantha* var. *pentzii*, *Hibiscus micranthus* and *Neuracanthus africanus*. The absence of *Themeda triandra* is conspicuous. Other herbaceous species that occur here are the following: *Aristida congesta* subsp. *barbicollis*, *Bothriochloa radicans*, *Fingerhutia africana*, *Pseudobrachiaria deflexa*, *Rhynchosia totta*, *Seddera capense*, *Indigofera vicioides*, *Phyllanthus burchellii*, *Monechma monechmoides*, *Tephrosia polystachya*, *Euphorbia neopolycnemoides*, *Becium obovatum*, *Ecbolium revolutum*, *Dalechampia galpinii*, *Aptosimum lineare* and *Leucas glabrata*.

Fauna

Elephant, buffalo and zebra are the most important game species, but occur infrequently. Eland and sable antelope seldom occur, but impala are quite common. Nyala and kudu are fairly widespread while duiker and steenbok are well represented. Some baobab trees are seriously damaged by elephant bulls at certain times of the year, but these trees have an amazing ability to recover.

26. *Colophospermum mopane* Shrubveld on Calcrete

Location and Geomorphology

This mopane-shrubveld occurs as two isolated areas in the far north of the KNP. One area is situated on the eastern boundary of the KNP North of the Nwambia Sandveld and the other along the western boundary on the watershed between the Limpopo and the Levubu Rivers. The underlying geological material of this landscape consists of the Malvernian Formations (Schutte 1974) which decompose to give rise to soil with a lot of lime concretions.

The area is situated between 215 and 445 metres above sea level. The eastern and western sub-regions are drained by the Shilahlandonga and Mutale spruits respectively. The terrain is intersected to undulating and covers 117 km² or 0.6 percent of the area of the KNP. The Malonga spring is located on the brink of this landscape.

Climate

Rainfall in this vicinity varies between 450 and 500 mm per year and the temperature is high in the summer and mild during the winter. The role that fog plays in winter in the dry mountainous areas will be explained in the discussion of Landscape 31. Temperature data for Shingwedzi (Table 6) is the most applicable to this landscape.

Soil Pattern

The soils of this landscape are shallow and calcareous. According to Van Rooyen (1978) as much as 10 percent of the surface of the soil is covered by stones and the pH varies between 7.9 and 8.4. Most important soil Forms are Milkwood, Mispah, Glenrosa and Mayo while the occurrence of lithosols are common.

Vegetation

Structurally the two sub-units of this landscape differ from one another. The sub-unit next to the eastern boundary at Shilahlandonga is mainly a shrub savanna (Fig.

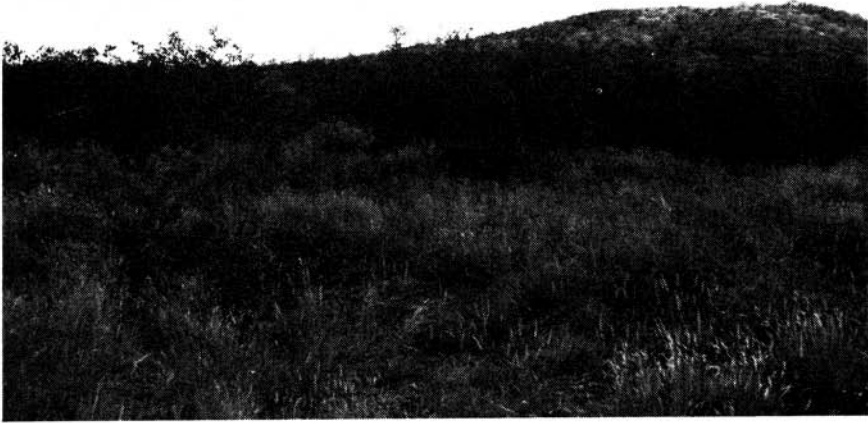


Fig. 60. Landscape 26. *Colophospermum mopane* Shrubveld on Calcrete.

60), while the sub-unit on the western boundary can be regarded as a tree savanna. The dominant woody species are: *Colophospermum mopane*, *Maytenus heterophylla*, *Euclea schimperi*, *Grewia bicolor*, *Acacia nigrescens*, *Combretum apiculatum*, *Terminalia prunioides*, *Euclea divinorum*, *Sterculia rogersii*, *Commiphora mollis*, *Zanthoxylum humilis* and *Dalbergia melanoxylon*.

The field layer is characterised by the presence of species such as *Enneapogon scoparius*, *Seddera capensis* and *Aristida congesta* subsp. *congesta* and *Panicum maximum* does not occur in this area. Other herbaceous species are *Heteropogon contortus*, *Fingerhutia africana*, *Eragrostis superba*, *Digitaria eriantha*, *Rhynchelytrum villosum*, *Indigofera vicioides*, *Rhynchosia totta*, *Barleria lancifolia*, *Tephrosia polystachya*, *Phyllanthus pentandrus*, *Hibiscus micranthus* and *Acalypha indica*.

Androstachys johnsonii-bush occurs on certain slopes of this landscape. The floristic composition of this bush will, however, be described in more detail under Landscape 31.

This landscape as a whole is unique, not only in the KNP but also in South Africa. This fact necessitates special conservation status for the area.

Fauna

This *Colophospermum mopane* Shrubveld on Calcrete is not a landscape that supports a high density of game. Zebra, kudu, steenbok, Sharpe's grysbok, nyala, eland and elephant are the most important animals, but they always occur in small numbers.

27. Mixed *Combretum* spp./*Colophospermum mopane* Woodland

Location and Geomorphology

Where the white sand of Quaternary origin mixes with the gravel and basalt, a landscape occurs that is reasonably flat and the altitude varies between 230 and 475 metres. This area is located north-east of Shingwedzi and is drained by the Hlamalala, Nwaswitsumbe and Nkulumbeni spruits. The landscape covers 329 km² or 1,9 percent of the KNP.

Climate

Rainfall in this area varies between 450 and 500 mm annually. Temperature data is comparable to that of Shingwedzi (Table 6).

Soil Pattern

The soil is of a mixed origin and consists of weathered products of basalt and Quaternary sand and gravel. The soils are deep and sandy at places, but normally well drained. Van Rooyen (1978) states that the soils are neutral (pH between 6,1 and 7,2) and up to 15 percent of the surface is covered with stone or gravel. Dominant Forms are Hutton, Shortlands, Bonheim, Valsrivier, Swartland, Glenrosa, Mispah and Mayo.

Vegetation

The landscape is an open tree veld with a large quantity of medium shrubs (Fig.61). Van Rooyen (1978) classifies it as an open tree savanna. Dominant woody species



Fig. 61. Landscape 27. Mixed *Combretum* spp./*Colophospermum mopane* Woodland.

in the tree and shrub layers are: *Colophospermum mopane*, *Sclerocarya caffra*, *Combretum apiculatum*, *Grewia bicolor*, *Dichrostachys cinerea* subsp. *africana*, *Acacia nigrescens*, *Boscia albitrunca*, *Combretum mossambicense*, *C. zeyheri*, *Euclea divinorum*, *Markhamia acuminata*, *Securinega virosa*, *Commiphora mollis*, *Sterculia rogersii*, *Lonchocarpus capassa*, *Dalbergia melanoxylon*, *Combretum hereroense*, *Bridelia mollis*, *Maytenus heterophylla*, *Grewia flavescens* and *Ziziphus mucronata*. Van Rooyen (1978) describes this landscape as one community viz. the *Colophospermum mopane/Combretum apiculatum/Digitaria eriantha*-open treeveld.

The field layer is moderate to dense and the dominant grasses are: *Digitaria eriantha* var. *pentzii*, *Schmidtia pappophoroides*, *Panicum maximum*, *Aristida congesta* subsp. *congesta*, *Heteropogon contortus*, *Aristida congesta* subsp. *barbicollis*, *Fingerhutia africana*, *Urochloa mosambicensis* and *Brachiaria xantholeuca*. Forbs commonly occurring are: *Vigna unguiculata*, *Tephrosia polystachya*, *Phyllanthus pentandrus*, *Hibiscus micranthus*, *Solanum panduraeforme*, *Neuracanthus africanus*, *Indigofera vicioides*, *Cyphocarpa angustifolia*, *Crotalaria virgulata*, *Euphorbia tettensis*, *Cassia mimosoides*, *Commelina bengalensis*, *Merremia tridentata* and *Lantana rugosa*.

Fauna

This landscape supports a low density of game. Elephant and kudu occur regularly and sable antelope are characteristic. Other species of game which occur regularly but in low densities are zebra, buffalo, giraffe, eland, impala and steenbok.

28. Limpopo/Levubu Floodplains

Location and Geomorphology

As the name indicates, this landscape occurs on the banks of the Limpopo and Levubu Rivers. The underlying material of this area is alluvium that has been deposited over the years on the floodplains along the rivers. This is a low lying landscape with a flat to concave topography. The altitude varies between 200 and 250 metres.

When the Limpopo and Levubu Rivers are both in flood, a blockage takes place above the confluence and because the area is flat, and sometimes concave, flooding of the land adjacent to the rivers takes place. Silt is deposited and pans that normally hold water for a long period such as the Gwalala, Rietbok, Nyala, Nwambi, Hulukulu, Makwadzi, Spokenyolo and Dakamila pans, are filled. This pan veld is a unique characteristic of this landscape while koppies do not occur.

Climate

Purely from a rainfall point of view, this is one of the driest landscapes in the KNP, with an annual average of 438 mm at Pafuri. Moisture is more available in these parts due to the flooding of the river banks. Temperatures are extremely high during summer, but there is no weather station situated near enough to record the temperature variations.

Soil Pattern

The soils of this landscape are alluvial and the material thus probably originates from granite, Waterberg Sandstone, Cave Sandstone, basalt, dolerite as well as other parent rock formations. Expected soil Forms are Inhoek, Dundee and Oakleaf on the floodplains, with Arcadia and Willowbrook soils in the pans.

Vegetation

Van Rooyen (1978) describes the following components of this landscape:

- i) *Colophospermum mopane*/*Acacia tortilis*/*Urochloa mosambicensis*-tree savanna.
- ii) *Acacia albida*/*Ficus sycomorus*-river forest.
- iii) *Acacia xanthophloea*/*Panicum meyerianum*-open tree savanna.
- iv) *Sporobolus consimilis*-grass veld.

The *Colophospermum mopane*/*Acacia tortilis*/*Urochloa mosambicensis*-tree savanna (Fig. 62) occurs on the basalt footslopes. Dominant woody species associated with *Colophospermum mopane* and *Acacia tortilis* are *Maerua parvifolia*, *Grewia bicolor*, *Azima tetracantha*, *Acacia senegal* var. *rostrata*, *Salvadora angustifolia*, *Hyphaene natalensis*, *Commiphora glandulosa*, *Thilachium africanum*, *Ximenia americana*, *Gardenia resiniflua*, *Maytenus heterophylla*, *Dalbergia melanoxylon*, *Acacia nigrescens*, *Gardenia spatulifolia*, *Zanthoxylum humilis*, *Boscia albitrunca* and *Adansonia digitata*. Almost homogeneous stands of baobab occur in certain localities. The field layer is sparse with a large variety of species. Grass species are



Fig. 62. Landscape 28. *Colophospermum mopane*/*Acacia tortilis*/*Urochloa mosambicensis* tree savanna.

Tragus berteronianus, *Aristida congesta* subsp. *barbicollis*, *Chloris virgata*, *Sporobolus smutsii*, *Enneapogon cenchroides* and *Dactyloctenium aegyptium*. Forbs are *Alternanthera pungens*, *Trianthema triguetra*, *Cyathula crista*, *Corbichonia decumbens*, *Pupalia lappacea*, *Hibiscus micranthus*, *H. engleri*, *Indigofera rhytidocarpa*, *Boerhaavia diffusa*, *Ecbolium revolutum*, *Gisekia africana* and *Ipomoea obscura*.

The *Acacia albida*/*Ficus sycomorus*-river forest (Fig. 63) occurs on the banks of the rivers and consists of a large variety of species. Van Rooyen (1978) gives a complete species list, but only a few of the most important species are mentioned here. The community is a closed forest of about 20 metres high. Dense undergrowth with little grass occurs. The most important woody species are: *Acacia albida*, *Ficus sycomorus*, *Acacia robusta*, *Trichilia emetica*, *Xanthocercis zambesiaca*, *Acacia ataxacantha*, *Ficus capreifolia*, *Combretum microphyllum*, *Grewia caffra*, *Diospyros mespiliformis*, *Tabernaemontana elegans*, *Acacia xanthophloea*, *Lonchocarpus capassa*, *Combretum imberbe*, *Acacia tortilis*, *Kigelia africana*, *Maclura africana*, *Albizia harveyi*, *Rauvolfia caffra*, *Ekebergia capensis*, *Strychnos potatorum*, *Breonadia microcephala*, *Syzygium guineense*, *Deinbollia oblongifolia*, *Ochna confusa*, *Nuxia oppositifolia*, *Azima tetracantha*, *Mimusops zeyheri*, *Garcinia livingstonei*, *Croton megalobotrys*, *Hyphaene natalensis* and *Ficus stuhlmannii*.

The field layer of this community is sparse and the following species are important: *Abutilon angulatum*, *Achyranthes aspera*, *Epilates gariepina*, *Hypoetes verticillaris*, *Hibiscus engleri*, *Wissadula rostrata*, *Ageratum conyzoides*, *Cynanchum schistoglossum*. The grass cover is sparse and consists of species such as *Panicum meyerianum*, *Urochloa mosambicensis*, *Echinochloa pyramidalis*, *Chloris gayana*, *Cymosestaria sagittifolia* and *Sporobolus consimilis*.



Fig. 63. Landscape 28. *Acacia albida*/*Ficus sycomorus* river forest.

The *Acacia xanthophloea*/*Panicum meyerianum*-open savanna (Fig. 64) is found in the floodplains. It is a tree veld from between six to 15 metres high and consists of the following species: *Acacia xanthophloea*, *Combretum imberbe*, *Dichrostachys cinerea* subsp. *africana*, *Securinega virosa*, *Combretum mossambicense*, *Lonchocarpus capassa*, *Combretum hereroense*, *Croton megalobotrys*, *Xanthocercis zambesiaca*, *Kigelia africana*, *Hyphaene natalensis*, *Spirostachys africana* and *Maytenus senegalensis*.

The above-mentioned community continues into a *Sporobolus consimilis*-grass veld (Fig. 65) with the disappearance of the woody component to leave an open grass veld. A grass height of two metres can be reached and the dominant species are: *Sporobolus consimilis*, *Setaria sphacelata*, *Panicum meyerianum*, *P. deustum*, *Ischaemum afrum*, *Panicum maximum*, *Chloris gayana*, *Cenchrus ciliaris*, *Echinochloa pyramidalis*, *Phragmites australis* and *Sorghum verticilliflorum*. Forbs that occur occasionally are: *Achyranthes aspera*, *Abutilon guineense* and *Corchorus kirkii*.

The communities occurring in and around the pans consist mainly of the following species: *Sporobolus consimilis*, *Panicum meyerianum*, *Echinochloa pyramidalis*, *Ischaemum afrum*, *Setaria sphacelata*, *Cyperus fastigiatus*, *C. corymbosus*, *C. sexangularis*, *C. immensus*, *C. articulatus*, *C. distans* and *Nymphaea caerulea*.

Fauna

This landscape accommodates the largest population of nyalas in the KNP. Other species of game that are abundant on these floodplains are bushbuck, duiker, buffalo, kudu, waterbuck, impala and elephant bulls. Baboons and vervet monkeys (*Cercopithecus pygerythrus*) are plentiful and recently Samango monkeys (*Cercopithecus albogularis*) were reintroduced. Hippo and crocodile (*Crocodylus niloticus*) are common in the water. This landscape also represents the only confirmed habitat of bushpigs (*Potamochoerus porcus*) in the KNP. This landscape is a paradise for birds, with its dense, high trees and water pans and Newman (1980) gives a complete list of the birds to be found here.

29. Lebombo South

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Location and Geomorphology

The Lebombo Mountains on the eastern side of the KNP form a physiographical unit of its own. Because of climatological reasons this range of mountains is divided into two landscapes. The area between the Crocodile River and Pumbe pan will be dealt with in this landscape. It is an undulating terrain with north/south running ridges and bottomlands. The geological formation is rhyolite and granophyre of the Lebombo Group, Sequence Karoo (Schutte 1982). The altitude varies between 360 metres in the south to 300 metres in the northern areas. The Lebombo Mountains are situated almost 100 metres higher than the adjacent basalt plains and sometimes form a low escarpment on the western slopes. All the large rivers and spruits that either flow through, or originate in the KNP, break through the Lebombo Mountains at some stage to form deep incisions or gorges. Of these the Crocodile, Sabie,



Fig. 64. Landscape 28. *Acacia xanthophloea* tree savanna.



Fig. 65. Landscape 28. *Hyphaene natalensis* fringe around a *Sporobolus consimilis* grassveld.

Nwaswitsontso and Nwanedzi River gorges are certainly the best known. This landscape covers 765 km² or 4,8 percent of the area of the KNP.

Climate

The rainfall on the Lebombo Mountain diminishes from south to north. In the vicinity of the Crocodile River the average annual rainfall is probably close to 700 mm and it drops to 500 mm in the vicinity of Pumbe. According to Gertenbach (1980) the isohyets turn northwards on the Lebombo Mountains which implies that the area is wetter than the adjacent basalt plains. The temperature on the western mountain side becomes extremely high in summer with no possibility of frost in winter.

Soil Pattern

The soils in the Lebombo Mountains can best be described as lithosols. Occasionally shallow soils from the Mispah and Glenrosa Forms can be expected, but this is the exception. The terrain is less undulating to the east of Muntche and deeper soils of the Swartland and Glenrosa Forms are present.

Vegetation

The vegetation of the landscape is divided by Coetsee (1983) into 12 associations (Fig. 66). The most common woody species are *Combretum apiculatum*, *Boscia albitrunca*, *Acacia exuvialis*, *Dichrostachys cinerea* subsp. *africana*, *Cassia abbreviata*, *Albizia harveyi*, *Tephrosia sericea*, *Kirkia acuminata*, *Commiphora mollis*, *Securinega virosa*, *Croton gratissimus*, *Euphorbia confinalis*, *E. cooperi*, *Sclerocarya caffra*, *Lannea stuhlmannii*, *Ozoroa engleri*, *Grewia bicolor*, *G. flavescens*, *Sterculia rogersii*, *Pappea capensis*, *Manilkara mochisia*, *Tricalysia allenii* and *Pavetta catophylla*. Under special circumstances a combination of the following species and those mentioned above may be found: *Maclura africana*, *Ficus ingens*, *F. soldanella*, *F. sycomorus*, *Pouzolzia hypoleuca*, *Olex dissitiflora*, *Portulacaria afra*, *Erythrina humeana*, *Monodora junodii*, *Maerua rosmarinoides*; *Thylacium africanum*, *Albizia brevifolia*, *Acacia burkei*, *Azelia quanzensis*, *Erythroxylum emarginatum*, *Vepris reflexa*, *Commiphora harveyi*, *Iboza riparia*, *Acacia caffra*, *Ptaeroxylon obliquum*, *Rhus gueinzii*, *Hippocratea longipetiolata*, *Berchemia zeyheri*, *Dombeya cymosa*, *Ochna natalitia*, *Galpinia transvaalica*, *Elephantorrhiza burkei*, *Combretum zeyheri*, *Terminalia phanerophlebia*, *Strychnos decussata*, *S. madagascariensis*, *Hymenodictyon parvifolium*, *Kraussia floribunda* and *Vangueria infausta*.

A community especially highlighted by Coetsee (1983) are the dry slopes where *Acacia erubescens* occur in association with *Combretum apiculatum*. The distribution of *Acacia burkei* is limited to the southernmost Lebombo Mountains near Komatipoort. In this case it is the sandveld variation of the species that occurs more commonly in Swaziland and Natal. East of Muntshe a short shrubveld of *Pterocarpus rotundifolius* and *Acacia gerrardii* (Fig. 67) occurs, with a dense stand of grass consisting of *Themeda triandra* and *Digitaria eriantha* var. *pentzii*. *Terminalia phanerophlebia* is a species which is virtually limited to the more mesic



Fig. 66. Landscape 29. Le bombo South.



Fig. 67. Landscape 29. *Pterocarpus rotundifolius* shrubveld east of Muntshu.

Lebombo Mountains, while Van Wyk (1973) maintains that *Newtonia hildebrandtii* occurs only in dry gorges in certain areas of the Lebombo Mountains. *Adansonia digitata* and *Androstachys johnsonii* like *Newtonia hildebrandtii* are restricted to the drier habitats of the Lebombo North (Landscape 31).

Grasses common in the rocky surroundings are: *Digitaria eriantha* var. *pentzii*, *Panicum maximum*, *Brachiaria xantholeuca*, *Enneapogon cenchroides*, *Aristida congesta* subsp. *barbicollis*, *Pogonarthria squarrosa*, *Heteropogon contortus*, *Themeda triandra*, *Schmidtia pappophoroides*, *Andropogon gayanus*, *Brachiaria nigropedata* and *Bothriochloa radicans*. According to Coetzee (1983), the following forbs occur in the Lebombo Mountains: *Pallaea calomelanos*, *P. viridis*, *Mariscus dregeanus*, *Kyllinga alba*, *Commelina africana*, *C. bengalensis*, *Aloe chabaudii*, *A. sessiliflora*, *Sansevieria hyacinthoides*, *S. dessertii*, *Asparagus falcatus*, *A. minutiflorus*, *Dioscorea sylvatica*, *Pupalia lappacea*, *Achyranthes aspera*, *Kalanchoe rotundifolia*, *Indigofera vicioides*, *Acalypha indica*, *Jatropha variifolia*, *Cissus rotundifolia*, *C. quadrangularis*, *Cyphostemma subciliatum*, *Abutilon angulatum*, *A. ramosum*, *Hibiscus lunariifolius*, *H. micranthus*, *Adenia hastata*, *Sarcostemma viminalis*, *Ipomoea albivenia*, *Paederia foetens*, *Coccinia rehmannii* and *Bidens ternata*.

Fauna

The game which is most common in this landscape are kudu, impala, giraffe, buffalo bulls and waterbuck. Waterbuck move into the Lebombo Mountains during the rainy season when water is available. For the rest of the dry season they keep to permanent water points on the flat plains. Other species of game that occur less frequent are zebra, elephant breeding herds and warthog. Wildebeest occur only in the *Pterocarpus rotundifolius* shrubveld behind Muntshu. Reedbuck also occur in small numbers. Klipspringers are plentiful.

30. Pumbe Sandveld

Location and Geomorphology

Quaternary sand from the Cretaceous period occurs extensively in the Lebombo Mountains in Mozambique. Only a small extension of this landscape occurs in the KNP in the vicinity of Pumbe, northeast of Satara. The terrain is flat or concave and is characterised by various pans with a lot of loose pebbles in the soils. The altitude of this landscape is about 380 metres a.s.l. and occupies 177 km² or 0.1 percent of the area of the KNP.

Climate

According to Gertenbach (1980) this area receives between 500 and 550 mm of rain per annum. The sandy soils have a higher availability of moisture and therefore this area has more available moisture than would be expected. Temperatures are comparable to that of Satara as shown in Table 3.

Soil Pattern

The soils of the landscape vary from deep sandy soils to shallow lithosols with a lot of pebbles in the horizon. The dominant Form is Hutton, with Portsmouth and Shorrocks as the most important Series. Mispah soils are commonly found and in certain places it is a pure lithosol. The bottoms of the pans consist of pebble-beds cemented with hard plinthite (Fig. 69).

Vegetation

The vegetation is a medium to high shrub savanna with almost no big trees (Fig. 68). The grass layer has a moderate cover. Dominant woody species are: *Combretum zeyheri*, *C. apiculatum*, *C. molle*, *Terminalia sericea*, *Cassia abbreviata*, *Lonchocarpus capassa*, *Lannea stuhlmannii*, *Dalbergia melanoxylon*, *Dichrostachys cinerea* subsp. *africana*, *Tephrosia sericea*, *Acacia nigrescens* and *Ozoroa engleri*. According to Pienaar (1963) the Pumbe Sandveld has the following rare species in common with Landscape 34: *Pseudolachnostylis maprouneifolia*, *Afzelia quanzensis*, *Combretum collinum* subsp. *gazense*, *Salacia kraussii* and *Eugenia zeyheri*. Recently *Diospyros usambarensis* was collected near Pumbe as a record from the KNP.

The field layer is sparse and the following species occur: *Panicum maximum*, *Digitaria eriantha* var. *pentzii*, *Schmidtia pappophoroides*, *Brachiaria nigropedata*, *Heteropogon contortus*, *Enneapogon cenchroides*, *Pogonarthria squarrosa*, *Eragrostis superba*, *Aristida congesta* subsp. *barbicollis*, *Cymbopogon plurinoidis* and *Urochloa mosambicensis*. Forbs include among others, the following: *Heliotropium steudneri*, *Aptosimum lineare*, *Indigofera filipes*, *Kohautia virgata* and *Agathisanthemum bojeri*.

Fauna

Pienaar (1963) maintains that this landscape is not a specific habitat for larger mammals. Coetzee (1983) records the occurrence of a small fish (*Nothobranchius rachovii*) in the Pumbe pans. This is the only area in South Africa where this fish occurs (Pienaar 1978). *Nothobranchius orthonotus* occurs only in pans in the Pumbe and Nwambia Sandveld.

Great excitement prevailed when, in April 1981, a specimen of the lungfish (*Protopterus annectens brienii*) was collected from the Pumbe pan. This was the first record of this fish in South Africa.

Buffalo, zebra, impala, giraffe and warthog have been observed in this area.

31. Lebombo North

Location and Geomorphology

This landscape is the extension of Landscape 29 on the rhyolites of the Lebombo Mountains. There is, never the less, good motivation as to why it is classified as a separate landscape, as will be seen from the descriptions of the climate and vegetation composition. This area extends from Pumbe sandveld northwards to the Shingwedzi River with Singomeni as a detached unit further north. The Lebombo Mountains are intersected west/east by deep incisions of the Olifants and



Fig. 68. Landscape 30. Pumbe Sandveld.



Fig. 69. Landscape 30. Pumbe Pan with pebble-bed.

Shingwedzi Rivers. This part of the landscape just north of the Olifants River, is drained south and south-west by a number of spruits of which the Mkhadzi, Mhthalmhala, Msimbitsane, Masaka and Marhandzala are the most important drainage channels.

The Lebombo Mountains in this area are situated between 300 and 400 metres a.s.l. and are strongly undulating with dense bushy ravines. This landscape covers 480 km² or 2,9 percent of the area of the KNP.

Climate

Climate and more specifically rainfall, is the most important reason why the Lebombo range has been divided into two landscapes. The rainfall in the northern part of the Lebombo Mountains varies between 450 and 500 mm annually. The occurrence of fog in the vicinity of the river gorges in the Lebombo Mountains contributes extensively to the availability of moisture to plants in this area. The temperature is high in summer with the absence of frost in winter. Temperature data from Letaba (Table 6) are applicable to this landscape.

Soil Pattern

The soils of this landscape are shallow and rocky and in most cases it cannot be classified as soil. Up to 80 percent of the surface can be covered with stones and rocks.

Vegetation

The vegetation of this landscape is very similar to that of the Lebombo South (Landscape 29) except that it is slightly drier (Fig. 70). The vegetation is conse-



Fig. 70. Landscape 31. Lebombo North.

quently less mesic and the following species are present: *Combretum apiculatum*, *Commiphora mollis*, *Kirkia acuminata*, *Euphorbia confinalis*, *E. cooperi*, *Ximenia caffra*, *Grewia flavescens*, *G. bicolor*, *G. hexamita*, *Cassia abbreviata*, *Tricalysia allenii*, *Boscia albitrunca*, *Croton gratissimus*, *Rhus gueinzii*, *Adenia spinosa*, *Rhoicissus revoilii*, *Phyllanthus reticulatus*, *Capparis tomentosa*, *Gardenia resiniflua*, *Elephantorrhiza burkei*, *Cissus rotundifolius*, *Strychnos decussata*, *Pavetta schumanniana*, *Lannea stuhlmannii*, *Sclerocarya caffra*, *Combretum mossambicense* and *Ficus soldanella*. The drier habitat of this landscape provides ideal habitat for trees such as *Adansonia digitata* and *Androstachys johnsonii* and they occur frequently on the slopes and in the ravines. Other rare species that occur sporadically are listed in Landscape 29.

The field layer on the Lebombo Mountains is naturally sparse, considering that 80 percent and more of the soil surface is covered with rock. Dominant grasses are *Panicum maximum*, *Digitaria eriantha* var. *pentzii*, *Heteropogon contortus*, *Enneapogon cenchroides* and *Aristida congesta* subsp. *barbicollis*. Forbs that occur regularly are *Barleria affinis*, *Tragia dioica*, *Heliotropium steudneri* and *Cardiospermum halicacabum*.

A characteristic attribute of this landscape is the occurrence of dense thickets of *Androstachys johnsonii* (Fig. 71), especially in the vicinity of the Olifants River valley. Coetzee (1983), Van Rooyen (1978) and Van Wyk (1973) provide descriptions of the composition of this bush. It is a dense forest community with closed canopies and is completely dominated by *Androstachys johnsonii*. Other species that occur are *Euphorbia confinalis*, *Phyllanthus reticulatus*, *Entandrophragma caudatum*, *Strophanthus kombe*, *Croton pseudopulchellus*, *Hymenodictyon parvifolium* and *Boscia albitrunca*. The field layer is usually very sparse to absent and the following species may be present: *Aristida congesta* subsp. *barbicollis*, *Cymbosetaria sagittifolia*, *Brachiaria xantholeuca*, *Cyperus rupestris* and *Selaginella dregei*.



Fig. 71. Landscape 31. *Androstachys johnsonii* bush on the Lebombo Mountains.

Van Rooyen (1978) describes *Androstachys johnsonii* bush in the Punda Maria area, and according to him the following woody species can be associated with the above-mentioned: *Pouzolzia hypoleuca*, *Euphorbia espinosa*, *Dombeya kirkii*, *Monodora junodii*, *Vitex amboniensis*, *Alchornea laxiflora*, *Cassia abbreviata* and *Combretum apiculatum*. The following species occur in the field layer: *Sporobolus panicoides*, *Enteropogon macrostachyus*, *Setaria ustilata*, *Leptocarydion vulpiastrum*, *Cymbosetaria sagittifolia*, *Danthoniopsis pruinosa*, *Panicum heterostachyum*, *Pseudobrachiaria deflexa*, *Achryanthes sicula*, *Celosia trigyna*, *Selaginella dregei*, *Cleome monophylla*, *Corchorus longipedunculatus*, *Blainvillea gayana*, *Xerophyta equisetoides* and *X. humilis*. It would appear that the *Androstachys johnsonii* bush at Punda Maria is more mesic than that of the Lebombo Mountains.

A characteristic of both these variations of the *Androstachys johnsonii* bush is the occurrence of the lichen, *Usnea poliotrix*. Under normal circumstances this climate would be too dry for this lichen and it can therefore be speculated that moisture, other than that coming from rain, plays a role in the occurrence of *U. poliotrix* as well as the *Androstachys johnsonii* bush. The regular occurrence of fog can perhaps play a role (Coetzee 1983). All areas where this plant community occurs are subject to regular fog and moisture may possibly be absorbed by the system in this manner.

Fauna

Kudu are the most important large mammal moving about in the Lebombo Mountains. Buffalo, impala, zebra, waterbuck and warthog occur regularly but in smaller numbers. Sharpe's grysbok, duikers and bushbuck occur in the dense ravines and in the *Androstachys johnsonii* bush. Giraffe is also present in this area. Elephant breeding herds occur regularly in the Lebombo Mountains just north and south of the Olifants River valley. Nyalas may be found along the lower Letaba and Mkhadzi and eland are sometimes seen in the vicinity of Longwe. The most important habitat for sable antelope has probably been fenced off by the boundary fence, but a small herd occurs along the Kalabyene spruit.

According to Newman (1980), the crested guinea fowl (*Guttera edouardi*) occurs in small numbers on the northern Lebombo Mountains, especially in the dense *Androstachys johnsonii* bush.

32. Nwambia Sandveld

Location and Geomorphology

After the formation of the Malvernian System was completed (Schutte 1974), there was a period of dry desert-like conditions under which sand was deposited. The colour of this sand is either red or yellow and can be present up to a depth of 30 metres. These sands are widely spread in Mocambique, but in the KNP they only occur in a small area on the western boundary between Shingwedzi and Pafuri. It is a flat landscape and the altitude varies between 474 and 530 metres.

A characteristic of the geomorphology is the absence of well defined drainage channels and the presence of a variety of pans. Good examples are Mathlakuza,

Shirombe, Nwambia, Magwitsi, Machayi, Masokosa, and Klawer pans. The landscape covers 139 km² or 0.8 percent of the area of the KNP.

Climate

There are no weather stations near Nwambia Sandveld and according to Gertenbach (1980) the rainfall probably varies between 450 and \pm 500 mm per year. If it is taken into consideration that this landscape lies at almost the same altitude as does Punda Maria, then it can be speculated that the rainfall may possibly be higher and the temperatures are also comparable to that of Punda Maria (Table 7).

Soil Pattern

The soils are deep, sandy, from yellow to red in colour and the pH varies between 4,3 and 5,5. Soil Forms are Hutton and Clovelly, with Gaudam and Sandspruit respectively as the dominant Series. Red sandy soils occur mainly in the eastern part of the landscape while yellow soils occur in the western parts. Heavy structured soils are present next to the pans with Valsrivier and Sterkspruit being the common Forms.

Vegetation

This is a tall shrubveld with very few trees. The crown cover of the woody species range up to 80 percent and the shrubs are mostly between two and four metres high. The structure of the vegetation, however, depends mainly on the plant communities as described by Van Rooyen (1978). There are three basic communities:

- i) The *Baphia massaiensis*/*Guibourtia conjugata*-thickets.
- ii) The *Xeroderris stuhlmannii*/*Combretum apiculatum*-tree savanna.
- iii) The *Terminalia sericea*/*Pogonarthria squarrosa*-tree savanna.

The *Baphia massaiensis*/*Guibourtia conjugata*-thickets (Fig. 72) occur in the eastern parts of the landscape on the red soils. It is a dense tall shrubveld with no trees. Dominant woody species are: *Baphia massaiensis*, *Guibourtia conjugata*, *Xylia torreana*, *Combretum celastroides*, *Hugoniq orientalis*, *Pteleopsis myrtifolia*, *Vitex amboniensis*, *Alchornea laxiflora*, *Grewia microthyrsa*, *Vangueria infausta*, *Hexalobus monopetalus*, *Spirostachys africana*, *Dichrostachys cinerea*, *Ptaeroxylon obliquum*, *Pavetta catophylla*, *Heinsia crinata*, *Zygoon graveolens*, *Combretum zeyheri* and *Strychnos madagascariensis*. The following rare species also occur in this landscape: *Pterocarpus antunesii*, *Drypetes mossambicensis*, *Cleistanthus schlechteri*, *Croton steenkampiana*, *Dalbergia nitidula* and *Uvaria lucida* subsp. *virens*.

The field layer is weakly developed and the following species contribute the most towards the cover: *Eragrostis pallens*, *Digitaria eriantha* var. *pentzii*, *Panicum maximum*, *Perotis patens*, *Brachiaria nigropedata*, *Tricholaena monachne*, *Aristida argentea*, *Pogonarthria squarrosa*, *Phyllanthus burchelli*, *Merremia tridentata*, *Indigofera vicioides*, *Vigna unguiculata*, *Commelina erecta* and *Borreria scabra*. From the list of plants above it can be deduced that this community is unique in the

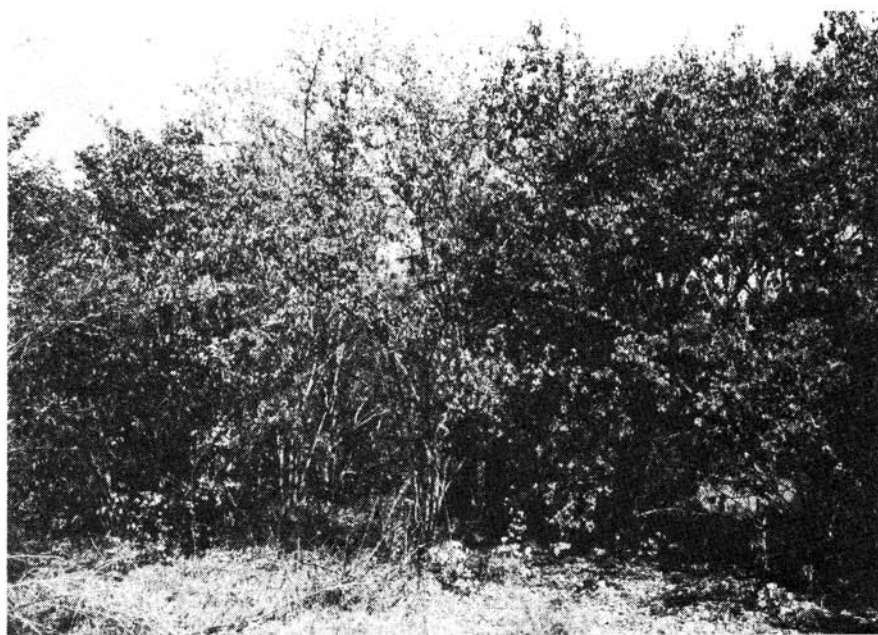


Fig. 72. Landscape 32. Nwambia Sandveld *Baphia massaiensis* thickets.



Fig. 73. Landscape 32. Nwambia Sandveld, *Xeroderris stuhlmannii* tree savanna.

KNP, but it is also unique in South Africa. It gives great priority to the conservation status of this area.

The *Xeroderris stuhlmannii*/*Combretum apiculatum*-tree savanna (Fig. 73) occurs on the yellow sands west of the previous community. It is a tree savanna with moderately high and low shrubs and a better developed field layer. Dominant trees and shrubs are: *Xeroderris stuhlmannii*, *Sclerocarya caffra*, *Combretum apiculatum*, *Adansonia digitata*, *Azelia quanzensis*, *Terminalia sericea*, *Combretum collinum* subsp. *suluense*, *Dalbergia melanoxylon*, *Strychnos madagascariensis*, *Balanites maughanii*, *Guibourtia conjugata*, *Zygoon graveolens*, *Vangueria infausta*, *Cissus cornifolia*, *Combretum mossambicense*, *Grewia monticola*, *Pteleopsis myrtifolia*, *Grewia bicolor* and *Boscia albitrunca*. *Spirostachys africana* is the dominant plant species around the pans where brackish soils occur.

Other plants that occur in the same habitat are: *Dichrostachys cinerea*, *Combretum imberbe*, *Euphorbia ingens*, *Diospyros mespiliformis*, *Ehretia amoena*, *Lonchocarpus capassa*, *Gardenia spatulifolia*, *Boscia albitrunca*, *Berchemia discolor*, *Dalbergia melanoxylon* and *Crossopteryx febrifuga*. The field layer of this community is better developed and the following species are present: *Aristida stipitata*, *A. junciformis*, *Digitaria eriantha* var. *pentzii*, *Panicum maximum*, *Schmidtia pappophoroides*, *Tricholaena monachne*, *Eragrostis pallens*, *Aristida congesta* subsp. *congesta*, *Pogonarthria squarrosa*, *Tephrosia polystachya*, *Vigna unguiculata*, *Merremia tridentata*, *Ipomoea magnusiana*, *Borreria scabra*, *Commelina africana*, *Rhynchosia resinosa*, *Euphorbia tettensis*, *Monechma monechmoides* and *Melhania forbesii*.

The *Terminalia sericea*/*Pogonarthria squarrosa*-tree savanna occurs in the southwestern part of this landscape but is more characteristic of Landscape 16, viz. the Punda Maria Sandveld on Cave Sandstone and was discussed in more detail in that landscape. This community is dominated by *Terminalia sericea* with *Kirkia acuminata*, *Lannea stuhlmannii*, *Sclerocarya caffra*, *Xeromphis obovata*, *Combretum zeyheri* and *Strychnos madagascariensis* as constant species.

The pans in the Nwambia area (Fig. 74) are characterised by the following plant species: *Nymphaea capensis*, *N. caerulea*, *Ottelia exserta*, *Paspalidium obtusifolium*, *Convolvulus mauritanicus*, *Neptunia oleracea*, *Bergia salaria*, *Epaltes gariiepina*, *Marsilea macrocarpa*, *Potamogeton schweinfurthii*, *Lagarosiphon crispus*, *Cyperus difformis*, *Fuirena ciliaris*, *Vahlia capensis* and *Buchnera longespicata*.

Fauna

The Nwambia Sandveld is the only area in the KNP where there is a confirmed evidence of the occurrence of the soeni (*Nesotragus livingstonianus zuluensis*). This area is also the only habitat for the Limpopo golden mole (*Calcholoris obtusirostris limpopoensis*) in the KNP (Pienaar, Rautenbach & De Graaff 1980). In addition to the uniqueness of this habitat it is also the only place where a variety of the lower vertebrates are to be found. Larger mammals occur in relatively smaller numbers. Of these kudu and grey duiker are certainly the most important. Other species which occur are elephant, buffalo, sable antelope, nyala, zebra, eland, steenbok, Sharpe's grysbok and giraffe (Pienaar 1963).

The crested guineafowl (*Guttera edouardi*) occur in large numbers in this Nwambia Sandveld where, with the exception of Punda Maria and areas in the Lebombo range, they are relatively scarce in the KNP. The small fish *Nothobranchius orthonotus* and *N. rachovii* occur only in this and the Pumbe vicinity (Pienaar 1978).

33. *Pterocarpus rotundifolius*/*Combretum collinum* Woodland

Location and Geomorphology

This landscape occurs as isolated spots between the Shingwedzi River and Punda Maria in the northwest of the KNP. The underlying material is classified by Schutte (1974) as andesite and tuff of the Waterberg System in the northern sub-regions, and schist and banded ironstone, amphibolite and undifferentiated metamorphic formations of the Swaziland System in the southern sub-regions. The terrain is flat to undulating and is drained by the Timatoro, Bububu, Dothole, and Phugwane. The Boshahuka ridge and Busizi koppies are outstanding points in this landscape. The altitude of this landscape varies between 400 and 450 metres a.s.l. and covers 180 km² or 0,9 percent of the area of the KNP.

Climate

According to Gertenbach (1980) this area receives between 500 and 600 mm of rain annually. The longterm average rainfall for Shangoni is 573 mm. Regarding temperature, this landscape experiences a climate similar to Punda Maria (Table 7).

Soil Pattern

The soils of this landscape are dark, reddish brown in colour and are relatively deep in comparison to soils originating from the surrounding granite. The most important soil Forms that occur here are Hutton and Glenrosa, with Makatini/Marikana/Hardap and Dothole/Ponda respectively as the dominant Series. The soils are very clayey (between 35 and 55% clay) in the B-horizon and has a massive apedal structure. Shallow lithosols occur on the above-mentioned koppies.

Vegetation

The vegetation of this landscape is a sparse shrub savanna with a few small trees (Fig. 75). The dominant woody species are *Pterocarpus rotundifolius* and *Combretum collinum* subsp. *suluense*. The higher the clay content of the soil, the denser the stands of *Pterocarpus rotundifolius*. Other woody species that occur are: *Combretum imberbe*, *C. apiculatum*, *C. hereroense*, *Cissus cornifolia*, *Neorautanenia amboensis*, *Lannea discolor*, *Lonchocarpus capassa*, *Ozoroa engleri*, *Maytenus heterophylla*, *Combretum molle*, *Acacia nigrescens*, *Dichrostachys cinerea* subsp. *nyassana*, *Dombeya rotundifolia*, *Albizia harveyi*, *Ximenia caffra*, *Acacia gerrardii*, *Lannea stuhlmannii*, *Tephrosia sericea*, *Cassia abbreviata*, *Securinega virosa* and *Colophospermum mopane*. Although the list of plants is a long one, not all occur together and when a species does occur it is usually an individual. This landscape is interesting considering that it is situated as an island in the mopane veld with very few mopane's in the landscape itself.



Fig. 74. Landscape 32. Nwambia Sandveld, Shirombe pan.



Fig. 75. Landscape 33. *Pterocarpus rotundifolius*/*Combretum collinum* Woodland.

The field layer of this landscape is dense with definite differentiating species. Such species are: *Setaria holstii*, *Urochloa brachyura* and *Oxalis latifolia*. Other grass species that are usually present are: *Themeda triandra*, *Digitaria eriantha* var. *pentzii*, *Panicum coloratum*, *Cymbopogon plurinodis*, *Brachiaria nigropedata*, *Panicum maximum*, *Aristida congesta* subsp. *barbicollis*, *Rhynchelytrum repens*, *Heteropogon contortus*, *Urochloa mosambicensis*, *Cenchrus ciliaris* and *Eragrostis rigidior*. Forbs occurring are the following: *Cassia mimosoides*, *Vernonia fastigiata*, *Indigofera rhytidocarpa*, *I. vicioides*, *Kohautia virgata*, *Corchorus asplenifolius*, *Ipomoea obscura*, *Hermannia glandiliger*, *Rhynchosia minima*, *Aspilia mossambicensis*, *Jatropha zeyheri*, *Striga asiatica* and *Crabbea velutina*.

An example of the vegetation composition on one of the koppies is as follows:

Woody species	Herbaceous species
<i>Combretum apiculatum</i>	<i>Panicum maximum</i>
<i>Acacia nigrescens</i>	<i>Andropogon gayanus</i>
<i>Elephantorrhiza burkei</i>	<i>Urochloa mosambicensis</i>
<i>Grewia monticola</i>	<i>Heteropogon contortus</i>
<i>Pterocarpus rotundifolius</i>	<i>Urochloa brachyura</i>
<i>Cissus cornifolia</i>	<i>Brachiaria xantholeuca</i>
<i>Ozoroa engleri</i>	<i>Digitaria eriantha</i> var. <i>pentzii</i>
<i>Combretum collinum</i>	<i>Hermannia glandiliger</i>
<i>Combretum hereroense</i>	<i>Stylosanthus fruticosa</i>
<i>Maytenus heterophylla</i>	<i>Jasminum stenolobum</i>
<i>Bauhinia kirkii</i>	<i>Vigna triloba</i>
<i>Dombeya rotundifolia</i>	<i>Cucumis africanus</i>
<i>Lantana rugosa</i>	<i>Asparagus plumosus</i>
<i>Diplorhynchus condylocarpon</i>	<i>Dyschoriste rogersii</i>
	<i>Vernonia fastigiata</i>
	<i>Solanum panduriforme</i>
	<i>Ipomoea obscura</i>
	<i>Aspilia mossambicensis</i>
	<i>Tragia dioica</i>
	<i>Commelina bengalensis</i>

Fauna

This landscape is apparently ideal habitat for roan antelope, because a herd occurs in every sub-unit. Zebra, sable, eland, kudu, impala, and buffalo are generally present but only elephant bulls stay in the vicinity. The largest "tusker" in the world, an elephant bull known as Mafunyane, was also regularly seen in this area. Tsesebe are often observed in this landscape. Smaller antelope such as steenbok and Sharpe's grysbok are well represented.

34. Punda Maria Sandveld on Waterberg Sandstone

Location and Geomorphology

Sandstone of the Waterberg System occurs extensively in the north-western portion of the KNP around Punda Maria. It is a dissected landscape with mountains and



Fig. 76. Landscape 34. Punda Maria Sandveld on Waterberg Sandstone. *Burkea africana* tree savanna.

plains that accommodate a variety of habitats. The area is drained by tributaries of the Levubu River such as Shidzivane, Mangovane, Matukwala and Shipudza. Mountains are relatively common and the following are the most conspicuous Gumbandevu, Shitshowa, Dongadziva, Thulamila and Mikambeni. Springs are common in this landscape and a few of them are reasonably permanent such as Shipudza, Shipale, Shilalani and the warm water spring at Tshalungwa. These springs are a unique characteristic of this landscape.

Diabase sills and dykes intruded into the Waterberg System, similar to dolerite. These intrusions have a big influence on the type of soil that originates and the vegetation that occurs. The area is relatively high lying and varies greatly in altitude as a result of the mountains. The altitude varies between 420 and 580 metres. The landscape covers 297 km² or 1,7 percent of the area of the KNP.

Climate

The Punda Maria environment has a moderate climate with an annual rainfall of \pm 600 mm. The temperature is never as high as in the lower lying areas and as an example the temperature data for Punda Maria (Table 7) is applicable to this area. As a result of the great differences in altitude, slope and aspect there is a great variation in habitat especially as far as the micro-climate is concerned.

Soil Pattern

The soils in this landscape vary from lithosols in the mountains to deep sandy soils on the middleslopes and brackish soils in the bottomlands. Dominant soil Forms on the mountains are Mispah and Glenrosa, while Hutton, Clovelly and Glenrosa

dominate the middleslopes. The bottomlands are dominated by soil Forms such as Valsrivier, Hutton, Swartland and Sterkspruit. Where diabase intrusions and sills occur the soils are more clayey and the following soil Forms can be expected: Shortlands, Hutton, Bonheim and Swartland.

Vegetation

The vegetation of this landscape as described by Van Rooyen (1978) is divided into the following communities:

- i) The *Burkea africana*/*Pseudolachnostylis maprouneifolia*-tree savanna.
- ii) The *Kirkia acuminata*/*Afzelia quanzensis*/*Combretum apiculatum*-tree savanna.
- iii) The *Androstachys johnsonii*/*Croton pseudopulchellus*-dry woodland.
- iv) The Diabase Community.

The *Burkea africana*/*Pseudolachnostylis maprouneifolia*-tree savanna (Fig. 76) occurs on deep sand to loam soils of the Hutton and Clovelly Forms. It is a tree savanna and Van Rooyen (1978) describes the structure in the following table.

Stratum	Percentage Crown Distribution
>6 metres	2
4-5 metres	5
3 metres	11
2 metres	14
1 metres	13
0,5 metre	10

Dominant woody species are: *Burkea africana*, *Pteleopsis myrtifolia*, *Pseudolachnostylis maprouneifolia*, *Hymenocardia ulmoides*, *Bauhinia galpinii*, *Diplorhynchus condylocarpon*, *Ochna pulchra*, *Holarrhena pubescens*, *Terminalia sericea*, *Guibourtia conjugata*, *Combretum collinum*, *Peltophorum africanum*, *Monodora junodii*, *Combretum zeyheri*, *Strychnos madagascariensis*, *Combretum apiculatum*, *Hexalobus monopetalus* and *Dalbergia melanoxylon*.

This community is also the home for a few rare species such as: *Acacia polyacantha* subsp. *campylacantha*, *Xylopia odoratissima*, *Crossopteryx febrifuga*, *Drypetes gerrardii*, *Pterocarpus angolensis*, *Heteropyxis natalensis*, *Turraea nilotica*, *Tylosema fassoglense*, *Combretum molle*, *Markhamia acuminata*, *Securidaca longipedunculata* and *Albizia versicolor*.

The field layer is moderate to dense and is characterised by the presence of the following species: *Andropogon gayanus*, *Digitaria eriantha* var. *pentzii*, *Panicum maximum*, *Fimbristylis hispidula*, *Pogonarthria squarrosa*, *Aristida argentea*, *Merremia tridentata*, *Agathisanthum bojeri*, *Vernonia fastigiata*, *Hermannia glanduligera*, *Tricholaena monachne*, *Rhynchosia totta*, *Perotis patens*, *Brachiaria nigropedata*, *Eragrostis pallens* and *Vigna unguiculata*.

The *Kirkia acuminata*/*Afzelia quanzensis*/*Combretum apiculatum*-tree savanna (Fig. 77) occurs mainly on steep slopes with stony soils. It is a moderate tree savanna and the following species are common: *Kirkia acuminata*, *Afzelia quanzensis*, *Croton*



Fig. 77. Landscape 34. Punda Maria Sandveld on Waterberg Sandstone. *Kirkia acuminata* tree savanna.

gratissimus, *Guibourtia conjugata*, *Combretum apiculatum*, *Hymenocardia ulmoides*, *Diplorhynchus condylocarpon*, *Monodora junodii*, *Hexalobus monopetalus*, *Combretum zeyheri*, *Strychnos madagascariensis*, *Rhoicissus revoilii*, *Bridelia mollis*, *Phyllanthus reticulatus*, *Alchornea laxiflora*, *Maytenus mossambicensis*, *Artabotrys brachypetalus*, *Tricalysia allenii* and *Tephrosia sericea*. Rare species that occur mainly in this community are: *Gyrocarpus americanus*, *Warburgia salutaris*, *Wrightia natalensis*, *Albizia tanganyicensis*, *Schrebera argyrotricha*, *Entandrophragma caudatum*, *Brachylaena huillensis*, *Elephantorrhiza burkei*, *Rhus leptodictya*, *Lagynias dryadum*, *Landolphia kirkii* and *Canthium huillense*.

The following plants are present in the bush ravines on the mountains of this landscape: *Cussonia spicata*, *Cordia grandicalyx*, *Ficus sansibarica*, *Rhus gueinzii*, *Urera tenax*, *Landolphia kirkii*, *Schotia brachypetala*, *Vepris reflexa*, *Erythrina lysistemon*, *Bridelia mollis*, *Pouzolzia hypoleuca*, *Bauhinia galpinii*, *Tecomaria capensis*, *Albizia versicolor*, *Cassine aethiopica*, *Schrebera alata*, *Strychnos usambarensis*, *Brachylaena huillensis*, *Acacia ataxacantha* and *Heteropyxis natalensis*.

The field layer of the *Kirkia acuminata*/*Azelia quanzensis*/*Combretum apiculatum* tree savanna have a low crown cover, with the following dominant grass species: *Digitaria eriantha* var. *pentzii*, *Panicum maximum*, *P. deustum* and *Pogonarthria squarrosa*. Commonly occurring forbs are *Pellaea viridis*, *P. calomelanos*, *Euphorbia polycnemoides*, *Cyphocarpa angustifolia*, *Asparagus falcatus*, *Indigofera lapatana*, *Achyranthes sicala*, *Triumfetta pentandra* and *Crabbea velutina*.

The *Androstachys johnsonii*/*Croton pseudopulchellus*-dry woodland occurs on the

drier slopes of the mountains and the composition of this woodland has already been discussed under Landscape 31. The same applies to the *Colophospermum mopane*/*Euclea divinorum*/*Enteropogon macrostachyus* high tree savanna that occurs on the brackish soils of the bottomlands of the landscape and this has been discussed in detail under Landscape 15.

The soils of the diabase intrusions and sills are more clayey and a unique community occurs. It is a shrub savanna with the following important woody species: *Combretum hereroense*, *Acacia nigrescens*, *Dichrostachys cinerea* subsp. *africana*, *Pterocarpus rotundifolius*, *Combretum collinum* subsp. *suluense*, *Lonchocarpus capassa*, *Combretum imberbe*, *Acacia gerrardii*, *Cassia petersiana*, *Grewia hexamita*, *Bolusanthus speciosus*, *Ormocarpum trichocarpum*, *Piliostigma thonningii*, *Combretum mossambicense* and *Dombeya rotundifolia*.

The field layer is dense and grasses such as *Setaria holstii*, *Hyparrhenia rufa*, *Cymbopogon excavatus*, *Themeda triandra*, *Setaria sphacelata*, *Urochloa mosambicensis* and *Panicum maximum* are present. Dominant forbs are *Helichrysum miconiifolium*, *Ipomoea papilio*, *Hypoxis rooperi*, *Desmodium lasiocarpum*, *Leonotis nepetifolia*, *Thesium resedoides*, *Corchorus trilocularis*, *Acalypha petiolaris* and *Vernonia oligocephala*. From this list of plants it can be concluded that the diabase community is very similar to the vegetation of Landscape 33.

The Levubu River forms the western boundary of the landscape. The riverine vegetation and that found on the banks of the larger spruits and around springs concurs with the description by Van Rooyen (1978) viz. the *Acacia albida*/*Ficus sycomorus*-river woodland which was discussed in detail under Landscape 28.

Fauna

This landscape accommodates a low density of larger mammals. Game species present are bushpig, bushbuck, kudu, nyala and grey duiker. Herds of buffalo are regularly encountered and elephant are present but in small numbers. Due to the low density of prey species, lion and other carnivores are scarce.

35. *Salvadora angustifolia* Floodplains

Location and Geomorphology

This landscape occurs along the lower Shingwedzi, Bububu, Mphongolo and Phugwane Rivers. As a result of the alluvium deposited on the banks of the above-mentioned rivers over the years, floodplains have developed that are periodically under water. However, what is important is that the material from the surrounding area is carried to the rivers and deposited on the banks before reaching the actual stream. The floodplains are flat to slightly concave.

The landscape is situated between 240 and 300 meters a.s.l. and it covers 133 km² or 0,7 percent of the area of the KNP.

Climate

This area receives between 450 and 500 mm of rain per year. The long term average for Shingwedzi, which falls in this landscape is 472 mm per year. Due to the con-

cave topography, moisture is more available than what is indicated by the rainfall. Temperature data for Shingwedzi is given in Table 6.

Soil Pattern

As a result of the accumulation of salts in the alluvium, the soils of this landscape are usually brackish. Dominant soil Forms are Valsrivier, Sterkspruit and Oakleaf. White salt deposits are sometimes detectable on the surface of the soil.

Vegetation

The vegetation of this landscape is unique in the respect that it is the only river system along which it occurs. It is a high tree savanna with a well developed shrub layer (Fig. 78). The field layer is very sparse and in some parts completely absent. The woody component of this landscape is dominated by *Colophospermum mopane* trees and shrubs and *Salvadora angustifolia* shrubs of \pm three metres high.

Other woody species which occur are *Adenium obesum*, *Euclea divinorum*, *Ximenia americana*, *Commiphora glandulosa*, *Thilachium africanum*, *Acacia tortilis*, *Grewia bicolor*, *Dichrostachys cinerea* subsp. *africana*, *Capparis tomentosa*, *Grewia monticola*, *Salvadora persica*, *Combretum mossambicense* and *Hyphaene natalensis*.

The field layer is weakly developed and bare patches frequently occur. Grass species which do occur are: *Urochloa mosambicensis*, *Panicum maximum*, *Sporobolus fimbriatus*, *Dactyloctenium aegyptium*, *Chloris virgata*, *Aristida congesta* subsp. *barbicollis*, *Tragus berteronianus*, *Chloris roxburghiana*, *Bothriochloa radicans*, *Schmidtia pappophoroides*, *Brachiaria xantholeuca*, *Enneapogon cenchroides*, *Oropetium capense* and *Chloris mossambicensis*.



Fig. 78. Landscape 35. *Salvadora angustifolia* Floodplains.

Forbs are very common in this community and the following are worth mentioning: *Commelina bengalensis*, *Abutilon guineense*, *Ruellia patula*, *Cyathula crista*, *Cyphocarpa angustifolia*, *Phyllanthus pentandrus*, *Portulaca kermessina*, *Hibiscus sidiiformes*, *Neuracanthus africanus*, *Abutilon austro-africanum*, *Sansevieria hyacinthoides*, *Amaranthes thunbergii*, *Pharnaceum elongatum*, *Ocimum americanum*, *Pupalia lappacea*, *Justicia flava*, *Elytraria acaulis*, *Asparagus plumosus* and *Portulaca quadrifida*.

The banks of the rivers are overgrown with high trees of which *Diospyros mespiliformis*, *Colophospermum mopane*, *Croton megalobotrys*, *Lonchocarpus capassa* and *Xanthocercis zambesiaca* are the most important. The conspicuous absence of *Trichelia emetica* in the Shingwedzi/Mphongolo-complex deserves mentioning.

Fauna

This landscape is the home of large herds of impala and a browse-line is often perceptible in the vegetation as a result of the presence of this game species. Waterbuck, kudu, buffalo and elephant are commonly found and even roan antelope are seen from time to time, usually on route to water. Quite a few herds of wildebeest stay on the bare patches in this environment and zebras are generally present. Baboons and monkeys are to be found along the rivers and carnivores such as lions and leopards occur regularly. Steenbok, duiker and nyala are present, while hippo and crocodile occur frequently in the rivers.

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REFERENCES

- ACOCKS, J.P.H. 1975. Veld Types of South Africa. *Mem. bot. Surv. S.Afr.* 40: 1-128.
- BRANDT, J.W. 1948. *Die Geologie van 'n gebied in Noordoos-Transvaal, met spesiale verwysing na die verspreiding en petrografie van die Rotsoorte van die Palabora-stollingskompleks*. D.Sc. thesis. Univ. of Stellenbosch.
- BRISTOW, J.W. 1980. *The Geochronology and Geochemistry of Karoo Volcanics in the Lebombo and adjacent areas*. Ph.D. thesis. Univ. of Cape Town.

- COETZEE, B.J. 1983. *Phytosociology, Vegetation Structure and Landscapes of the Central District, Kruger National Park, South Africa*. Dissertationes Botanicae, Cramer & Vaduz. 456 pp.
- CODD, L.E.W. 1951. Bome en Struik van die Nasionale Krugerwildtuin. *Mem. bot. Surv. S.Afr.* 26: 1-192.
- CLEVERLY, R.W. and J.W. BRISTOW. 1979. Revised Volcanic Stratigraphy of the Lebombo Monocline. *Trans. geol. Soc. S.Afr.* 82: 227-230.
- GERTENBACH, W.P.D. 1978. *Plantgemeenskappe van die Gabbro-kompleks in die noordweste van die Sentrale Distrik van die Nasionale Krugerwildtuin*. M.Sc. thesis. Univ. of Potchefstroom for CHE, Potchefstroom.
- GERTENBACH, W.P.D. 1980. Rainfall patterns in the Kruger National Park. *Koedoe* 23: 35-43.
- GERTENBACH, W.P.D. (*in prep.*) 'n Ekologiese studie van die suidelikste Mopanieveld en die belang van vuur in die Nasionale Krugerwildtuin. Project of the National Parks Board.
- GERTENBACH, W.P.D. and A.L.F. POTGIETER. 1979. Veldbrandnavorsing in die Struikmopanieveld van die Nasionale Krugerwildtuin. *Koedoe* 22: 1-28.
- HARMSE, H.J. VON M. and P. VAN WYK. 1972. Verkeningsgrondkaart van die Suidelike Distrik van die Nasionale Krugerwildtuin. Unpublished map. Univ. of Potchefstroom for CHE, Potchefstroom.
- HARMSE, H.J. VON M., P. VAN WYK and W.P.D. GERTENBACH. 1974. Verkeningsgrondkaart van die noordelike gedeelte van die Krugerwildtuin. Unpublished map. Univ. of Potchefstroom for CHE, Potchefstroom.
- JOUBERT, S.C.J. 1975. 'n Meesterplan vir die bestuur van die Nasionale Krugerwildtuin. Unpublished Report to the National Parks Board of Trustees.
- JOUBERT, S.C.J. 1976. The population ecology of the roan antelope *Hippotragus equinus equinus* (Desmarest, 1804), in the Kruger National Park. D.Sc. thesis. Univ. of Pretoria, Pretoria.
- JOUBERT, S.C.J. (*in prep.*) Aerial surveys in the Kruger National Park. Unpublished internal report. National Parks Board of Trustees.
- MACVICAR, C.J., D.M. SCOTNEY, T.E. SKINNER, H.S. NIEHAUS and J.H. LOUBSER. 1974. A classification of land (climate, terrain form, soil) primarily for rainfed agriculture. *S.A. Jour. Agric.* 3: 21-24.
- MACVICAR, C.N., R.F. LOXTON, J.J.N. LAMBRECHTS, J. LE ROUX, H.J. VON M. HARMSE, J.M. DE VILLIERS, E. VERSTER, F. R. MERRYWEATHER and T.H. VAN ROOYEN. 1977. Grondklassifikasie. 'n Binomiese sisteem vir Suid-Afrika. Department of Agricultural and Technical Services. Pretoria. 152 pp.
- NEWMAN, K. 1980. *Voëls van Suider-Afrika*. Deel 1. Krugerwildtuin. Johannesburg: Macmillan.
- OOSTING, H.J. 1956. *The Study of Plant Communities. An introduction to Plant Ecology*. San Francisco: W.H. Freeman.
- PIENAAR, U. DE V. 1963. The large mammals of the Kruger National Park — their distribution and present-day status. *Koedoe* 6: 1-37.

- PIENAAR, U. DE. V. 1978. *The Freshwater Fishes of the Kruger National Park*. National Parks Board of Trustees.
- PIENAAR, U. DE. V., I.L. RAUTENBACH and G. DE GRAAFF. 1980. *The Small Mammals of the Kruger National Park*. National Parks Board of Trustees.
- SCHUTTE, I.C. 1974. 'n Geologiese verkenningsopname van die Noord-Sentrale gedeelte van die Nasionale Krugerwildtuin. Pretoria: Geological Survey.
- SCHUTTE, I.C. 1982. Eerste verslag oor die geologie van die Suid-Sentrale gebied, Nasionale Krugerwildtuin, Pretoria: Geological Survey.
- SCHUTTE, I.C. and A.R. CLUBLEY-ARMSTRONG. 1982. Eerste verslag oor die geologie van die Suidelike gedeelte van die Nasionale Krugerwildtuin. Pretoria: Geological Survey.
- SMUTS, G.L. 1974. Game movement in the KNP and their relationship to the segregation of sub-populations and the allocation of culling compartments. *J. Sth. Afr. Wildl. Mgmt. Ass.* 4(1): 51-58.
- VAN DER SCHIJFF, H.P. 1957. *Ekologiese Studie van die Flora van die Nasionale Krugerwildtuin*. Deel 1. D.Sc. thesis. Univ. of Potchefstroom for CHE, Potchefstroom.
- VAN ROOYEN, N. 1978. 'n *Ekologiese Studie van die Plantgemeenskappe van die Punda Milia-Pafuri-Wambiyagebied in die Nasionale Krugerwildtuin*. M.Sc. thesis. Univ. of Pretoria, Pretoria.
- VAN WYK, P. 1973. *Bome van die Nasionale Krugerwildtuin* Deel I en II. Johannesburg: Perskor.
- VENTER, F.J. 1981. *Grondtipes van die Swenispruit-Opvanggebied*. M.Sc. thesis. Univ. of Potchefstroom for CHE, Potchefstroom.
- WEBBER, N.W. 1979. *The effects of fire on Soil/Plant Ecological relationships in the southern part of the Kruger National Park. A study in soil geography*. M.Sc thesis. UNISA, Pretoria.